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**MRI with intrathecal gadolinium to detect a CSF leak: a prospective open label cohort study.**

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The methods and first three patients were published in Dutch. (1)

## **Abstract**

**Objectives:** The techniques currently used to detect a CSF leak are indium radio nucleotide scan or CT scan with intrathecal iodinated contrast agent. They have a low spatial and temporal resolution and are unpleasant for the patient. This open label prospective observational cohort study was designed to investigate the feasibility, success ratio, complications and therapeutic consequences of MRI with gadolinium administered by lumbar puncture to detect a CSF leak.

**Methods:** Patients were selected with either confirmed liquorrhoea, recurrent bacterial meningitis or symptoms and MRI findings of spontaneous intracranial hypotension. High resolution T1 weighted MRI with fat suppression of the spinal column at 1 hour and of the brain at 6 and 24 hours post injection of 0.5 ml of gadolinium were performed.

**Results:** 27 patients were included. The clinically suspected CSF leak was found in 6 of 8 patients with liquorrhoea, 3 of 5 patients with recurrent bacterial meningitis and 9 of 14 patients with spontaneous intracranial hypotension. The procedure was easy to perform and generally well tolerated. One patient developed streptococcal meningitis in the hours following the procedure but recovered completely with antibiotic treatment. 17 of 18 patients in whom a dural defect was found underwent surgery. All patients became symptom free after closure of the dural leak.

**Conclusions:** Spinal cord and brain MRI after intrathecal gadolinium injection is an easy to perform and accurate technique for detection of a dural defect with excellent anatomical detail.

## Background

The diagnosis of a cerebrospinal fluid (CSF) leak can be suspected in patients with orthostatic headache or a sweet tasting clear nasal drip. Headache attributed to low CSF pressure is characterised by a dull headache that worsens within 15 minutes of sitting or standing and that can be associated with tinnitus, hyperacusis, neck stiffness, photophobia and nausea. Nasal CSF drip can be confirmed with high specificity and sensitivity by beta-trace protein detection. Spinal CSF leaks can occur after lumbar puncture, complicating spinal surgery or epidural infiltrations. Cranial CSF leaks can be a complication of head trauma, surgery to the ear and nose or neurosurgical interventions. Idiopathic intracranial hypotension or spontaneous intracranial hypotension was recently reported to be caused by spinal epidural leaks. Cranial MRI with intravenous gadolinium can show meningeal thickening and contrast enhancement, downward displacement of the cerebellar tonsils, subdural collections, engorgement of veins and pituitary hyperaemia. The treatment of a CSF leak usually consists of pain medication and prolonged bed rest. A blood patch is successful in up to 75% of patients. (2) With a blood patch 20-50 ml autologous blood is injected in the lumbar epidural space. The mode of action is not known. Refractory spinal and cranial CSF leaks require surgery. The techniques currently used to detect and localise a dural defect with CSF leak are indium radio nucleotide scan or CT scan with intrathecal iodinated contrast agent. They have significant limitations in spatial and temporal resolution and important side effects with meningeal irritation, large volumes to be injected, imaging artefacts and irradiation dosage. Intermittent leaks can be missed with both techniques. (2) MRI with intrathecal gadolinium was reported to be safe and a promising technique to detect CSF leaks. (3, 4, 5) Intravenous administration of gadolinium is rarely complicated with nephrogenic systemic fibrosis. There

is no information whether this could be an issue with intrathecal administration. The intravenous dosage usually is 20 ml, while only 0.5 ml is injected intrathecally.

## Methods

We included patients 18 y or older with either nasal liquorrhea confirmed by beta-trace protein, recurrent bacterial meningitis or symptoms and MRI findings of spontaneous intracranial hypotension. When a spinal leak was suspected, a lumbar epidural blood patch was performed and if needed repeated up to 3 times. A lumbar puncture was performed at lumbar level L3-4 with a 22 Gauge atraumatic needle and 0.5 ml of gadolinium (Magnevist, Schering, Germany) was injected. The patient was positioned in Trendelenburg position for 30 minutes. From February 2005 till January 2006 MRI scanning was performed with a 1.5 Tesla Philips Achieva (Best, The Netherlands) and from then onwards with a 3 Tesla Philips X-series Quasar Dual Achieva (Best, The Netherlands). The full spine was scanned at 1 hour post injection with high resolution T1 with fat suppression with coronal and sagittal slices and axial slices through regions of interest. Thin T1 with fat suppression coronal slices of the head including all paranasal sinuses, the middle ear and mastoid bone were taken at 6 and 24 hours post injection. All scans were performed and reported by the same neuroradiologist (JWC). The local ethics committee reviewed and approved this study design. Written informed consent was obtained from all patients.

## Results

Between February 2005 and January 2009, 27 patients were included: 8 with confirmed nasal CSF drip, 5 with recurrent bacterial meningitis and 14 with spontaneous intracranial hypotension (**table 1**). The average age was 45 (18-73), 18 patients were female, 9 male. In 6

out of 8 patients with confirmed nasal CSF drip a dural leak was detected. This leak was through the ethmoid bone in all, mainly at the olfactory recessus and lamina cribrosa. A CSF leak was found in 3 out of 5 patients with recurrent meningitis. Two of these leaks were through the ethmoid bone in close association with the olfactory bulb. One patient had a leak through the roof of the petrous bone into the middle ear. In 9 of 14 patients with spontaneous intracranial hypotension we found a CSF leak. All 9 were spinal epidural leaks mainly at the cervicodorsal junction (**illustration 1**). The intrathecal injection of 0.5 ml of Gadolinium by lumbar puncture was well tolerated. No new headaches occurred. We did not observe drowsiness, behavioural disturbances, attention deficit or epileptic seizures. One patient with liquorrhea developed meningitis 12 hours after intrathecal gadolinium injection presenting with rapidly worsening headache, fever and obtundation. CSF obtained within two hours of the first symptoms contained 29600 white blood cells /mm<sup>3</sup>, with a 93% neutrophilic formula. CSF lactate was 14.2 meq/l and glucose 0 mg/dl. Treatment with 2 g ceftriaxon and 1 g vancomycin intravenously was started promptly. Streptococcus Pneumoniae was cultured in CSF and the patient was treated for 14 days with IV ceftriaxon 2 g bid with full recovery. Documented nasal CSF leaks were closed by the ENT specialist with endoscopic nasal surgery using fibrin glue (Tissucol, Baxter Healthcare, Deerfield, IL, USA). The spinal epidural CSF leaks but one were closed by the neurosurgeon. One spinal epidural leak resolved spontaneously. The neurosurgeon observed dural tears associated with minor osseous protrusions or a herniated thoracic disc. In some cases an artificial dural patch was applied. All patients who underwent surgery had a complete resolution of symptoms.

## Discussion

This prospective observational cohort was set up to study the feasibility, success ratio, complications and therapeutic consequences of MRI with intrathecal gadolinium. We did not make a direct comparison with iodinated contrast CT myelography or cisternography with radiolabeled indium since it was found unethical to subject patients to three sequential intrathecal contrast injections. Positive predictive values and sensitivity can therefore not be calculated. MRI with intrathecal gadolinium proved to be easy to perform. The contrast ratio and detail of the scans was excellent with superior spatial and temporal resolution. The gadolinium remains in the cranial cavity over 24 hours permitting detection of intermittent leaks. We found a leak in 18 of 27 carefully selected patients (67%). The intrathecal injection of gadolinium was well tolerated. No behavioural disturbances, seizures or new headaches occurred. It must be noted that the majority of the patients had orthostatic headaches at presentation, worsening of headache was not reported. One patient developed bacterial meningitis in the hours after the injection, he was treated with antibiotics and made a full recovery. The cultured *Streptococcus Pneumoniae* suggests a nasal entry through the documented ethmoidal CSF leak rather than a complication of the intrathecal injection with gadolinium. 17 of 18 patients in whom a dural defect was found successfully underwent surgical closure of the defect and became symptom free. All patients with spontaneous intracranial hypotension in which a leak was found had the same MRI finding of spinal epidural collections (**illustration 1**). The gadolinium enhanced CSF leak through a dural defect was usually seen at the cervicodorsal junction in association with a small herniation of an intervertebral disc. Recent publications have reported similar findings. (2, 6, 7, 8, 9) In a minority of patients we could not detect a CSF leak which is also in concordance with other observations. (10) The fact that a spinal epidural leak being the cause of spontaneous

intracranial hypotension was only reported in the last years makes us believe that MRI is superior to CT with intrathecal iodinated contrast or radiolabeled indium cisternography.

## **Illustration legend**

**illustration 1:** spinal epidural CSF leak.

Axial (A,B) and sagittal (C) 4 mm thick T1-weighted images of the thoracal spinal column with fat suppression following intra-thecal gadolinium injection. (A): A disc-osteophyte protrusion is causing a disruption of the anterior wall of the dural sac and gadolinium is leaking through a defect in the dura mater (arrow) into the anterior epidural spaces on the left and right side. (B): At an adjacent level one can see another disc herniation, but the signal intensity of the intradural gadolinium is much higher than the gadolinium-CSF intensity in the surrounding epidural collection (arrow), indicating that the entry of gadolinium in the epidural space is not situated at this level. (C): On the sagittal image a dubbel fluid space can be seen anterior to the medulla: intrathecal gadolinium is separated from the gadolinium in the epidural collection by the dura mater (arrowheads).

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There are no competing interests. This study was not sponsored by industry, government or institutional funding.



## References

- 1 Dedeken P, Casselman J, Vlaminck S, Vanopdenbosch LJ. MRI met intrathecaal gadolinium voor evaluatie van liquorlekkage. Tijdschr Neurol Neurochir 2007;108:16-20
- 2 Schievink WI. Spontaneous spinal cerebrospinal fluid leaks. Cephalalgia 2008;28:1345-1356
- 3 Zheng Q, Xiong L, Jinkins JR, Fan Z, Liu Z. Intrathecal gadolinium-enhanced MR myelography and cisternography: a pilot study in human patients. AJR Am J Roentgenol 1999;173:1109-1115
- 4 Tali ET, Ercan N, Kaymaz M, Pasaoglu A, Jinkins JR. Intrathecal gadolinium (gadopentetate dimeglumine)-enhanced MR cisternography used to determine potential communication between the cerebrospinal fluid pathways and intracranial arachnoid cysts. Neuroradiology 2004;46:744-754
- 5 Aydin K, Guven K, Sencer S, Jinkins JR, Minareci O. MRI cisternography with gadolinium-containing contrast medium: its role, advantages and limitations in the investigation of rhinorrhoea. Neuroradiology 2004;46:75-80
- 6 Moayeri NN, Henson JW, Schaefer PW, Zervas NT. Spinal dural enhancement on magnetic resonance imaging associated with spontaneous intracranial hypotension. Report of three cases and review of the literature. J Neurosurg 1998;88:912-918
- 7 Rabin BM, Roychowdhury S, Meyer JR, Cohen BA, LaPat KD, Russel EJ. Spontaneous intracranial hypotension: spinal MR findings. AJNR Am J Neuroradiol 1998;19:1034-1039.
- 8 Albayram S, Kilic F, Ozer H, Baghaki S, Kocer N, Islak C. Gadolinium-enhanced MR cisternography to evaluate dural leaks in intracranial hypotension syndrome. AJNR Am J Neuroradiol 2008;29:116-121

9 Watanabe A, Horikoshi T, Uchida M, Koizumi H, Yagashita T, Kinouchi H. Diagnostic value of spinal MR imaging in spontaneous intracranial hypotension syndrome. *AJNR Am J*

*Neuroradiol* 2009;30:147-151

10 Leep Hunderfund AN, Mokri B. Orthostatic headache without CSF leak, *Neurology*

2008;71:1902-1906

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