



The Correlation between Brain MRI and MRV Findings and CSF Pressure Value in Idiopathic Intracranial Hypertension

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ABSTRACT:

BACKGROUND:

Idiopathic intracranial hypertension is a clinical entity characterized by increased cerebrospinal fluid pressure of unknown cause. The diagnosis depends on raised intracranial pressure and the absence of identifiable causes.

OBJECTIVE:

To investigate the correlation between CSF pressure value and radiological findings based on cranial MRI and MRV in patients with idiopathic intracranial hypertension.

PATIENTS AND METHOD:

A correlational diagnostic yield study of 46 patients diagnosed with idiopathic intracranial hypertension who underwent brain MRI and MRV between June 2019 to March 2022 was evaluated. The radiological score was based on the following findings: Partially empty Sella, Posterior displacement of the stalk, Flat posterior globe, Intra-ocular protrusion of optic nerve, Peri-optic fat distention, Vertical tortuosity of optic nerve, Slit-like ventricles, Tight subarachnoid space, Inferior displacement of cerebellar tonsils, Large Meckel's caves, Prominent arachnoid pits, and transverse sinus stenosis.

The radiological score was calculated by assigning one point for each finding present, with a maximum score of 12 points. The correlation between the computed radiological scores and CSF pressure was investigated.

RESULT:

There was a positive correlation between CSF pressure and radiological scores ($R = 0.32$; $P = 0.003$, Kendall's rank correlation tau). But no significant correlation was detected between CSF pressure and each of the radiological findings (partial empty Sella ($P = 0.06$), Posterior displacement of stalk ($P = 0.1$), Flat posterior globe ($P = 0.1$), Intra-ocular protrusion of optic nerve ($P = 0.04$), Peri-optic fat distention ($P = 0.6$), Vertical tortuosity of optic nerve ($P = 0.4$), Slit-like ventricles ($P = 0.2$), Tight subarachnoid space ($P = 0.3$), Inferior displacement of cerebellar tonsils ($P = 0.7$), Large Meckel's caves ($P = 0.5$), Prominent arachnoid pits ($P = 0.2$), Wilcoxon rank sum test).

CONCLUSION:

There was a positive correlation between CSF pressure and the radiological score of idiopathic intracranial hypertension.

KEYWORDS: MRI, MRV, Pseudotumor Cerebri, IIH.

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INTRODUCTION:

Idiopathic intracranial hypertension (IIH) is a disorder where there is an increase in intracranial pressure, with a lack of a predisposing focal lesion within the brain, and is uncommon in occurrence.⁽¹⁾

Despite the recognition of an association with venous drainage impairment and altered venous hemodynamics, this association has not been raised

to be completely valid nor single as the only causative factor for the pathology.⁽²⁾

One of the most prevalent findings in intracranial hypertension is the expanded partially empty sella, which is due to elevated pressure acting on a long time frame causing depression of the arachnoid, concavity of the superior gland, and leveling down of the floor⁽³⁾

BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

This flattening of the superior sella is thought to be due to a defect, be it a congenital or acquired defect in the diaphragm sellae, that enables herniation of the arachnoid layer, and subsequent compressive flattening of the Sella, this is extremely frequent in IIH so that it bears a sensitivity of 85% and specificity of nearly 93%⁽⁴⁾ Another well-recognized and established imaging finding in IIH is dilated optic nerve sheaths which can be readily detectable by MR with a sensitivity of 72-80% and specificity of 69%⁽⁵⁾ another finding that is also observed in IIH is posterior globe flattening due to raised intracranial pressure, to the extent that if this was the sole imaging finding it will still raise the odds of having IIH by 50 times, nonetheless, taken as a single predictor it bears a sensitivity of nearly 43% for the condition,⁽⁶⁾ interestingly, this finding was found to be more in keeping with the primary form of IIH, utilizing the data of research comparing the signs of primary and secondary forms of the condition,⁽⁷⁾ being a more extreme indicator of raised intracranial pressure, protrusion of the optic nerve itself is also recognized MR finding in IIH. (1)

Another conventional imaging finding is the presence of tortuous optic nerve, which as a radiological sign was found to be associated with five times raised risk for the condition, (6), and vertical tortuosity was found to be present in 54% of IIH cases vs 9% of controls, emphasizing the role of the sign for diagnosis of the condition,⁽⁸⁾

Studies have predicted IIH in 90% of cases, showing a constellation of optic nerve tortuosity, enhancement, and empty sella turcia⁽⁹⁾

By the same mechanism of arachnoid pushing and herniation, it is understandable why there is an increase in signs such as pseudomenigoceles (11%) and large Meckel's caves (9%)⁽⁹⁾.

All these imaging variables, while established clues for IIH diagnosis, bear no obvious link to the severity of the condition reflected by how severe papilloedema is or how marked visual loss would be.⁽¹⁰⁾

An imaging finding that was previously noted in cases of IIH is the narrowing of the venous sinus, frequently observed at the junction point between the transverse and sigmoid portions⁽¹¹⁾

Farb et al found a frequency of 90% of this finding in patients with IIH. in this study, the researchers utilized 3D MR with contrast enhancement⁽¹²⁾

Data from CTV studies did not differ much, also showing a figure of nearly 90% lateral sinus narrowing in IIH cases.⁽¹³⁾

Back to conventional imaging findings, a finding that was noted in IIH was the prevalence of encephalocele, by understandable means due to the raised pressure⁽¹³⁾

Also, another conventional imaging feature that has fallen out of favor as a diagnostic criterion recently is the presence of slit-like ventricles.⁽¹⁴⁾

Remarkably, slit-like ventricles were often reported in cases of IIH diagnosed by ventriculography or CT before MRI became available but are not used as a criterion today.⁽¹⁵⁾

The lumbar puncture has a dual role in the diagnosis of IIH. First, it is attained to confirm the presence of an increased CSF opening pressure. Second, evaluation of the CSF constituents is required to exclude other etiologies of increased intracranial pressure⁽¹⁶⁾.

A CSF opening pressure of greater than 25 cm H₂O is considered high, while a pressure of 20 cm H₂O to 25 cm H₂O is considered borderline, although probably abnormal in a patient who has symptoms, signs, and neuroimaging findings suggesting increased intracranial pressure⁽¹⁷⁾.

This study aims to investigate the correlation between CSF pressure and radiological scores based on cranial MRI and MRV in patients with idiopathic intracranial hypertension (IIH).

PATIENTS and METHOD:

Design: Correlational diagnostic yield study of 46 patients diagnosed with IIH.

Setting: The study was performed in Al-Imamain Al-Kadhimain Medical City and Baghdad Teaching Hospital between June 2019 and March 2022

PATIENTS:

Forty-six (46) patients with an established diagnosis of PTC based on clinical features, physical examination, brain MRI / MRV, and cerebrospinal fluid pressure by LP in addition to confirmation by a neurology consultant were studied.

Inclusion criteria:

New clinical cases confirmed as IIH by thorough clinical evaluation, imaging aid, and by lumbar puncture were included in this study

Exclusion criteria:

Study exclusion criteria are the following:

1. If brain imaging of any patient discloses venous sinus thrombosis.
2. Clinical cases where the surgical history includes

BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

Data collection

in addition to detailed clinical evaluation, comprising history and clinical examination, consideration of imaging findings with special attention to the findings of MRI and MRV.

Protocol for imaging:

Dhis comprised whole cranium evaluation utilizing 3T TX 32 CH Philips' healthcare Achieva standard neurovascular 8 channel coil, Sequences that are used included coronal, axial

Evaluation and Analysis of Scanned Images

The MRI and MRV images were organized in a random sequence and reviewed by radiologists with expertise in neuro and vascular imaging, and the radiologist was not blinded to the diagnosis. Imaging studies were evaluated for the presence or absence of the following defined findings:

- (1) Partially empty Sella turcica (when the pituitary gland occupies less than 50% of the pituitary fossa and the upper part is concave).
- (2) posterior displacement of the pituitary stalk.
- (3) Flattening of the posterior globe (the normal outward convexity of the sclera at the area of attachment to the ON becomes flatter).
- (4) Intraocular protrusion of the ON (the outwards convexity of the sclera becomes concave towards the globe at the area of attachment to the ON).
- (5) distension of the ON sheath (the surrounding optic nerve CSF space is wider than 2 mm).
- (6) Vertical tortuosity of the optic nerve (a "redundant" and "S-shaped" appearance of the optic nerve on sagittal views)
- (7) slit-like ventricles (the walls of the lateral ventricles appear collapsed; this appearance would not be expected in the normal adult population)
- (8) tight subarachnoid spaces (the sulci and cisterns appear very small)
- (9) downward displacement of the cerebellar tonsils by 5 mm descent distance
- (10) Enlargement of Meckle's caves
- (11) Large arachnoid pits for the definition of venous sinus stenosis.

The following criteria were adapted: narrowing of the sinus by more than 50% compared to the distal portion of the superior sagittal sinus.

A researcher-designed radiological score was then obtained by giving 1 point for the presence of each finding, with the highest possible score of 12 points, and the score was compared to CSF pressure values.

Statistical analysis

Continuous parameters were checked for normality using graphical (bar chart) and mathematical methods (Shapiro test), and thus the mean \pm SD was used for parametric variables and the median (range) was used for non-parametric variables. Categorical variables were expressed as percentages. Wilcoxon rank-sum test with continuity correction was used for assessing the statistical significance between the two medians. Kendall's rank correlation tau was used to test for the correlation between continuous and ordinal variables.

R Statistical Packages were used for statistical analysis. and P values less than 0.05 will be considered to be statistically significant.

RESULTS:

Forty-six patients with complete imaging data and a diagnosis of IIH were enrolled in the study, three of which were males and 43 were females. The mean age of the patients was 32.5 (range 16 – 47) (Table 1).

The Presenting signs and symptoms were Headache at 93 %, Transient visual obscuration at 61%, Pulsatile tinnitus at 43%, Papilledema at 98%, and 6th nerve palsy at 13 % (Table 1).

The incidence of MRI radiological findings was Partially empty Sella 83%, Posterior displacement of stalk 74%, Flat posterior globe 43%, Intra-ocular protrusion of optic nerve 26%, Peri-optic fat distention 67%, Vertical tortuosity of optic nerve 59%, Slit-like ventricles 43%, Tight subarachnoid space 9%, Inferior displacement of cerebellar tonsils 2%, Large Meckel's caves 2%, Prominent arachnoid pits 9%, Transverse sinus stenosis was found in 74% of patients with IIH. (Table 2).

There was no significant correlation between CSF pressure and individual radiological findings (P-value > 0.05).

The resulting radiological score was the sum of all MRI (0 - 11) and MRV (0 - 1) findings mentioned above, with a maximum possible score of 12 points.

The MR score results and the median CSF pressure for each score were as follows:

Score 0 CSF pressure was 360 mmH₂O (one patient), score 1 CSF pressure was 280 mmH₂O (one patient), score 2 median CSF pressure was 360 mmH₂O (3 patients, range 300-470), score 3 median CSF pressure was 315 mmH₂O (2 patients, range 310-320), score 4 median CSF pressure was

BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

408 mmH₂O (8 patients, range 300-500), score 5 median CSF pressure was 380 mmH₂O (11 patients, range 310-430), score 6 median CSF pressure was 465 mmH₂O (4 patients, range 300-700), score 7 median CSF pressure was 428 mmH₂O (8 patients, range 320-600), score 8 median CSF pressure was 460 mmH₂O (7 patients, range 320-710), score 9 CSF pressure was 440 mmH₂O (one patient)

The Median MRI score was 5. The lowest score was 0 and the highest one was 9 (Table 1).

Figure (1) shows the levels of the MRI score from 0 to 8, plotted against the CSF pressure

summarized using Boxplots. Only one patient got a score of 0, and one patient got a score of 8. The median CSF pressure was 395, with a range from 280 to 710 mm H₂O. As the level of the score increases, the median Pressure also increases, indicating a positive relationship between them. The relationship between the radiological score and CSF pressure shows a positive correlation (Figure 1).

There was a positive correlation between CSF pressure values and radiological scores ($r = 0.32$; P value = 0.003, Kendall's rank correlation tau) (Table 3) (Figure 2).

Table 1: Characteristics of 46 patients with idiopathic intracranial hypertension (IIH).

Age (mean \pm SD)	32.5 \pm 8.31
Male %	7 %
Female %	93 %
CSF pressure, median (range)	395 (280 - 710)
Presenting signs and symptoms	
Headache %	93 %
Transient visual obscuration %	61 %
Pulsatile tinnitus %	43 %
Papilledema %	98 %
6 th nerve palsy %	13 %
Radiological findings	
MRI Score, median (range)	5 (0 - 9)

Table 2: Correlation between individual MRI, MRV radiological findings, and CSF pressure.

	Present %	P-value*
Partially empty Sella	83 %	0.06
Posterior displacement of the stalk	74 %	0.1
Flat posterior globe	43 %	0.1
Intra-ocular protrusion of optic nerve	26 %	0.04
Peri-optic fat distention	67 %	0.6
Vertical tortuosity of optic nerve	59 %	0.4
Slit-like ventricles	43 %	0.2
Tight subarachnoid space	9 %	0.3
Inferior displacement of cerebellar tonsils	2 %	0.7
Large Meckel's caves	2 %	0.5
Prominent arachnoid pits	9 %	0.2
Transverse sinus stenosis	74 %	0.1
*Wilcoxon rank-sum test with continuity correction		

Table 3: Correlation between MRI Score and CSF pressure.

	CSF pressure	P-value
MRI Score	0.32	0.003*
*Kendall's rank correlation tau		

BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

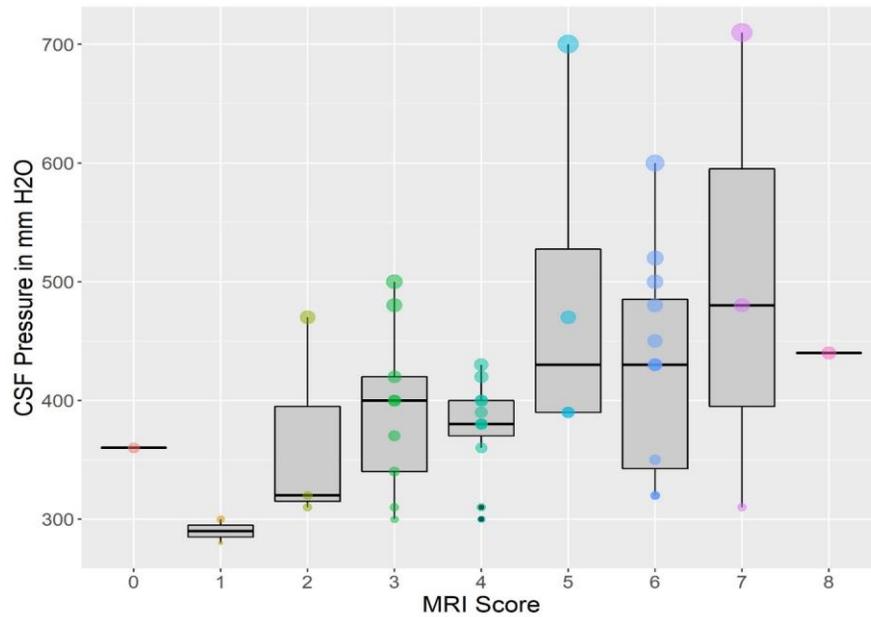


Figure 1: Boxplot showing the comparison between MRI score and CSF pressure.

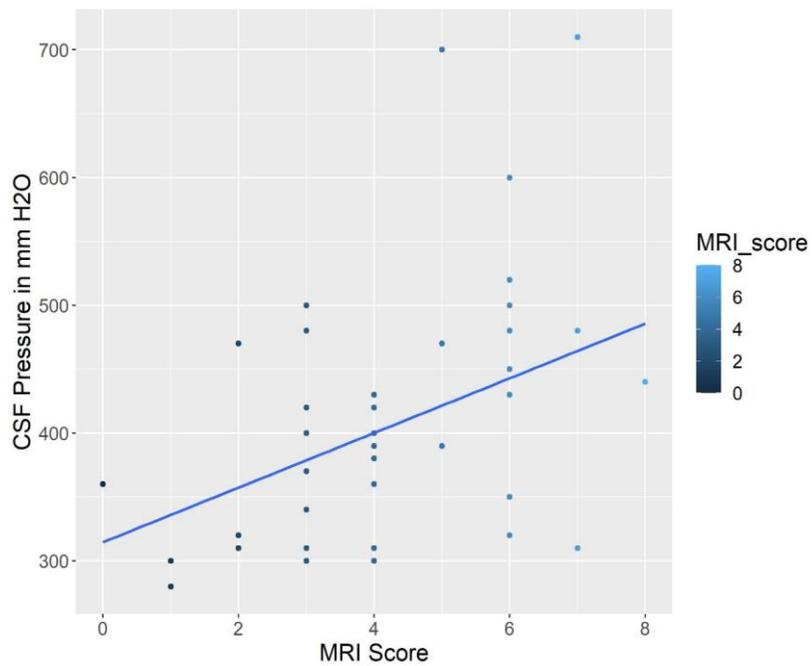


Figure 2: Scatterplot showing the correlation between MRI score and CSF pressure, regression line shows positive correlation.

BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

DISCUSSION:

Clinical and laboratory evidence used to be used to define IIH. Rapid advancements in radiologic imaging have resulted in more accurate diagnoses. Because clinical diagnosis is usually determined by exclusion, radiological findings must be evaluated. Furthermore, some imaging findings identified in the last 20 years can support the diagnosis of IIH in clinically questionable cases, according to the most recent diagnostic criteria; for example, patients without papilledema or normal CSF pressure values⁽¹⁸⁾.

The radiographic finding of transverse sinus stenosis in instances suspected of IIH was originally assumed to be causal, but current discoveries reveal that it is a consequence of the condition⁽¹⁹⁾.

Endovascular stent treatment has been used to treat patients with clinically persistent transverse sinus stenosis⁽²⁰⁾. However, for this treatment to become commonplace in clinical practice, significant long-term studies evaluating its efficacy are needed.

Unilateral transverse sinus hypoplasia, which is common in the general population, should not be considered stenosis⁽²¹⁾. In our research, we discovered that 74% of individuals have bilateral or localized transverse sinus stenosis, whereas Tuncel et al.⁽²¹⁾ only identified 41%.

While there are a variety of clinical symptoms associated with IIH, vision loss is the most serious one. Our study identified 61% of cases with transient vision loss. According to one prospective study, the long-term risk of permanent vision loss is 4%, necessitating immediate intervention⁽²²⁾. Surgical procedures (optic nerve sheath fenestration, ventriculoperitoneal, and limbo-peritoneal shunt) are advised in these cases rather than medicinal or conservative therapy.

About three-quarters of our patients had an empty Sella. There was no information on the frequency of empty Sella regression since no post-treatment MRI was performed. Other radiological findings, likewise, must be explored.

Although high CSF pressure levels may suggest IIH, this criterion should be used with caution because CSF pressure measurements are only taken at a one-time point, and CSF pressure values can vary during the day⁽²³⁾. Furthermore, in the general population, elevated CSF pressure readings have been documented⁽²⁴⁾. As a result, if the diagnosis of IIH is in dispute, additional CSF pressure measures should be obtained⁽²³⁾.

In our study, we found a positive correlation between CSF pressure and combinations of radiological findings. Based on our result, CSF pressure can be used as a major criterion for the diagnosis of IIH.

Only a few studies have looked into the correlation between combinations of radiological findings and CSF pressure in children and adults, of which Tuncel et al.⁽²¹⁾ (4), Lim MJ et al.⁽²⁵⁾, and Agid R et al.⁽²⁶⁾ did not find a correlation between radiological findings and CSF pressure. These studies found that a combination of radiographic abnormalities had no bearing on the diagnosis of IIH. This disparity suggests that other factors may also contribute to this correlation like age and severity of IIH.

Limitations include single CSF pressure measurement, differences in the time between MRI and lumbar puncture between patients. Furthermore, because invasive procedures of lumbar puncture were required, we did not enlist healthy controls.

CONCLUSION:

In conclusion, a positive correlation between CSF pressure and the radiological score of IIH was observed. However, there was no correlation between CSF pressure and individual radiological features.

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BRAIN MRI AND MRV FINDINGS AND CSF PRESSURE IDIOPATHIC INTRACRANIAL HYPERTENSION

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