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Incidence of spinal CSF leak on CT myelography in patients with nontraumatic intracranial SDH

비외상성 두개 내 경막하혈종 환자에서 전산화단층촬영-척수강조영술에서의 뇌척수액 누출 빈도에 대한 연구

2022년 8월

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Incidence of spinal CSF leak on CT myelography in patients with nontraumatic intracranial SDH

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Abstract

Incidence of spinal CSF leak on CT myelography in patients with nontraumatic intracranial SDH

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In our tertiary medical center, we observed a higher rate of cerebrospinal fluid (CSF) leak on computed tomography (CT) myelography in patients with nontraumatic intracranial subdural hematoma (SDH) than that reported in previous literature. Therefore, we designed the present study to demonstrate which screening criteria were responsible for the difference of the prevalence, and determine potential clinical and imaging parameters favoring CSF leak in patients with nontraumatic intracranial SDH.

Patients diagnosed with nontraumatic intracranial SDH who underwent CT myelography (60 patients) and who did not undergo CT myelography (50 patients) between January 2012 and March 2018 were selected. Patients with CT myelography

were divided into CSF leak-positive and CSF leak-negative groups according to CT myelography reports. Clinical and magnetic resonance imaging findings were statistically compared among the three groups.

Patients with the following findings significantly tended to be selected as CT myelography candidates: lower mean age, no aspirin intake, no clopidogrel administration, no unilateral weakness, no gait disturbance, normal Glasgow coma scale score, orthostatic headache, nonpostural headache, bilateral SDH, thinner maximal hematoma thickness, dural thickening/enhancement, cisternal obliteration, transverse sinus convexity, decreased pontomesencephalic angle and mamillopontine distance. In total 48 of the 60 (80%) patients exhibited CSF leak on CT myelography. Between the leak-positive and negative groups, an age of < 69 years was significantly associated with the presence of CSF leak. However, patients aged ≥ 69 years also had tendency to exhibit spontaneous intracranial hypotension (SIH)-induced SDH (14/23; 60.87%). There were no other variables, except age, that showed statistical differences between the leak-positive and negative groups.

If variable clinical and imaging factors are taken into consideration when selecting patients who needed CT myelography, more cases with CSF leak can be diagnosed in

patients with nontraumatic intracranial SDH. Importantly, clinicians need to broaden the patients' age-related indication to a higher age group for CT myelography to detect CSF leak. Also, the absence of postural headache or well-known typical SIH-related MRI features in patients does not mean that SIH can be completely excluded in clinical practice.

Keywords: Intracranial subdural hematoma, nontraumatic, spontaneous intracranial hypotension, CT myelography, epidural blood patch

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1. Introduction

Nontraumatic intracranial subdural hematoma (SDH) can be induced by a variety of causes. Hypertensive cortical artery rupture [1], middle meningeal artery aneurysm rupture [2], idiopathic bleeding, coagulopathy, oncological bleeding, and cocaine-induced bleeding have been reported as causative factors for acute SDH [3]. Causative factors for chronic SDH include stretching of bridging veins due to extensive brain atrophy, fragile neovasculatures associated with neomembrane formation after subdural hygroma or acute SDH [4]. For both acute and chronic SDH, conservative management (reversal of anticoagulation and prophylactic anticonvulsants) or surgical treatment (hematoma evacuation) is used depending on the patient's symptoms and extent of hematoma [4].

Spontaneous intracranial hypotension (SIH) can also result in nontraumatic SDH. SIH is a disorder characterized by decreased cerebrospinal fluid (CSF) volume and pressure, and it is caused by a persistent CSF leak through a dural defect along the neuraxis [5]. Spontaneous focal dural thinning and dehiscence are common causes of CSF leak. Degenerative abnormalities of the spine, including disk protrusions and osteophytes, may also result in thecal sac tears. Although some authors also report CSF-venous fistula as one of the causes, this remains a topic of speculation [6]. A CSF leak can result in downward traction on the brain, causing headaches, subdural fluid collection, and possible brain herniation [5]. Occasionally, tearing of the bridging veins results in SDH [7]. In such cases, hematoma evacuation prior to repair of the CSF leak may be ineffective, and untreated downward traction can lead to

further postoperative accumulation of SDH [8]. Therefore, for optimal treatment of some patients with SDH, clinicians should recognize the possibility of SIH as a cause of hematoma and search for CSF leak requiring repair with procedures such as an epidural blood patch (EBP) [8]. When dealing with patients with SDH, the differential diagnosis of SIH should be emphasized, particularly in younger patients, patients without a history of head trauma, and patients with postural headache [9]. Currently, computed tomography (CT) myelography is considered the gold standard for the initial evaluation of SIH [10–12] because it offers superior anatomic details [13].

Beck [14] conducted a prospective study and reported that spinal CSF leak was present in 25.9% nongeriatric patients (≤ 60 years) with chronic SDH. To the best of our knowledge, there is no other structured study on the incidence of imaging-confirmed CSF leak in patients with SDH. Since 2012, neurosurgeons at our institution request CT myelography to rule out SIH in patients with nontraumatic SDH without any explainable cause. If a CSF leak is detected on CT myelography, EBP is performed. Accordingly, we have observed a higher rate of CSF leak than that reported in Beck's study. Therefore, we designed the present study to demonstrate which screening criteria were responsible for these differences in prevalence, and determine potential clinical and imaging parameters favoring CSF leak in patients with nontraumatic SDH.

2. Materials and methods

2.1. Patients

This retrospective study was approved by the institutional review board of our hospital, which waived the need for informed consent because of the retrospective study design. Neurosurgeons at our institution requested CT myelography to rule out SIH in patients with nontraumatic SDH without any explainable cause. Two research assistants went through the hospital's electronic medical records between January 2012 and March 2018 then retrieved the details of patients diagnosed with SDH and subjected to CT myelography. The following inclusion criteria were applied to the patients identified from the medical records: no history of trauma, absence of coagulopathy according to a coagulation panel and platelet count measurements, absence of intracranial mass lesions susceptible to spontaneous bleeding, no history of drug abuse, performance of brain magnetic resonance imaging (MRI) at the initial presentation, performance of follow-up brain CT imaging at three months after the initial treatment for SDH, and age > 18 years. Eventually, 60 patients (male:female, 39:21; mean age, 58.65 ± 15.52 years; range, 20-82 years) were included. According to the previously written formal reports of CT myelography, the patients were divided into CSF leak-positive and CSF leak-negative groups.

Also, in order to confirm the criteria that may have acted on the selection of patients for CT myelography, 50 patients with nontraumatic intracranial SDH who did not undergo CT myelography during the same period were consecutively obtained as a control group. The following inclusion criteria were applied for the control group: no history of trauma, absence of coagulopathy according to a coagulation panel and platelet count measurements, absence of intracranial mass lesions susceptible to spontaneous bleeding, no history of drug abuse, performance of brain MRI at the initial

presentation, and age > 18 years. Eventually, 50 patients (male:female, 36:14; mean age, 75.58 ± 7.40 years; range, 61–92 years) were included as the control group.

2.2. Retrospective review of electronic medical records and imaging findings

A radiologist retrospectively reviewed the patients' demographic data, anticoagulant use, Glasgow coma scale scores, presence or absence of nonpostural headache, orthostatic headache, unilateral weakness, gait disturbance at the first visit, brain MR images taken at the initial presentation, treatment the CT leak–positive and negative groups underwent, and follow–up brain CT images taken within, and at three months [15, 16] after the initial treatment for SDH. The following parameters were evaluated on brain MRI: age of SDH (acute = hypo– to isointensity on T1WI, hypointensity on T2WI, hyperintensity on FLAIR images; subacute = hyperintensity on T1WI; chronic = isointensity relative to CSF on T1W1 and T2WI, hyperintensity on FLAIR images; acute on chronic (mixed) = mixed signals indicating different stages; hygroma = isointensity relative to CSF on all image sequences), laterality of SDH, the maximal thickness of SDH, the degree of midline shifting, SIH–related findings such as pachymeningeal thickening/enhancement, transverse sinus convexity, pituitary hyperemia (8 to 11 mm) [5], cisternal obliteration (narrowing of the suprasellar or/and perimesencephalic cistern) [17], a decreased mamillopontine distance (< 5.5 mm), a decreased pontomesencephalic angle (< 50 degrees) [18], and tonsilar ectopia (tips under the foramen magnum) [17]. On the basis of the findings, we decided whether imaging–confirmed SIH was present (in cases showing smooth

dural thickening and enhancement or ≥ 2 of the following findings: subdural collection, marked narrowing of the suprasellar or/and perimesencephalic cistern, and cerebellar tonsillar ectopia) [17]. Enhanced images were required for the assessment of pachymeningeal enhancement, while sagittal images were required for assessment of the transverse sinus convexity, pituitary hyperemia, mamillopontine distance, and pontomesencephalic angle. If contrast-enhanced or sagittal MR images were not available (MRI was performed at various institutions having different machines and protocols), the findings/measurements for that case were not evaluated. The radiologist also recorded whether recurrence had developed on follow-up brain CT images after the initial treatment for SDH. We defined 'recurrence' of SDH as a subsequent increase in hematoma volume in subdural space and compression of the brain surface after treatment, by referring to the previous several studies [16, 19].

2.3. Statistical analysis

To determine variables that were associated with selection of patients for CT myelography and to find factors which were associated with CSF leak, the clinical and imaging data were statistically analyzed. Independent-Samples T-Test/Mann-Whitney U test was used for continuous variables in the two groups which did/did not undergo CT myelography. Kruskal-Wallis test and Dunn test with Bonferroni correction was conducted for continuous variables in the leak-positive, leak-negative and the control groups (= the patients who did not undergo CT myelography). Chi-square tests/Fisher's exact tests were used for discrete variables. Logistic regression was performed for

multivariate analysis. A P value of < 0.05 was considered statistically significant.

2.4. Our routine CT myelography procedure & interpretation

In a fluoroscopy room, the patient is placed on a radiolucent table in the lateral decubitus position with the right side up and knee flexed. Using a midline interlaminar approach between the third and fourth lumbar vertebrae under fluoroscopy guidance, a trained musculoskeletal radiologist inserts a 22-gauge spinal needle into the CSF space. Following the confirmation of CSF drainage via the spinal needle, 15 cc of contrast medium (OMNIPAQUE 300, Amersham Health, Princeton, NJ) is slowly injected through the needle. When the contrast medium reached the spinal canal at the atlantooccipital level, the patients are transferred to the CT unit for whole-spine imaging, and the acquired data are presented in axial, sagittal, and coronal planes (Brilliance 64 CT scanner, Philips healthcare, Best, Netherlands; helical; beam collimation, 64 × 0.625 mm; kVp, 120; mAs, 250; pitch, 0.798; rotation time, 0.5 s; thickness, 2 mm; increment, 1 mm).

Trained musculoskeletal radiologists immediately interpret the obtained images to confirm the presence of contrast media leak (= CSF leak) exists. A positive CSF leak is defined as extrathecal CSF accumulation at any level. Meningeal diverticula are not considered as CSF leak because single or multiple nerve root sleeve diverticula of various sizes and configurations can be seen as incidental findings [6].

2.5. Our routine EBP procedure

If CSF leak is confirmed by CT myelography, targeted EBP with autologous blood is performed under fluoroscopic guidance. If there are multiple leak, EBP is performed at the mid-level of the leak in order to ensure the widest coverage. Generally, 10 cc of blood is used for each targeted level and a total of up to 20 cc blood is used.

3. Results

Patients with the following findings significantly tended to be selected as CT myelography candidates (Table 1 and 2): lower mean age, no aspirin intake, no clopidogrel administration, no unilateral weakness, no gait disturbance, normal Glasgow coma scale score, orthostatic headache, nonpostural headache, bilateral SDH, thinner maximal hematoma thickness, sufficient imaging findings for SIH, dural thickening/enhancement, cisternal obliteration, transverse sinus convexity, decreased pontomesencephalic angle and mamillopontine distance. In total 48 of the 60 (80%) patients exhibited CSF leak on CT myelography.

Table 1. Clinical parameters of the patients with and without CT myelography

	The patients with CT myelography (the leak (+) and (-) groups) Total N=60	The patients without CT myelography (the control group) Total N=50	P Value
Male sex, n (%)	39 (65.00)	36 (72.00)	0.433
Mean age ± SD	58.65 ± 15.52	75.58 ± 7.40	< 0.001
Warfarin, n (%)	1 (1.67)	3 (6.00)	0.328
Aspirin, n (%)	9 (15.00)	16 (32.00)	0.034
Clopidogrel, n (%)	3 (5.00)	12 (24.00)	0.004
Orthostatic headache, n (%)	13 (21.67)	0 (0.00)	< 0.001
Nonpostural headache, n (%)	44 (73.33)	21 (42.00)	0.001
Unilateral weakness, n (%)	11 (18.33)	22 (44.00)	0.003
Gait disturbance, n (%)	9 (15.00)	17 (34.00)	0.020
Glasgow coma scale score of 15, n (%)	60 (100.00)	46 (92.00)	0.040

Table 2. Imaging parameters of the patients with and without CT myelography

	The patients with CT myelography (the leak (+) and (-) groups)	The patients without CT myelography (the control group)	P Value
	n/Total N (%)	n/Total N (%)	
Bilateral SDH, n (%)	46/60 (76.67)	19/50 (38.00)	< 0.001
Acute SDH, n (%)	3/60 (5.00)	0/50 (0.00)	0.249
Acute or subacute SDH, n (%)	14/60 (23.33)	6/50 (12.00)	0.125
Acute or mixed stage SDH, n (%)	37/60 (61.67)	36/50 (72.00)	0.253
Acute, subacute or mixed stage SDH, n (%)	48/60 (80.00)	42/50 (84.00)	0.588
Mixed stage SDH, n (%)	34/60 (56.67)	36/50 (72.00)	0.096
Chronic SDH, n (%)	10/60 (16.67)	5/50 (10.00)	0.310
Hygroma, n (%)	2/60 (3.33)	3/50 (6.00)	0.657
Chronic or mixed stage SDH, n (%)	44/60 (73.33)	41/50 (82.00)	0.280
Hygroma, chronic or mixed stage SDH, n (%)	46/60 (76.67)	44/50 (88.00)	0.125
Maximal hematoma thickness, mm ± SD	8.95 ± 4.76	11.88 ± 6.66	0.011
The degree of midline shift, mm ± SD	3.44 ± 3.65	4.72 ± 4.16	0.066
Sufficient imaging findings for SIH, n (%)	35/60 (58.33)	10/50 (20.00)	< 0.001
Dural thickening/enhancement, n (%)	26/48 (54.17)	3/50 (6.00)	< 0.001
Cisternal obliteration, n (%)	22/60 (36.67)	8/50 (16.00)	0.015
Tonsilar ectopia, n (%)	2/60 (3.33)	1/50 (2.00)	1.000
Transverse sinus convexity, n (%)	10/48 (20.83)	1/50 (2.00)	0.003
Pituitary gland 8–11 mm, n (%)	0/48 (0.00)	0/50 (0.00)	N/A
Pontomesencephalic angle < 50 degrees, n (%)	23/48 (47.92)	5/50 (10.00)	< 0.001
Mamillopontine distance < 5.5 mm, n (%)	21/48 (43.75)	10/50 (20.00)	0.011

Differences in clinical parameters among the leak-positive, the leak-negative and the control (the patients with intracranial SDH who did not undergo CT myelography) groups are shown in Table 3, while differences in MRI parameters of the three groups are

presented in Table 4. In comparison with the control group, in the leak-positive group, the followings were significant variables: younger mean age, nonpostural headache, orthostatic headache, absence of unilateral weakness, bilateral SDH, sufficient imaging findings for SIH, pachymeningeal thickening/enhancement, cisternal obliteration, transverse sinus convexity, decreased pontomensencephalic angle and mamillopontine distance. When comparing the leak-positive and negative groups, the proportions of patients those aged < 69 years were significantly higher in the leak-positive group. However, patients aged ≥ 69 years also had tendency to exhibit SIH-induced SDH (14/23; 60.87%). Otherwise, there were no other variables that showed significant differences between the leak-positive and negative groups.

Targeted EBP was performed for all 48 leak-positive patients with 31 undergoing surgical removal of hematoma as well as EBP. Of these 31 patients, three developed recurrence repeatedly after several surgeries but showed complete resolution following one or two EBP procedures; 10 patients developed recurrence after a single EBP procedure and necessitated repeated EBP from one to three times with surgical evacuation (eight patients needed one surgery and two patients required two surgeries) until there was no recurrence; 18 underwent surgery and EBP at about the same time (within 24 hours), and among them one had additional surgery due to recurrence, meanwhile the other 17 did not have to undergo further invasive procedures. The reoperation rate after EBP was 9.7% (3/31). Of the 17 patients who underwent EBP only, 14 developed no recurrence (Figure 1A-1F) and three developed recurrence after a single EBP procedure; the latter three patients underwent a second EBP procedure and did not develop recurrence

thereafter.

Of the 12 leak-negative patients, eight underwent surgical removal of hematoma, one underwent both surgical removal of hematoma and EBP, and one underwent EBP alone. The latter two patients underwent empirical nontargeted EBP at the discretion of neurosurgeons although they showed negative CT myelography findings. The remaining two patients only received conservative management. All 12 leak-negative patients showed hematoma resolution with no recurrence after treatment.

Table 3. Clinical parameters of the leak-positive, the leak-negative and the control groups

	Leak (+)	Leak (-)	The control group	Overall P Value	Leak (+) vs. Leak (-)	Leak (+) vs. The control group	Leak (-) vs. The control group
	Total N=48	Total N=12	Total N=50		P Value	P Value	P Value
Male sex, n (%)	31 (64.58)	8 (66.67)	36 (72.00)	0.767			
Mean age ± SD	56.85 ± 15.50	65.83 ± 13.93	75.58 ± 7.40	< 0.001	0.252	< 0.001	0.018
Age < 69, n (%)	34 (70.83)	3 (25.00)	11 (22.00)	< 0.001	0.019	< 0.001	1.000
Warfarin, n (%)	0 (0.00)	1 (8.33)	3 (6.00)	0.208			
Aspirin, n (%)	8 (16.67)	1 (8.33)	16 (32.00)	0.107			
Clopidogrel, n (%)	3 (6.25)	0 (0.00)	12 (24.00)	0.017	1.000	0.044*	0.301
Orthostatic headache, n (%)	12 (25.00)	1 (8.33)	0 (0.00)	< 0.001	1.000	< 0.001	0.581
Nonpostural headache, n (%)	36 (75.00)	8 (66.67)	21 (42.00)	0.003	1.000	0.003	0.372
Unilateral weakness, n (%)	7 (14.58)	4 (33.33)	22 (44.00)	0.005	0.617	0.004	1.000
Gait disturbance, n (%)	7 (14.58)	2 (16.67)	17 (34.00)	0.065			
Glasgow coma scale score of 15, n (%)	48 (100.00)	12 (100.00)	46 (92.00)	0.168			

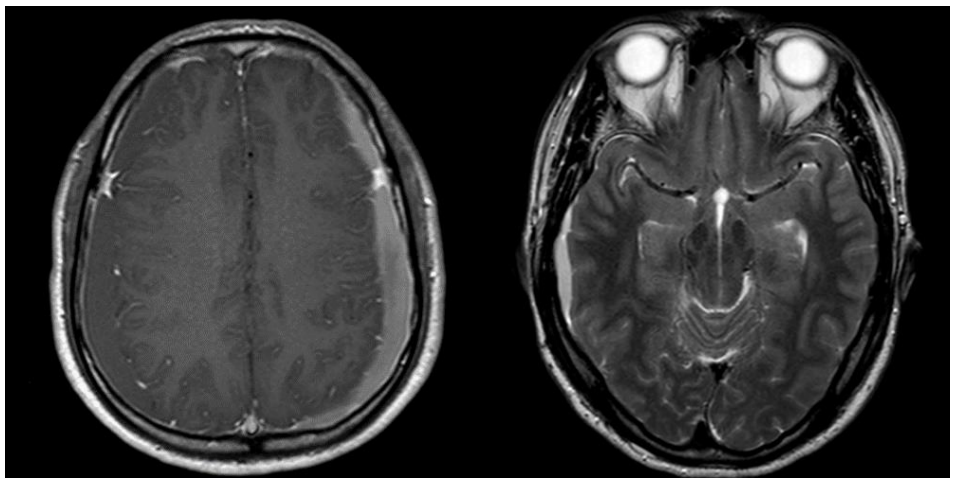
*Insignificant when adjusted by age (P value = 0.096)

Table 4. Imaging parameters of the leak-positive, the leak-negative and the control groups

	Leak (+)	Leak (-)	The control group	Overall P Value	Leak (+) vs. Leak (-)	Leak (+) vs. The control group	Leak (-) vs. The control group
	n/Total N (%)	n/Total N (%)	n/Total N (%)		P Value	P Value	P Value
Bilateral SDH, n (%)	39/48 (81.25)	7/12 (58.33)	19/50 (38.00)	< 0.001	0.385	< 0.001	0.600
Acute SDH, n (%)	3/48 (6.25)	0/12 (0.00)	0/50 (0.00)	0.242			
Acute or subacute SDH, n (%)	12/48 (25.00)	2/12 (16.67)	6/50 (12.00)	0.255			
Acute or mixed stage SDH, n (%)	29/48 (60.42)	8/12 (66.67)	36/50 (72.00)	0.524			
Acute, subacute or mixed stage SDH, n (%)	38/48 (79.17)	10/12 (83.33)	42/50 (84.00)	0.879			
Mixed stage SDH, n (%)	26/48 (54.17)	8/12 (66.67)	36/50 (72.00)	0.171			
Chronic SDH, n (%)	9/48 (18.75)	1/12 (8.33)	5/50 (10.00)	0.485			
Hygroma, n (%)	1/48 (2.08)	1/12 (8.33)	3/50 (6.00)	0.511			
Chronic or mixed stage SDH, n (%)	35/48 (72.92)	9/12 (75.00)	41/50 (82.00)	0.581			
Hygroma, chronic or mixed stage SDH, n (%)	36/48 (75.00)	10/12 (83.33)	44/50 (88.00)	0.255			
Maximal hematoma thickness, mm ± SD	9.20 ± 4.99	7.95 ± 3.74	11.88 ± 6.66	0.085			
The degree of midline shift, mm ± SD	3.34 ± 3.47	3.82 ± 4.46	4.72 ± 4.16	0.179			
Sufficient imaging findings for SIH, n (%)	30/48 (62.50)	5/12 (41.67)	10/50 (20.00)	< 0.001	0.571	< 0.001	0.425

Dural thickening/enhancement, n (%)	21/37 (56.76)	5/11 (45.46)	3/50 (6.00)	< 0.001	1.000	< 0.001	0.010
Cisternal obliteration, n (%)	21/48 (43.75)	1/12 (8.33)	8/50 (16.00)	0.003	0.123	0.008	1.000
Tonsilar ectopia, n (%)	2/48 (4.17)	0/12 (0.00)	1/50 (2.00)	0.728			
Transverse sinus convexity, n (%)	10/37 (27.03)	0/11 (0.00)	1/50 (2.00)	0.001	0.267	0.002	1.000
Pituitary gland 8–11 mm, n (%)	0/37 (0.00)	0/11 (0.00)	0/50 (0.00)	N/A			
Pontomesencephalic angle < 50 degrees, n (%)	20/37 (54.05)	3/11 (27.27)	5/50 (10.00)	< 0.001	0.356	< 0.001	0.443
Mamillopontine distance < 5.5 mm, n (%)	19/37 (51.35)	2/11 (18.18)	10/50 (20.00)	0.005	0.250	0.006	1.000

Figure 1A–1F (on the next page). Findings for a representative case involving a 41–year–old man with nontraumatic intracranial SDH. The patient presented with a chief complaint of headache not related to a specific posture. 1A. Contrast–enhanced, fat–suppressed T1 weighted image shows bilateral nontraumatic SDH with pachymeningeal thickening and enhancement. 1B. T2 weighted image shows cisternal obliteration. 1C. CT myelography shows CSF leak at the level of the C6/7 ventral epidural space (solid arrows). 1D. CT myelography shows CSF leak at the level of the L2/3 dorsal epidural space (a solid arrow) and the L2/3 left extraforaminal space (a hollow arrow). 1E. Epidural blood patch is performed at the C6/7 and L2/3 (not shown) levels. 1F. Follow–up brain CT shows no evidence of SDH.



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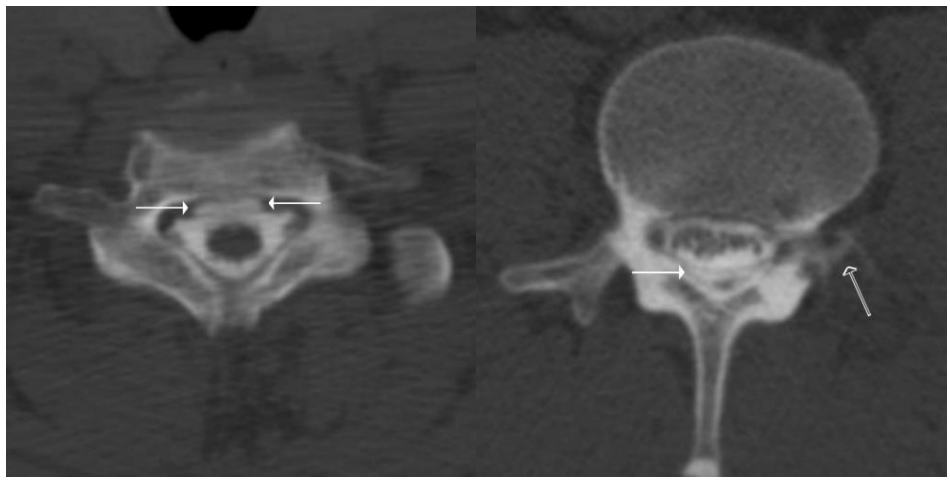

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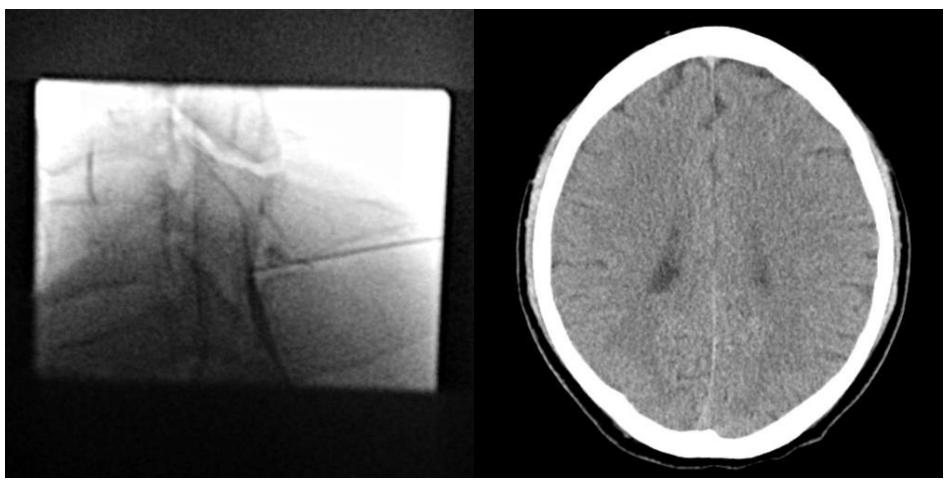

1E 1F

4. Discussion

In a study of the incidence of imaging-confirmed CSF leak in patients with SDH, Beck [14] found that spinal CSF leak was present in 25.9% nongeriatric patients (≤ 60 years) with chronic SDH. In the present study, we detected leak in higher percentage of patients probably by taking more into consideration than suggested in Beck's study when selecting patients who needed CT myelography. Several previous studies [5, 9, 17, 18] mention that age of the fourth or fifth decade of life, postural headache, nonpositional headache (in patients with subdural effusion/hematoma), bilateral SDH, smooth dural thickening/enhancement, transverse sinus engorgement, pituitary gland hyperemia, cerebellar tonsillar descent, narrow cisterns, decreased pontomensencephalic angle and decreased mamillopontine distance are associated with SIH. In the current study it is likely that neurosurgeons took these data into account in determining which patients needed CT myelography and this likely led to the successful detection of more patients with CSF leak.

In this study, between the leak-positive and negative groups, an age of < 69 years was significantly associated with the presence of CSF leak. However, patients aged ≥ 69 years also had tendency to exhibit SIH-induced SDH (14/23; 60.87%); interestingly SIH-induced SDH was seen in patients with older age than in the study by Beck (≤ 60 years). These suggest that clinicians need to broaden the patients' age-related indication to a higher age group for CT myelography to detect CSF leak, in patients with nontraumatic SDH. Also, it is noteworthy that there were no other variables, except age, that showed significant differences between

the leak-positive and negative groups, including orthostatic headache and typical SIH-related MRI findings. Although these results may have been derived from the small number of cases in this study, it should be noted that the absence of postural headache or well-known typical SIH-related MRI features in patients with nontraumatic SDH does not mean that SIH can be completely excluded in clinical practice. Variable clinical and imaging factors should be taken into consideration altogether when selecting patients who needed CT myelography.

The standard management strategy for SDH generally involves decompression surgery or conservative care with close observation depending on the age of the hematoma, degree of the midline shift, clot thickness, and neurological status [4, 20]. However, a different treatment strategy is necessary for the sealing of CSF leak in patients with SIH-induced SDH [21-24]. Therefore, for optimal treatment in some patients with SDH, recognition of the possibility of SIH as a cause of SDH is important [8]. The percentage of reoperation in patients with SDH varies depending on the literature. According to one study, reoperation rate for chronic SDH is 9.4 to 19.5% [15]. In the current study 31 patients of the leak-positive group underwent surgical removal of hematoma and among them 3 patients needed reoperation (9.7%) after EBP. This figure meets the low margin of the previously reported range and it suggests that timely diagnosis of SIH and subsequent EBP may allow a good outcome in patients with SIH induced SDH.

This study has several limitations. First, it was a retrospective study and we cannot ignore other conditions that may have played a role in selecting patients for CT myelography, such as symptom onset, symptom duration, etc., which were not always clearly stated

in the electronic medical records. Furthermore, since only small number of patients who underwent brain MRI were selected as the control group, the control group cannot be regarded as a complete representative of cases without SIH. Further prospective and large-scale studies are needed to reveal the incidence of SIH in cases of nontraumatic intracranial SDH and to find significant clinical and imaging findings indicating SIH. Second, it is possible that relatively small amount leak which is not large enough to be detected on CT myelography was missed and it could falsely lower the percentage of the leak-positive cases. In further researches, MR myelography with intrathecal gadolinium, which is considered an effective medium for the detection of low flow leak, can be considered.

5. Conclusion

If variable clinical and imaging factors are taken into consideration when selecting patients who needed CT myelography, more cases with CSF leak can be diagnosed in patients with nontraumatic intracranial SDH. Clinicians need to broaden the patients' age-related indication to a higher age group for CT myelography to detect CSF leak. Also, the absence of postural headache or well-known typical SIH-related MRI features in patients does not mean that SIH can be completely excluded in clinical practice. Timely diagnosis of SIH and subsequent EBP may allow a good outcome in patients with SIH induced SDH.

6. Disclosure

Before this paper, an article on a similar topic and a similar patient group by the same researchers was published in December 2021 (*Diagnostics* 2021;11:2278.)

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초 록

본원에서 비외상성 두개내 경막하혈종 환자를 대상으로 CT 척수강조영술을 시행하는 경우 기존 문헌에 보고된 것보다 높은 빈도로 뇌척수액 누수가 확인되어, 이에 본원 CT 척수강조영술 적용 기준을 살펴보고 비외상성 두개내 경막하혈종 환자에서 CT 척수강조영술을 필요로 하는 유의미한 임상 및 영상 소견을 밝혀내고자 하였다.

2012년 1월부터 2018년 3월 사이 비외상성 두개내 경막하혈종으로 진단받고 CT 척수강조영술을 시행 받은 환자(60명)와 비외상성 두개내 경막하혈종으로 진단받았으나 CT 척수강 조영술을 시행 받지 않은 환자(50명)를 대상으로 하였다. 전자의 환자는 CT 척수강조영술 결과에 따라 뇌척수액 누수가 존재하는 군과 그렇지 않은 군으로 분류되었다. 연구진은 이 세 군 사이의 임상적 소견 및 자기공명영상 소견을 통계학적으로 분석하였으며 비외상성 두개내 경막하혈종 환자는 다음과 같은 경우에 유의미하게 CT myelography를 시행 받는 경향이 있었다 : 낮은 연령인 경우, 아스피린이나 클로피도그렐을 복용하지 않는 경우, 편측성 위약감을 보이지 않는 경우, 보행장애를 보이지 않는 경우, Glasgow coma scale 점수가 정상인 경우, 기립성 두통이 있는 경우, 자세와 무관한 두통이 있는 경우, 자기공명영상에서 양측성 경막하 혈종, 비교적 얇은 혈종두께, 경질막 비후/조영증강, 수조폐쇄, 횡단정맥의 팽창, 교뇌-중뇌 사이각 감소, 유두체-교뇌 간격 감소를 보이는 경우. 이렇게 CT myelography 시행 받은 례의 80%에서 뇌척수액 누수를 보였으며, 누수를 보이는 군은 누수를 보이지 않는 군에 비해 통계적으로 유의미하게 낮은 연령(69세 미만)이었으나 69세 이상의 환자에서도 뇌척수액 누수를 보이는 경향이 있었다(14/23; 60.87%).

비외상성 두개내 경막하혈종 환자에서 상기 기술된 다양한 임상적, 영상적 소견을 고려하여 뇌척수액 누수 확인 검사가 필요한 환자군을 선택한다면 기존 문헌에 보고된 것보다 높은 비율로 뇌척수액 누수가 있는 자발성 두개내 저혈압 환자를 진단할 수 있어 시기적절한 치료가 가능하다. 기존 문헌에 보고된 것에 비해 고연령인 경우에도 자발성 두개내 저혈압 환자가 있을 수 있다는 점에 주의하여야 한다.

주요어 : 두개내 경막하혈종, 비외상성, 자발성 두개내 저혈압, CT

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