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- G** Funds Collection

# Non-Invasive and Minimally Invasive Imaging Evaluation of CSF Rhinorrhoea – a Retrospective Study with Review of Literature

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**Background:**

Localization of a cerebrospinal fluid [CSF] fistula is a diagnostic challenge. The choice of an optimal imaging technique is necessary to locate the site of CSF leak which is required for surgical/endoscopic repair of the CSF fistula.

**Material/Methods:**

Retrospective analysis of imaging was performed in 33 patients who presented with symptoms suggestive of CSF rhinorrhoea over a period of two years. Either a bone defect on high resolution CT [HRCT] or CSF column extending extracranially from the subarachnoid space with or without brain/ meningeal herniation on magnetic resonance [MR] cisternography was considered positive for CSF leak. The MR imaging technique included 1-mm heavily T2-weighted [TR 2000 ms; TE-200 ms] fast spin echo study in coronal and sagittal planes. HRCT sections involved 0.625 to 0.8-mm sections in the coronal plane, with or without axial planes, through the paranasal sinuses, reconstructed in a sharp algorithm and acquired with the patient in prone position. Imaging findings were compared with endoscopic findings, being the gold standard for the assessment of CSF rhinorrhoea.

**Results:**

A total of 25 patients had a combination of HRCT and MR cisternography. The sensitivity, specificity, positive predictive value [PPV] and negative predictive value [NPV] of both MR cisternography and HRCT together were 93%, 100%, 100% and 50% respectively. Two patients underwent only MR cisternography, 5 patients underwent only HRCT and one patient underwent HRCT, MR cisternography and CT cisternography. Though PPV was 100% in the groups with HRCT alone, MR cisternography alone and combined CT cisternography, HRCT and MR cisternography, the results were not statistically significant as the number of patients in those groups was lower.

**Conclusions:**

Combination of MR cisternography and HRCT appears to be complementary, accurate and non-invasive and should be considered as optimal imaging modality for pre-op imaging in the evaluation of CSF rhinorrhoea.

**MeSH Keywords:**

**Cerebrospinal Fluid Rhinorrhea • Magnetic Resonance Imaging • Multidetector Computed Tomography**

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<http://www.polradiol.com/abstract/index/idArt/895698>

## Background

Cerebrospinal fluid [CSF] rhinorrhoea results from a direct communication between the subarachnoid space and the nasal cavity or the mucosalized space of the paranasal sinuses. Factors like osseous defect, disruption of arachnoid and dura, CSF pressure gradient greater than healing tensile strength of disrupted tissue lead to separation of dural

fibres and CSF leakage. The complications involved in CSF fistulas are such that the fistulas open a path for spread of pathogens, causing meningitis and creating a route for development of pneumocephalus and secondary brain compression.

Localisation of a CSF fistula is a diagnostic challenge. An optimal imaging technique which would precisely locate

**Table 1.** Distribution of patients in relation to the treatment options.

Site of fistula	No: of defects
Cribriform plate	16
Lateral lamella	2
Junction of fovea and cribriform plate	1
Posterior wall of frontal sinus	1
Lateral recess of sphenoid	1

the site of CSF leak is required prior to surgical/endoscopic repair of the CSF fistula [1]. The main objective of the study was to evaluate the role of non-invasive imaging modalities in the pre-op assessment of CSF rhinorrhoea.

**Material and Methods**

The study was carried out in a tertiary university hospital in South-East Asia. We retrospectively analysed the results of imaging on 33 patients who presented with symptoms suggestive of CSF rhinorrhoea to the ENT department over a period of two years. Magnetic resonance [MR] cisternography and high resolution CT [HRCT] were used in combination or alone for the evaluation of CSF rhinorrhoea. The MR imaging technique included contiguous 1-mm heavily T2-weighted [TR 2000ms;TE-200ms] fast spin echo study in coronal and sagittal planes, with no interslice gap. High-resolution 0.625 to 0.8-mm CT sections in coronal plane, with or without axial planes, were obtained through the paranasal sinuses, with the patient in a prone position and reconstructed in a sharp algorithm. In one patient, CT cisternography was also done by instillation of 5 mL of non-ionic iodinated contrast into the thecal sac via lumbar puncture and then placing the patient in Trendelenburg position to distribute the contrast into the basal cisterns. Prior to CT, patient can be advised to do some manouvers that can promote active CSF leak, like lying prone or valsalva etc. No complications were documented in our patient.

Imaging characteristics that were considered diagnostic of CSF leak were:

- a CSF column extending extracranially from the subarachnoid space on MRI;
- herniation of brain tissue/meninges extracranially on MRI;
- a bone defect on CT with air communicating from the paranasal sinuses intracranially;
- a bone defect on CT with contiguous CSF opacification of the paranasal sinus or nasal cavity;

- a bone defect on CT cisternography with contrast opacification of the paranasal sinus or nasal cavity.

The distribution of patients who underwent various imaging modalities is shown in Table 1.

**Results**

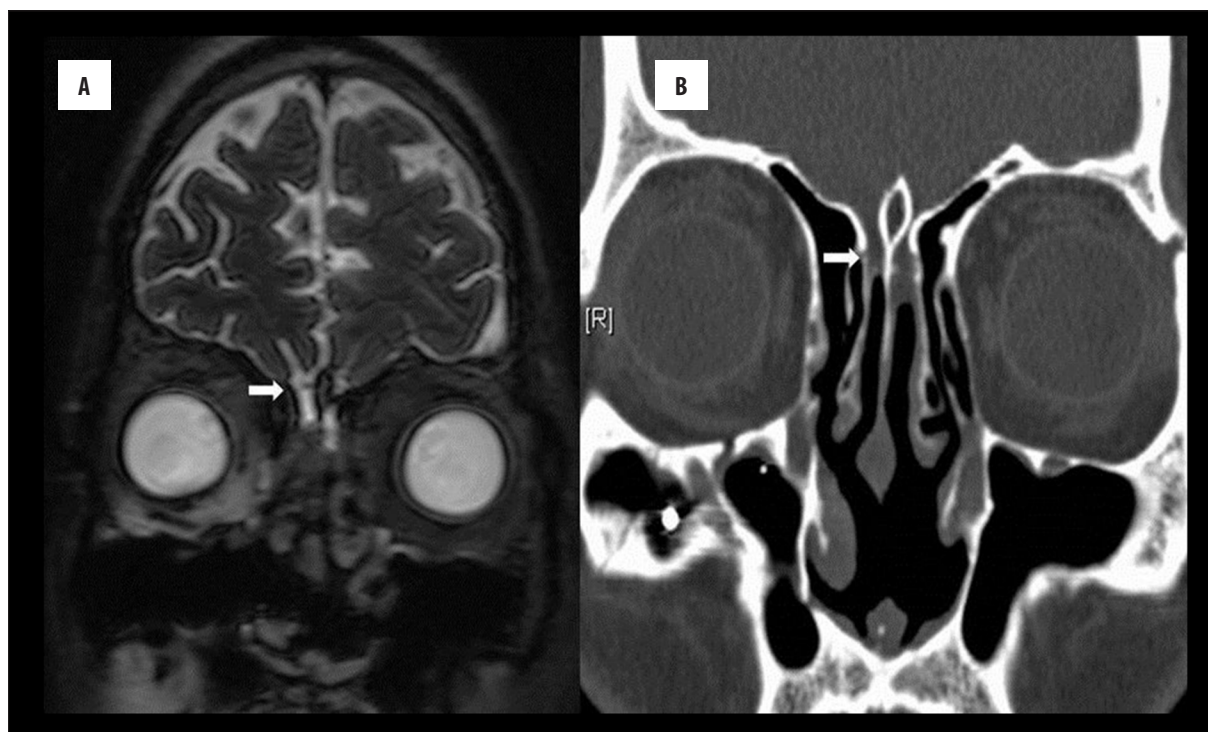
Of the 33 patients who were included in the study, 17 were females and 16 were males. Among the patients, only 3 patients were children [2 boys and 1 girl], others were in the age group ranging from 23 to 54 years. The HRCT, MR cisternography and CT cisternography findings were correlated with the endoscopic findings. In our study, 21 patients underwent endoscopic repair of CSF fistulas and the remaining 12 were managed conservatively. The various sites of CSF fistulas as per endoscopic findings are mentioned in Table 2. The most common site of CSF leak was in the cribriform plate (Figures 1, 2) as reported in other studies [2]. Two defects were noted in the lateral lamella, one defect each were noted at the junction of the fovea ethmoidalis and cribriform plate, posterior wall of the frontal sinus (Figure 3) and lateral recess of the sphenoid sinus (Figure 4). Meningocele was seen in one patient (Figure 5). Distribution of CSF leak based on etiology is given in Table 3. The various causes of CSF rhinorrhoea encountered in our study included spontaneous, traumatic, post-FESS and post-meningitis sequelae.

A total of 25 patients underwent both HRCT and MR cisternography. However, 8 patients did not have endoscopy because in 6 of them there was no defect either in one or in both modalities and in 2 patients the endoscopy was not done due to patient-related reasons, though there was a defect in both modalities. Out of 17 patients who had endoscopy, 16 patients had a fistula and one patient had no fistula, as was reported in both MR cisternography and CT. In 13 patients the defect was seen in both modalities which was confirmed on endoscopy as well. In 2 patients, only one of the modalities detected a defect; however, the combined positive findings led the surgeons to do endoscopy which was found to be positive. In one patient, no defect was found in either of two modalities but there was a defect in endoscopy. Therefore, the sensitivity, specificity, positive predictive value [PPV] and negative predictive value [NPV] of both MR cisternography and HRCT together were 93%, 100%, 100%, and 50%, respectively.

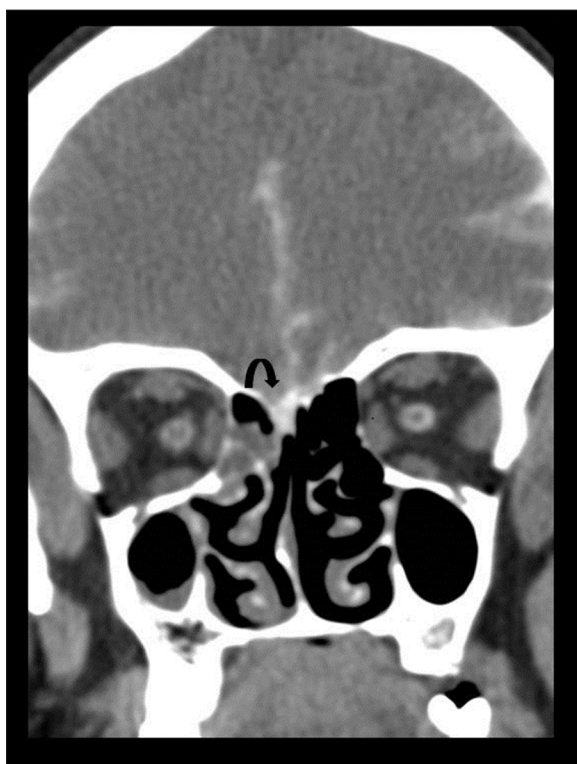
Five patients underwent HRCT only. All the patients had defects on CT, but only 3 underwent endoscopy which showed the defect. In the remaining 2 patients, endoscopy was not performed. Hence PPV was 100%, but the sensitivity,

**Table 2.** Distribution of CSF fistulas based on the site of involvement as per endoscopic findings.

MR cisternography + HRCT	16	9	25
HRCT alone	3	2	5
MR cisternography	1	1	2
CT cisternography + MR cisternography + HRCT	1	0	1
<b>Total</b>	<b>21</b>	<b>12</b>	<b>33</b>



**Figure 1.** (A, B) Defect in the right cribriform plate with CSF leak.



**Figure 2.** CT cisternography shows contrast leak through the right cribriform plate [black curved arrow].

specificity and NPV could not be assessed. The radiation dose of HRCT studies ranged from 300 to 350 mGycm.

Two patients underwent MR cisternography only. Just one patient had CSF leak, which was positive on endoscopy

as well. In the other patient, no CSF leak was found and endoscopy was not performed either. Thus PPV for MR cisternography was 100%, but again, the sensitivity, specificity and NPV could not be calculated as endoscopy was not done in all patients.

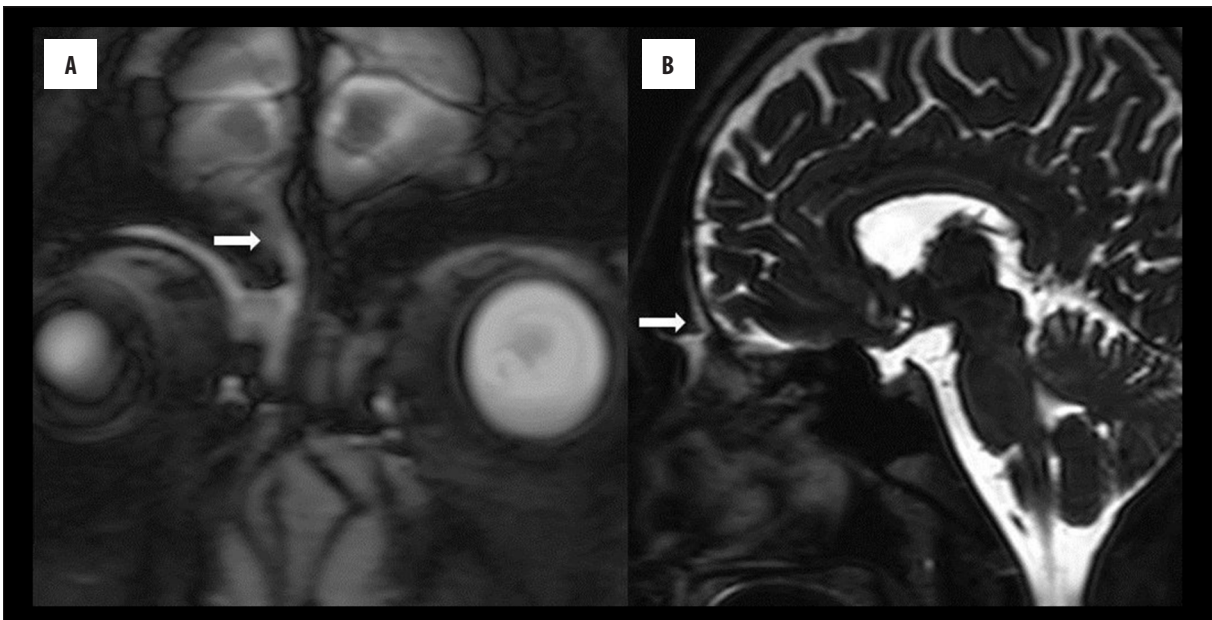
One patient underwent HRCT, MR cisternography and CT cisternography. The defect which was found on imaging in all three modalities, was confirmed on endoscopy as well. No complications were encountered following CT cisternography. The radiation dose was 306 mGycm.

Though positive predictive value was 100% in the groups with HRCT alone, MR cisternography alone and combined CT and MR cisternography, the results were not statistically significant as the number of patients in those groups was lower. The sensitivity, specificity and NPV cannot be commented on in those groups either, as endoscopy was not done in all the patients in the groups with HRCT and MR cisternography alone. The group with MR cisternography and CT cisternography had only one patient.

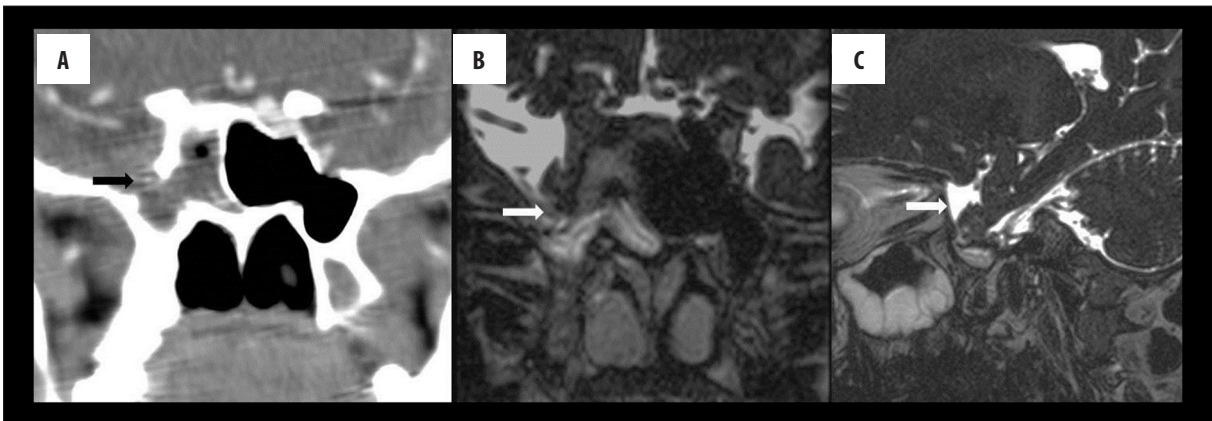
Table 4 compares the sensitivity, specificity, positive and negative predictive value of the present study with previously published data in the literature.

## Discussion

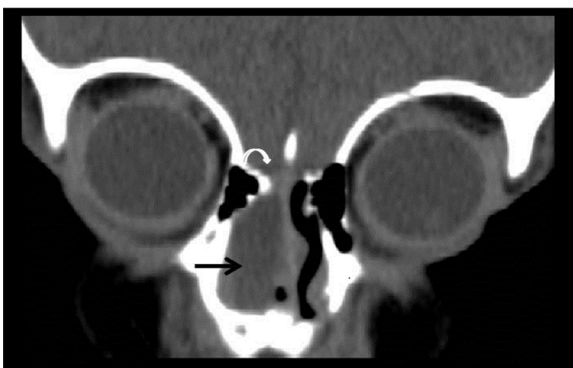
As endoscopic endonasal surgery has replaced open transcranial surgery for the management of CSF rhinorrhoea, accurate pre-operative localisation of the CSF leak is very important. Some of the reasons for the preference of endoscopic surgery include better success rate, low complication rate, improved cosmetics and olfactory preservation [3–5].



**Figure 3.** (A, B) Coronal and sagittal MR cisternogram shows CSF leak through the posterior wall of the right frontal sinus [white arrow]



**Figure 4.** (A) HRCT showing the bony defect at the right lateral recess of the sphenoid sinus [black arrow]. (B, C) MR cisternogram depicting the CSF leak through the right lateral recess of the sphenoid sinus.



**Figure 5.** Defect in the right cribriform plate [white curved arrow] with a meningocele [black arrow] in the right nasal cavity.

In the past, various techniques have been used to detect CSF leaks, but, each had their own limitations to accurately determine the site of leak. Those procedures included plain skull radiography, intra-operative injection of fluorescein dye and radionuclide cisternography [6].

**Table 3.** Distribution of CSF fistulas based on etiology.

Etiology	No: of
CSF fistulas	16
Spontaneous	15
Traumatic	3
Post FESS related	2
Post meningitis sequelae	2

CT cisternography was considered to be the procedure of choice for detection of CSF fistula in the past. However, it is invasive, time-consuming and less patient-compliant. There is also a risk of potential complications like meningitis. MR cisternography is a non-invasive technique that can detect a CSF fistula by the inherent bright signal of CSF on heavily T2-weighted images. HRCT sections are helpful in depicting the bony defect. In our study the accuracy of

**Table 4.** Review of previous literature on non-invasive evaluation of CSF rhinorrhoea

Previously published data with the present study	Total patients/ No. of years of study		Non-enhanced MR cisterno- graphy	Gadolinium- enhanced MR cisternography	HRCT	MR [non- enhanced] cisternography + HRCT	CT cisterno- graphy
Shetty et al.	35 [3 years]	Sensitivity	87		92	95	
		Specificity	100		100	100	
		Accuracy	93		93	96	
Mosafa et al.	20	Sensitivity	88.88		88.25	89.74	
		Accuracy	90		89.5	89.47	83.3
Ragheb et al.	24	Sensitivity		95.6	65.2		
		Specificity		100	33		
		Accuracy		95.8	61.5		
Algin et al.	17 (5 years)	Sensitivity	76	100	88		
Schuknecht et al.	27						
Present study	25 – MR cisternography + HRCT 5 – HRCT alone 2 – MR cisternography 1 – CT cisternography + MR cisternography	Sensitivity				93	
		Specificity				100	
		Positive predictive value	100		100	100	100
		Negative predictive value				50	

combination of MR cisternography with HRCT was 81%. We recommend the combined use of HRCT and MR cisternography for increasing the efficacy in detecting the CSF leak site.

The sensitivity of unenhanced MR cisternography, gadolinium-enhanced MR cisternography and HRCT in a study carried out on 17 patients by Algin et al. [7] was 76%, 100%, and 88%, respectively.

Mostafa et al. [8] used a similar combination of techniques with an accuracy of 89.47%. CT metrizamide cisternography accurately detected the leak in 10 out of 12 patients. CT cisternography, although considered a reference standard, has a low acceptance rate as it is an invasive procedure with potential complications.

MR cisternography using intra-theal gadolinium was performed by Ragheb et al. [9] in 24 patients with an accuracy of 95%. Although intra-theal administration of gadolinium is not FDA approved, other studies in Europe have shown that there are no serious side effects. We did not have any patients in whom intrathecal gadolinium was injected.

Shetty et al. [4] used a combination of HRCT and MR cisternography in 35 patients and that was 100% specific and 96% accurate. In our study, the overall accuracy of imaging modalities was 95%. The positive predictive value was 100% in HRCT alone, unenhanced MR cisternography

alone, CT cisternography and in combined HRCT and MR cisternography. As found in the study by Shetty et al., combined HRCT and MR cisternography was 100% specific in our study as well.

Though there are recommendations to consider CT cisternography as the investigation of choice for CSF rhinorrhoea [10], its minimally invasive nature and possible complications make it second best to a combination of MR cisternography and HRCT which are non-invasive studies. Another advantage of using a combination of MR cisternography and HRCT is that it increases the specificity and accuracy. CT cisternography is recommended only as a last resort and preferably with a nasal pledget to avoid missing slow leaks.

## Conclusions

MR cisternography with heavily T2W MRI images and high-resolution CT appear to be complementary, accurate and non-invasive modalities to localise the site of CSF leak prior to surgery. Hence, a combination of these two should be considered as an optimal pre-op imaging tool in the evaluation of CSF rhinorrhoea. In addition to imaging the nasal cavity and paranasal sinuses, the ears should also be imaged to identify patients with perilymph leak or CSF leak into the middle ear, who may present with CSF rhinorrhoea.

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