EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

Volume-2 | Issue-4 |Jul-Aug-2020 | DOI: 10.36349/EASJRIT.2020.v02i04.002

OPEN ACCESS

Research Article

Comparative retrospective study of HRCT, CT Cisternography and MRI in evaluation of CSF Leak

Dr. Dimple Bhatia[1] and Dr. Nagaraj Murthy*[2]

[1] Assistant Professor Department of radio diagnosis, CMC Medical College, Ludhiana, India
[2] Professor & HOD, Department of Radiology, JSSAHER, Mysore

Article History
Received: 10.08.2020
Accepted: 25.08.2020
Published: 30.08.2020

Journal homepage:
https://www.easpublisher.com/easjrit

Quick Response Code

Abstract: ***Background:*** Localizing and repairing CSF leaks needs robust radiological work up. HRCT & CT Cisternography are the routinely used investigations, sometimes complimented with heavily T2W MRI in localizing the bony / dural defects. The sensitivity and specificity of HRCT, CT Cisternography and MRI needs further validation. ***Aims & objectives:*** To evaluate the utility of HRCT, CT Cisternography and MRI, individually and in combination, in localizing CSF fistula and compare the results with intra-operative findings. ***Materials and Methods:*** Retrospective evaluation of radiological procedures of 40 patients with clinically suspected CSF rhinorrhea / otorrhea was carried out in JSS hospital, JSSAHER Mysore. HRCT was done in all 40 patients, while CT cisternography in 38 patients and MRI in only 18 patients. Endoscopic evaluation / repair were carried out on 38 patients and was used as gold standard for statistical analysis. ***Results:*** Among 40 patients evaluated for CSF leak by radiological imaging, total of 38 patients underwent surgical / endoscopic exploration. Most common presenting symptom was CSF rhinorrhoea with cribriform plate and lateral lamella showing maximum number of defects. Sensitivity and specificity of imaging techniques improved significantly when used in combination. ***Conclusion****:* HRCT of skull base is simple, fast, noninvasive and cost effective choice of examination in the workup of CSF leak. However when used in adjunct with CSF cisternography and heavily T2W MRI the accuracy improves significantly, justifying the additional efforts and cost.

Keywords: Rhinorrhea, CT Cisternography, HRCT of olfactory fossa, MR Cisternography.

INTRODUCTION

CSF leak can present in two main forms depending on site of leakage, CSF rhinorrhea or CSF otorrhea (Aarabi, B., & Leibrock, L. G. 1992).

Based on etiology, CSF leakage can be categorised as traumatic, non- traumatic and spontaneous. Traumatic causes can be iatrogenic or non-iatrogenic. Non traumatic variety includes congenital developmental defects such as meningocele & meningo-encephalocele or intracranial tumors causing erosion of skull base / obstructive hydrocephalus with resultant CSF leak. Spontaneous CSF leaks are predominantly seen in obese middle aged females, attributed to idiopathic intra-cranial hypertension (Schlosser, R. J., & Bolger, W. E. 2002).

Beta-2 transferrin is a reliable marker of CSF leak in evaluation of nasal/otologic secretions (Bachmann, G., & Michel, O. 2000). Radio-nucleotide Cisternography was also being used to determine leakage by intrathecal administration of radiotracer Tc-99. The activity of radiotracer in nasal cavity/ nasopharynx suggested active leak.

The disadvantage of the above tests are lack of anatomical details / bone defect characterization owing to which HRCT & CSF Cisternography emerged as the routine choice of investigation (Lund, V. J. *et al.*, 2000). MRI Cisternography can compliment further assessment of CSF leak in detection of congenital skull base defects and brain parenchymal herniation through the defects (Connor, S. E. J. 2010).

MATERIALS AND METHODS

It is a retrospective study conducted in JSS hospital, JSSAHER, Mysore between June 2017 & June 2019, which included 40 clinically suspected cases of CSF leak whose nasal / aural secretions turned positive for Beta-2 transferrin. All 40 patients underwent HRCT, while CT Cisternography was possible only in 38 patients and two were not fit for the procedure. HRCT of skull base including the temporal bones were

***Corresponding Author:** Dr. Nagaraj Murthy

acquired in the axial plane and multiplanar images were obtained in bone reconstruction algorithm.

CT cisternography was performed under aseptic precautions, lumbar puncture was done at L3-L4 level and 15 ml of iodinated contrast medium was injected intra-thecaly. Trendelenburg position was maintained for 30 minutes and CT PNS was acquired in prone position. Maneuvers that provoke an active leak, such as head hanging or sneezing were performed to visualize intermittent or occult leaks. Heavily T2 weighted images in coronal and sagittal planes were obtained in 3T MRI equipment in 18 patients who were cooperative.

CT cisternography images were compared with the HRCT image to look for bone defect and the CSF leaks. Continuous column of CSF or lobular non dependent soft tissue herniation through the defect into sinonasal cavity on CSF cisternography and MR sequences were considered positive. Out of the 40 patients, 38 underwent endoscopic exploration and repair. The imaging findings were compared with the post operative findings to evaluate the accuracy.

RESULTS

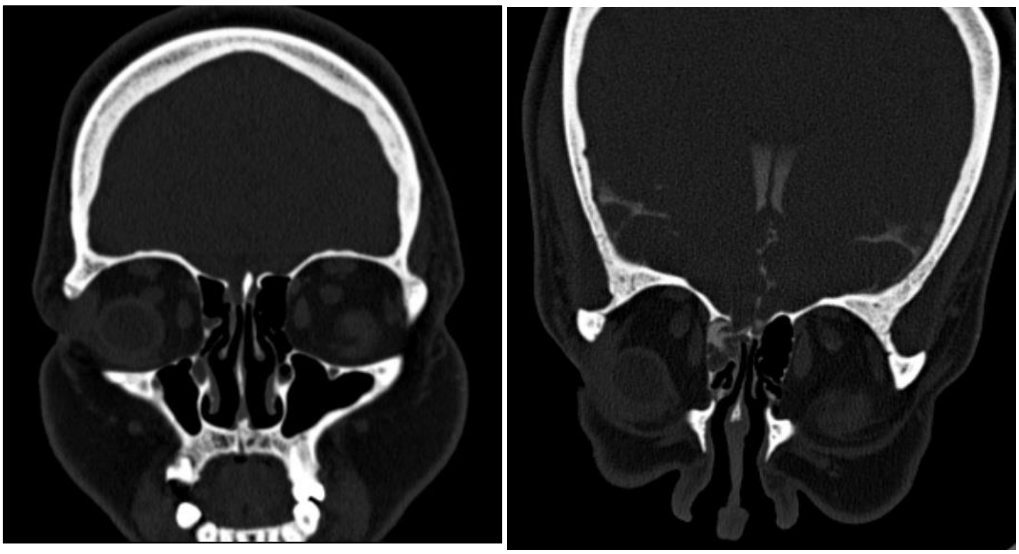

Figure 1: Shows bony defect in right lateral lamella with extravasation of contrast through the bony &dural defect into left ethmoidal air cells.

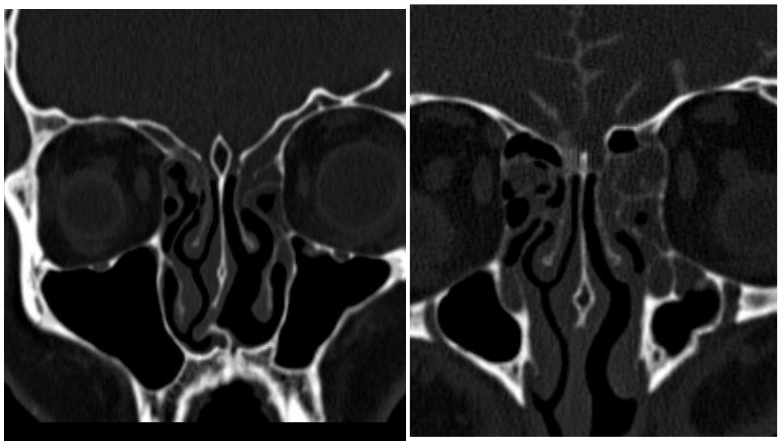

Figure 2: Demonstrates fracture in the right cribriform plate with extravasation of contrast through the osseodural defect into right ethmoidal air cells.

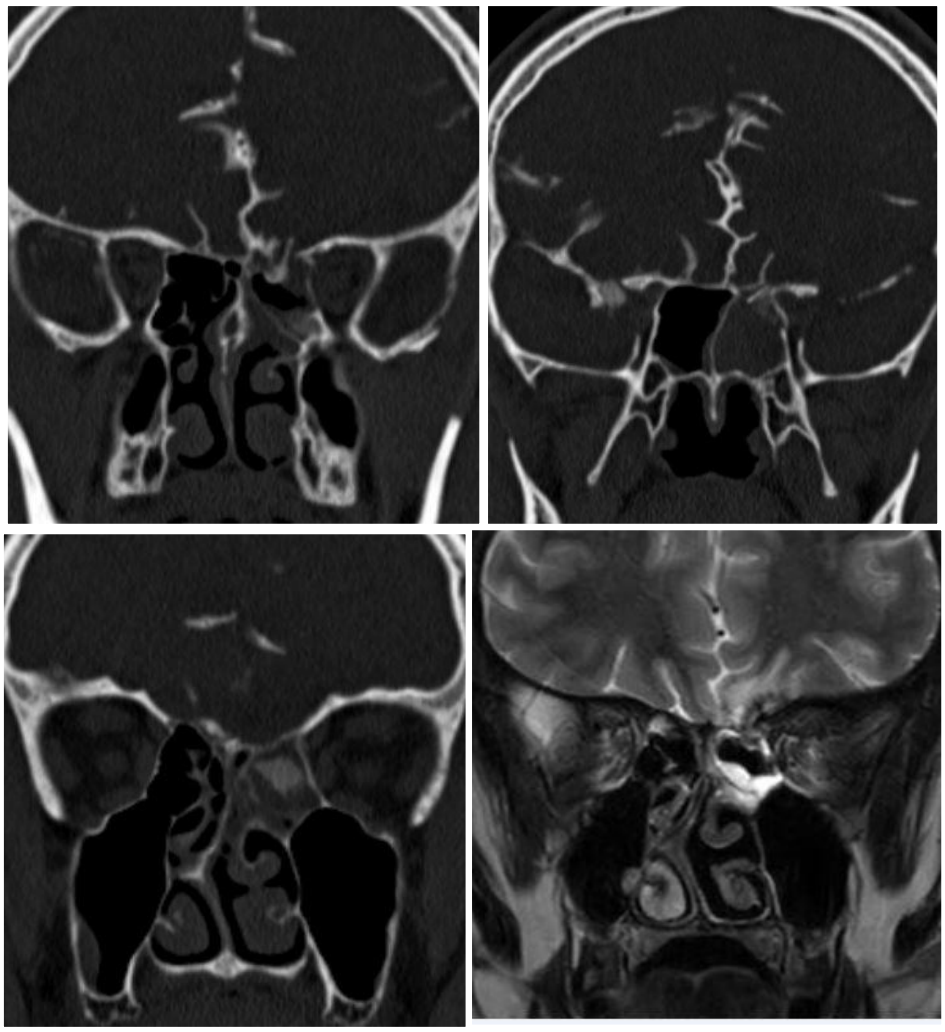

Figure 3: CSF cisternogram coronal images show bony defect in the ethmoidal and sphenoid roof with CSF leak opacifying the ethmoid and sphenoid sinuses. T2 W MRI sequence show stalk of brain parenchyma herniating through the defect with gliotic changes in the frontal lobe consistent with post traumatic ethmoid encephalocele.

Table. 1: Demonstrates distribution of CSF fistula on various imaging techniques with post -operative correlation.

Investigations	Numbers	True positive	False positive	True negative	False Negative	Operative confirmation
HRCT	38	31	1	3	3	38
CT Cisternogram	38	32	1	3	2	38
Heavily T2 weighted MRI	18	14	2	1	1	18
HRCT+ CT Cistenogram	38	33	1	3	1	38
HRCT+ Heavily T2 weighted MRI	18	15	1	2	0	18

Table. 2: Shows the sex distribution diagnosed with CSF leak.

Sex	Number
Female	17
Male	21

In total of 38 cases, 21 male patients and 17 females were diagnosed with positive findings of CSF fistula.

Table. 3: Shows the presenting symptoms of CSF fistula.

Finding	Numbers
CSF Rhinorrhea	36
CSF Otorrhea	1
BOTH	1

The nasal or ear discharge were sent for beta transferrin activity to confirm clinical diagnosis of CSF in the secretions. Most common presentation was found out to be CSF rhinorrhea.

Table. 4: Demonstrates etiological factors of CSF fisulta.

Cause	Numbers
Trauma	32
Iatrogenic	1
Spontaneous	3
Congenital	2

The underlying etiology seen in 32 cases of CSF fistula was post traumatic considering it the most common cause of leak and congenital meningoencephalocele was seen in two cases. Spontaneous variety comprised of cases with bone defect and CSF leak in absence of any underlying etiology.

Table.no.V: Demonstrates site of bone defect leading to CSF Leak.

Site of leak	Numbers
Cribriform plate	25
Lateral lamella	4
Sphenoid & parasellar region	2
Ethmoid roof	3
Frontal bone	3
Cribriform + Tegmen	1

The most common site of bone defect depicted on CT was cribriform plate seen in 25 cases. The minimum bone defect measured was 1mm.

Total of 40 Beta-2 transferrin positive patients were selected for the study, all of whom underwent HRCT imaging of skull base and exploratory endoscopy was carried out on 38 patients and were included in the statistical analysis. All the 38 patients underwent CT cisternography and 18 underwent heavily T2W MR imaging.

HRCT depicted bone defect with indirect signs of CSF leak in 31 patients positively as verified on endoscopy. While 3 patients were found to have dural defect on endoscopy, which HRCT failed to demonstrate. No bone defect was found in 1 patient on endoscopy with positive finding on HRCT. Sensitivity of HRCT alone in detecting the CSF leak was 91.18% and specificity was 75%.

Among the 38 patients who underwent CT cisternography, CSF leak was detected in 32 patients and failed to do so in 2 patients. Out of the other 5 patients who were negative for CSF leak on CT cisternography, 3 were confirmed to have no defects on endoscopy and defect was found in 2 patients, which was not picked up by CT cisternography, probably due to intermitted leak. Sensitivity of CT cisternography alone in detecting the CSF leak was 94.12% and specificity was 75%.

Heavily T2W MRI was possible only in 18 patients, who were capable of lying down for long periods of time in MRI gantry in prone position. Out of the 18, 14 patients had positive correlation on endoscopy, while no defect was found in 2 patients. True negative and false negative correlation was noted in one case each. Sensitivity of heavily T2W MRI alone in detecting the CSF leak was 93.33% and specificity was 33.33%.

When two of the above modalities were utilized in evaluating the site of leak the sensitivity and specificity increased significantly. HRCT & CT cisternography combined revealed sensitivity of 97.06% and specificity of 75% while HRCT in combination with heavily T2W MRI had 100% sensitivity. However the specificity of HRCT and heavily T2W MRI together remained low at 66.67%.

DISCUSSION

CSF leak is due to communication of subarachnoid space with pneumatized structures within the skull base via an osseo-dural defect. Leak can be secondary to traumatic / non-traumatic causes or may be entirely spontaneous with no identifiable cause (Goddard, J. C. *et al.*, 2010).

Radio-nucleotide Cisternography was a popular method of diagnosing CSF leak during 1970's and 1980's. Due to its inability to localize and characterize the defect, other techniques have emerged (Glaubitt, D. *et al.*, 1983). Multi-detector HRCT scanning for CSF leak has emerged indispensable for demonstrating bone defect and necessary for planning surgical technique (Gürkanlar, D. *et al.*, 2007). Positive findings may also include air-fluid level in the contiguous sinus or opacification. Lobular non-

dependent soft tissue opacity through a bone defect can be observed in cases of meningocele, meningo-encephalocele and encephalocele. Some times pneumocephalus can also indicate CSF leak (Meco, C., & Oberascher, G. 2004).

Spontaneous CSF leak is result of multi-factorial process involving elevated intracranial pressure, thinning of the skull base structures as result of prominent arachnoid villi in abnormal locations or herniation of dura and brain parenchyma via congenital bony defects (Woodworth, B. A. *et al.*, 2008). Heavily T2 weighted MR Imaging plays an important role in evaluation of such fistula due to its excellent anatomic resolution demonstrating CSF column in cases of active/ intermittent leak and non ionizing nature (Goel, G. *et al.*, 2007).

The most common presenting site of CSF leak in our study was cribriform plate followed by lateral lamella. Same was described in study by Shetty *et al.,*. Where the most common site of CSF fistula was cribriform plate followed by junction of cribriform plate and fovea ethmoidalis (Shetty, P. G. *et al.*, 1998).

The study by Shetty *et al.,*, HRCT showed an accuracy of 92%, sensitivity of 92% and specificity of 100% as opposed to MR Cisternography where the accuracy, sensitivity, and specificity were 89%, 87%, and 100% respectively. Reported combined sensitivity of both HRCT and MR was 95%.

In a study by Mostafa, combined sensitivity of HRCT and MR Cisternography was 89.74% whereas for HRCT and MRI alone was 88.25% and 90% respectively. HRCT is an inevitable screening tool for assessing bone details (Mostafa, B. E., & Khafagi, A. 2004).

Robinson Vimala *et al.,*. found sensitivity, specificity and accuracy for combined use of HRCT and MR Cisternography 93%, 100% and 81% respectively recommending over CSF Cisternography owing to its invasive nature and associated complications (Vimala, L. R. *et al.*, 2016). All these studies and study by Eljazzar *et al.*, advocated that combined use of HRCT and MRI increase the sensitivity, hence prove promising in imaging CSF leak (Vimala, L. R. *et al.*, 2019).

Review of literature	Modality	Sensitivity	Specificity	Accuracy
Tahir *et al.*, (2019)	HRCT	48%	45%	
	CTC	100%	93%	
	MRI	61.1%	66%	
Raghe*bet al.*, (2011)	HRCT	33%	65%	61%
	MRC	100%	95.65%	95.83%
Shetty *et al.*, (1998)	HRCT	92%	100%	93%
	MR	87%	100%	89%
	HRCT +MR	95%	100%	96%
Mostafa, B. E., & Khafagi, A. (2004)	HRCT	88.25%		
	MRI	88.88%		
	HRCT +MRI	89%		
Vimala *et al.*, (2016)	HRCT+MRC	93%	100%	81%
Present study	HRCT	91.18%	75%	89.47%
	CTC	94.12%	75%	92.11%
	MRI	93.33%	33.33%	83.33%
	HRCT + CTC	97.06%	75%	94.74%
	HRCT + MRI	100%	66.67%	94.44%

While in our study the sensitivity, specificity and accuracy of HRCT alone was 91.18%, 75% and 89.47% respectively. But when combined with CT cisternography sensitivity increased to 97.06% and accuracy to 94.74%, while specificity remained unchanged at 75%. While the combination of HRCT & MRI was used the sensitivity and accuracy improved to 100% and 94.74% respectively, but the specificity dropped to 66.67%. HRCT alone is less sensitive or accurate as compared to the combination of HRCT + CT cisternography or HRCT +MRI. However there was no improvement in specificity. The drop in specificity when MRI was used in conjunction with HRCT may be attributed to higher rates of false positives in MRI. MRI alone has a very poor specificity in our study at 33.33%. Hence our study advocates HRCT & MRI for routine evaluation of CSF leak and CT cisternography only when absolutely required owing to its invasive nature.

CONCLUSION

Various imaging techniques have been used in the diagnosis of CSF leak with CSF Cisternography being the standard reference technique for preoperative planning. Being invasive in nature with associated complications such as headache, meningitis and bleeding etc and not being useful in cases of intermittent leak, HRCT base of skull becomes mainstay investigation to assess osseo-dural defect and anatomic details. MR Cisternography/ CSF cisternography can be used as an adjunct to HRCT if

necessary in cases of spontaneous fistula or multiple fractures.

REFERENCES

1. Aarabi, B., & Leibrock, L. G. (1992). Neurosurgical approaches to cerebrospinal fluid rhinorrhea. *Ear, nose & throat journal*, *71*(7), 300-305.
2. Bachmann, G., & Michel, O. (2000). Clinical experience with beta-trace protein as a marker for cerebrospinal fluid. *Annals of Otology, Rhinology & Laryngology*, *109*(12), 1099-1102.
3. Connor, S. E. J. (2010). Imaging of skull-base cephalocoeles and cerebrospinal fluid leaks. *Clinical radiology*, *65*(10), 832-841.
4. Eljazzar R, Loewenstern Eljazzar, R., Loewenstern, J., Dai, J. B., Shrivastava, R. K., & Iloreta Jr, A. M. (2019). Detection of cerebrospinal fluid leaks: is there a radiologic standard of care? A systematic review. *World Neurosurgery*, *127*, 307-315.
5. Eljazzar, R., Loewenstern, J., Dai, J. B., Shrivastava, R. K., & Iloreta Jr, A. M. (2019). Detection of cerebrospinal fluid leaks: is there a radiologic standard of care? A systematic review. *World Neurosurgery*, *127*, 307-315.
6. Glaubitt, D., Haubrich, J., & Cordoni-Voutsas, M. (1983). Detection and quantitation of intermittent CSF rhinorrhea during prolonged cisternography with 111In-DTPA. *American Journal of Neuroradiology*, *4*(3), 560-563.
7. Goddard, J. C., Meyer, T., Nguyen, S., & Lambert, P. R. (2010). New considerations in the cause of spontaneous cerebrospinal fluid otorrhea. *Otology & Neurotology*, *31*(6), 940-945.
8. Goel, G., Ravishankar, S., Jayakumar, P. N., Vasudev, M. K., Shivshankar, J. J., Rose, D., & Anandh, B. (2007). Intrathecal gadolinium-enhanced magnetic resonance cisternography in cerebrospinal fluid rhinorrhea: road ahead?. *Journal of neurotrauma*, *24*(10), 1570-1575.
9. Gürkanlar, D., Akyuz, M., Acıkbas, C., Ermol, C., & Tuncer, R. (2007). Difficulties in treatment of CSF leakage associated with a temporal meningocele. *Acta neurochirurgica*, *149*(12), 1239–1242.
10. Lund, V. J., Savy, L., Lloyd, G., & Howard, D. (2000). Optimum imaging and diagnosis of cerebrospinal fluid rhinorrhoea. *Journal of laryngology and otology*, *114*(12), 988-992.
11. Meco, C., & Oberascher, G. (2004). Comprehensive algorithm for skull base dural lesion and cerebrospinal fluid fistula diagnosis. *The Laryngoscope*, *114*(6), 991-999.
12. Mostafa, B. E., & Khafagi, A. (2004). Combined HRCT and MRI in the detection of CSF rhinorrhea. *Skull Base*, *14*(3), 157.
13. Ragheb, A. S., Mohammed, F. F., & El-Anwar, M. W. (2014). Cerebrospinal fluid rhinorrhea: Diagnostic role of gadolinium enhanced MR cisternography. *The Egyptian Journal of Radiology and Nuclear Medicine*, *45*(3), 841-847.
14. Schlosser, R. J., & Bolger, W. E. (2002). Nasal cerebrospinal fluid leaks. J Otolaryngol 31(suppl1):S28 –37.
15. Shetty, P. G., Shroff, M. M., Sahani, D. V., & Kirtane, M. V. (1998). Evaluation of high-resolution CT and MR cisternography in the diagnosis of cerebrospinal fluid fistula. *American Journal of Neuroradiology*, *19*(4), 633-639.
16. Tahir, M. Z., Khan, M. B., Bashir, M. U., Akhtar, S., & Bari, E. (2011). Cerebrospinal fluid rhinorrhea: an institutional perspective from Pakistan. *Surgical neurology international*, *2*.
17. Vimala, L. R., Jasper, A., & Irodi, A. (2016). Non-invasive and minimally invasive imaging evaluation of CSF Rhinorrhoea–A retrospective study with review of literature. *Polish journal of radiology*, *81*, 80.
18. Woodworth, B. A., Prince, A., Chiu, A. G., Cohen, N. A., Schlosser, R. J., Bolger, W. E., ... & Palmer, J. N. (2008). Spontaneous CSF leaks: a paradigm for definitive repair and management of intracranial hypertension. *Otolaryngology—Head and Neck Surgery*, *138*(6), 715-720.