

ORIGINAL ARTICLE

Airplane flights triggering spontaneous intracranial hypotension: Observations from the Danish headache centre

Vlasta Vukovic-Cvetkovic  | Henrik W. Schytz

Danish Headache Center, Rigshospitalet-Glostrup, University of Copenhagen, Copenhagen, Denmark

Correspondence

Vlasta Vukovic-Cvetkovic, Danish Headache Center, Rigshospitalet-Glostrup, University of Copenhagen, Valdemar Hansens vej 5, 2600 Glostrup, Copenhagen, Denmark.
Email: vlasta.vukovic@uclmail.net

Objective: Spontaneous intracranial hypotension (SIH) manifests as orthostatic headache, which can be confirmed by radiological signs of low intracranial pressure on magnetic resonance imaging of the brain. The most common mechanisms of SIH are ruptured meningeal diverticula, ventral dural tears and CSF-venous fistulas. SIH is associated with connective tissue disorders, and cases of SIH onset after trivial trauma have been reported. As SIH is often underdiagnosed, the aim of this study is to identify possible new risk factors of SIH onset in a case series of SIH patients.

Materials and methods: We retrospectively reviewed the medical records of 36 patients diagnosed with SIH. We reviewed and identified potential factors that led to or presented at headache onset in SIH patients.

Results: We identified 4/36 (11%) patients that had a close temporal relationship between the onset of SIH symptoms and airplane travel. In all four patients, the clinical and imaging features confirmed the diagnosis of SIH.

Conclusion: This is the first report of a case series of four patients with SIH that could be related to airplane travel. Describing four cases (11%) is not proof but should alert us to a possible causal relationship, which calls for further research. We suggest that when taking medical history, thorough details about the patient's activities, such as headache onset, should be documented because of their importance in correctly diagnosing SIH, which is a debilitating, yet treatable, disease.

KEYWORDS

airplane, headache, spontaneous intracranial hypotension, trigger

1 | INTRODUCTION

Spontaneous intracranial hypotension (SIH) is the result of spinal cerebrospinal fluid leaks that manifests as orthostatic headache, which can be confirmed by radiological signs of low intracranial pressure using magnetic resonance imaging (MRI) of the brain. The three most common mechanisms for spontaneous cerebrospinal fluid leaks are ruptured meningeal diverticula, ventral dural tears and cerebrospinal fluid venous fistulas.¹⁻⁴

Cerebrospinal fluid leaks may be caused by minor neck movements or minimal trauma, such as sneezing, coughing, hysterical crying and chiropractic manipulation of the neck.⁵⁻⁷ An association with connective tissue disorders, such as Marfan and Ehlers-Danlos syndromes, have been described.^{8,9} Furthermore, discogenic microspurs have been identified as a major cause of intractable IH.¹⁰

The most frequent symptom in patients with SIH is orthostatic headache; however, the headache is alleviated in a recumbent position.^{3,11} MRI findings of the brain in most patients are characterized

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2022 The Authors. *Acta Neurologica Scandinavica* published by John Wiley & Sons Ltd.

by diffuse pachymeningeal gadolinium enhancement on T1-weighted images, subdural effusions hyperintense on T2-weighted images and other radiological signs, such as pituitary engorgement, brain sagging/descent of the cerebellar tonsils, flattening of the pons against the clivus, decreased ventricular volume and signs of venous distension.¹² Epidural blood patches are considered the first-choice treatment in SIH patients with severe symptoms that are nonresponsive to pharmacological treatments^{13,14}; however, no controlled trials are available.

In this article, we describe 4 cases in which the onset of SIH symptoms was temporally related to airplane travel. Next, we review the existing literature.

2 | MATERIALS AND METHODS

In this case series, we retrospectively (from March 2003 to June 2021) reviewed the medical records of 36 patients (61% women) diagnosed with SIH in our outpatient clinic. The diagnosis was based on clinical presentation, and supported by neuroimaging findings. The Danish Headache Centre is a tertiary headache centre in the Department of Neurology, Rigshospitalet-Glostrup affiliated with the University of Copenhagen and the Centre functions as a national referral centre for severely affected headache patients in Denmark.

Patients with previous trauma or lumbar puncture were excluded from the study. The following data were collected and analysed: demographic variables, onset and description of clinical symptoms, possible trigger factors, comorbidities and neuroimaging findings.

We identified four cases that had a close temporal relationship between airplane flight and headache onset. In all four patients, the clinical and imaging features confirmed the diagnosis of SIH, in accordance with the International Classification of Headache Disorders 3rd edition criteria.¹⁵ In the results, we focused only on the four patients in which a connection between airplane travel and the onset of SIH symptoms was suspected.

3 | RESULTS

The average age of symptom onset was 45 years (range 19–75 years); (mean age was 47 in women; 42 in men), 61% were women. In total, 4/36 (11%) of patients recalled that headache onset was related to airplane travel (3), bicycle ride and relapse in the same patient after airplane travel (1), physical activity (3), body flexion (2), massage (1), yoga exercise (1), minor trauma (1) and chiropractic treatment and relapse after jogging in the same patient (1).

The demographic data, comorbidities and possible trigger factors for the whole group of analysed patients are shown in [Table 1](#).

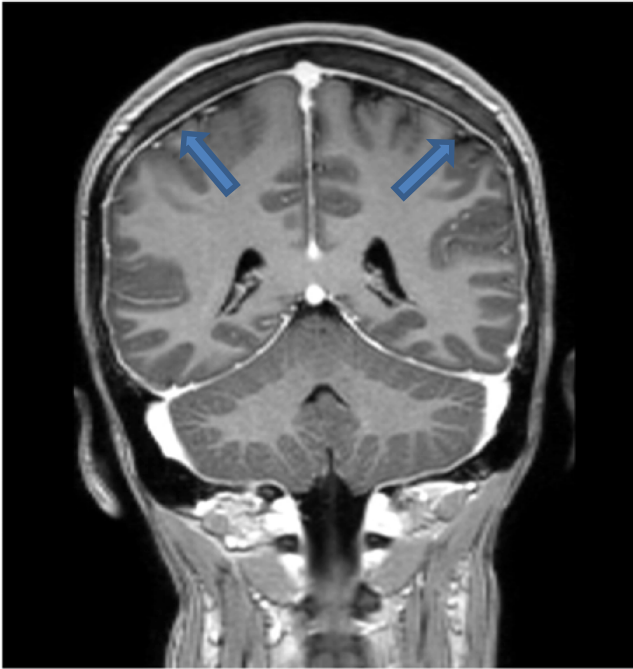
We discussed in more detail the four cases in which SIH symptom onset was closely related to airplane travel.

3.1 | Case one

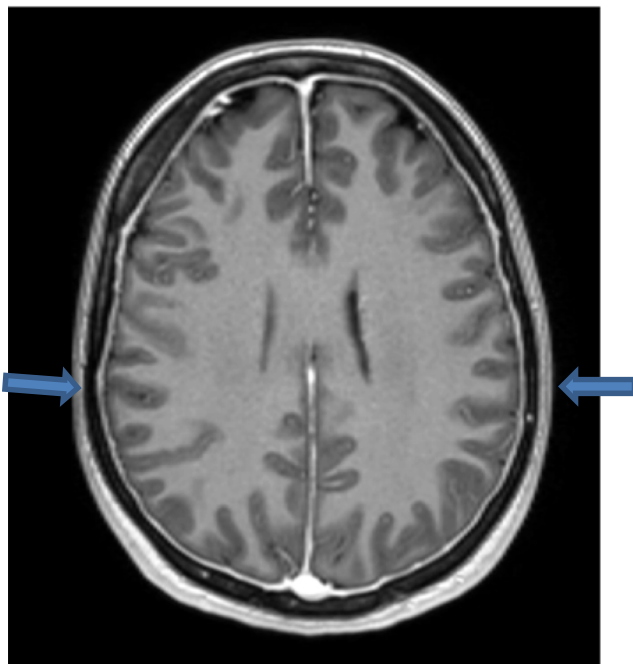
The patient was a 30-year-old female with an existing diagnosis of episodic migraine with aura attacks. A couple of hours after a commercial flight, she began to suffer from a new type of headache. The headache intensity was 8–9 on a visual analogue scale, ranging from 0 to 10, with pressing, bilateral pain and nonspecific dizziness. Nausea and vomiting occurred when headache was most intense but photo- and phono-phobia did not occur. The headache always occurred in an upright position and was instantly relieved in the recumbent position. One-month later, MRI of the brain showed diffuse pachymeningeal gadolinium enhancement, please see [Figures 1 and 2](#). Treatment with analgesics and caffeine was insufficient. She received three epidural blood patches and experienced little relief after the first two patches; however, full relief was achieved after the third epidural blood patch, which was applied 1 month after onset. The result of a control MRI of the brain taken 2 months after the third epidural blood patch was normal. At the 6 months follow-up visit, she only had usual episodic attacks of migraine with aura, with the same frequency as before SIH.

TABLE 1 Demographic data

Nr (36)	Sex (nr) men=M women=W	Mean age (range)	Possible trigger (nr)	Comorbidities (nr)
Suspected relation to airplane travel (4)	M 2 W 2	45 (30–53)	airplane travelling (3) bicycle ride and relapse after airplane travel (1)	endometriosis (1)
Others (32)	M 12 W 20	45 (19–75)	physical activity (3) body flexion (2) massage (1) yoga exercise (1) minor trauma (1) chiropractic treatment and relapse after jogging (1)	endometriosis (2) disc prolapse (2) hypertension (3) atrial fibrillation (1) migraine (5) factor Leiden V mutation (1) irritable bowel syndrome (1)



FIGURES 1 Pachymeningeal gadolinium enhancement



FIGURES 2 Pachymeningeal gadolinium enhancement

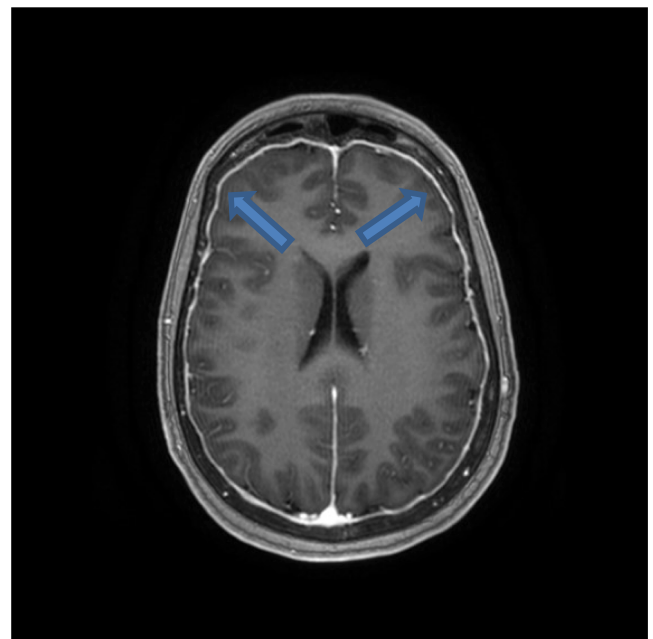
3.2 | Case two

The patient was a healthy 53-year-old female. She received her first SIH diagnosis after a bicycling tour, with no associated trauma. The headache was characterized as pressing pain, which escalated in severity from 2 to 9 on the visual analogue scale, worsened in an upright position and alleviated in a recumbent position. Accompanying symptoms were paresthesia in both arms and between the

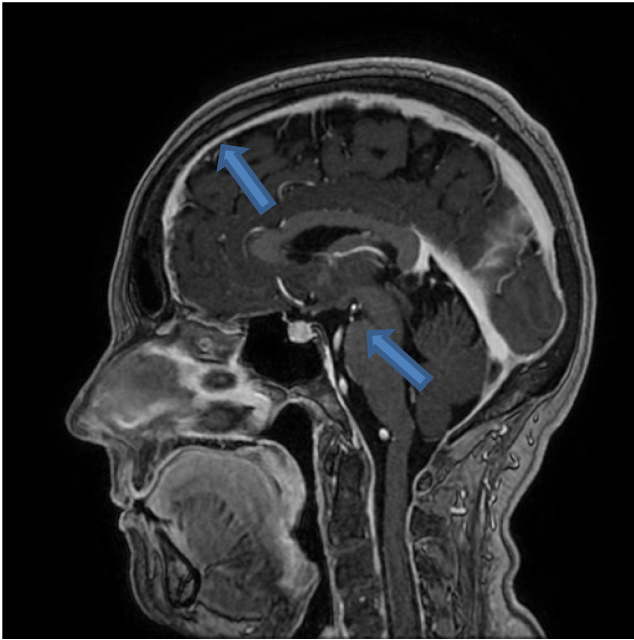
shoulders, hypoacusis, tinnitus and phonophobia. MRI of the brain and the cervical spine showed diffuse pachymeningeal gadolinium enhancement and a tapered distance between the pituitary gland and chiasma, please see [Figures 3 and 4](#). After an SIH diagnosis was established, two epidural blood patches were applied, and the effects of the first epidural blood patch lasted two days. After the second epidural blood patch was applied, she experienced relief from daily headaches but developed headaches associated with physical activity. One year later, during a commercial airplane flight, she experienced a sudden headache, the same quality to the headache she experienced after the bicycling tour. All the symptoms of SIH recurred. She received a single epidural blood patch, and all the symptoms were relieved. At the 6 months follow-up, the patient had only sporadic attacks of headache associated with physical activity.

3.3 | Case three

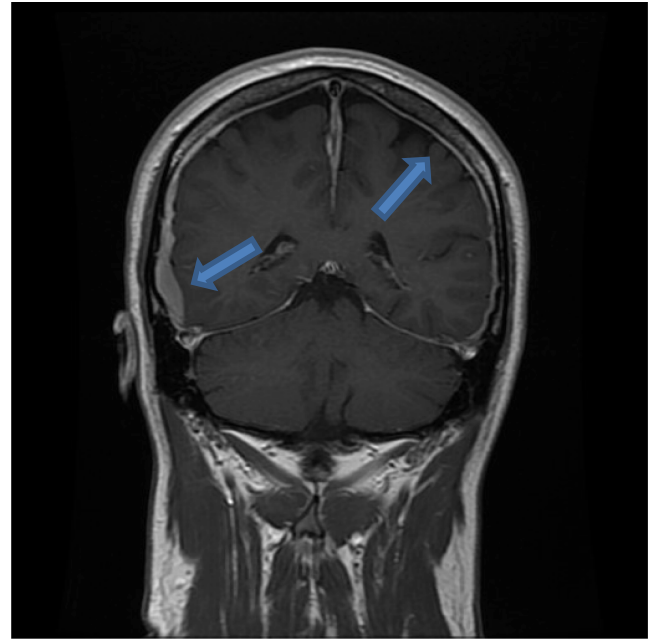
The patient was a 42-year-old healthy male who was a commercial airplane pilot. During one flight, he experienced a sudden severe headache that was continuous in an upright position and was instantly relieved in a recumbent position. The headache was characterized by pressing, bilateral pain, followed by nausea when the headache was the most painful, but there were no other accompanying symptoms. MRI of the brain showed diffuse pachymeningeal gadolinium enhancement and subdural effusions hyperintense on T2-weighted images on the right side, please see [Figures 5 and 6](#). He received epidural blood patches twice, and experienced partial relief after the first epidural blood patch was applied and full remission after the second. A control MRI of the brain that was performed after the epidural blood patch was applied showed spontaneous



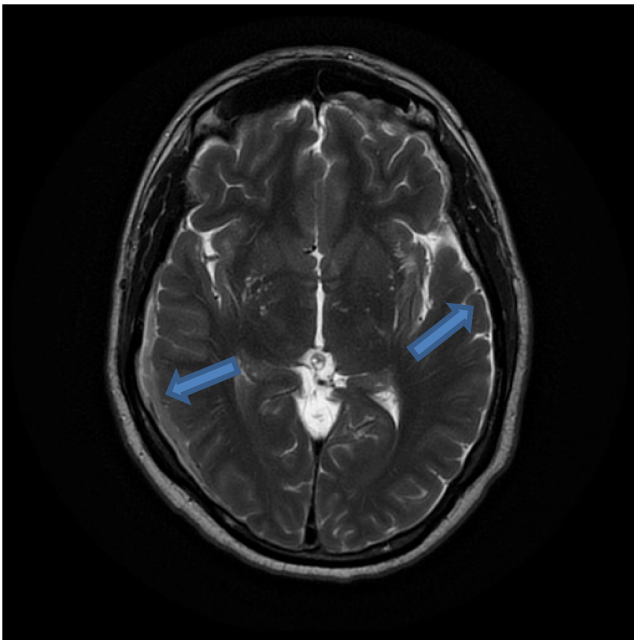
FIGURES 3 Pachymeningeal gadolinium enhancement, tapered distance between pituitary gland and chiasma



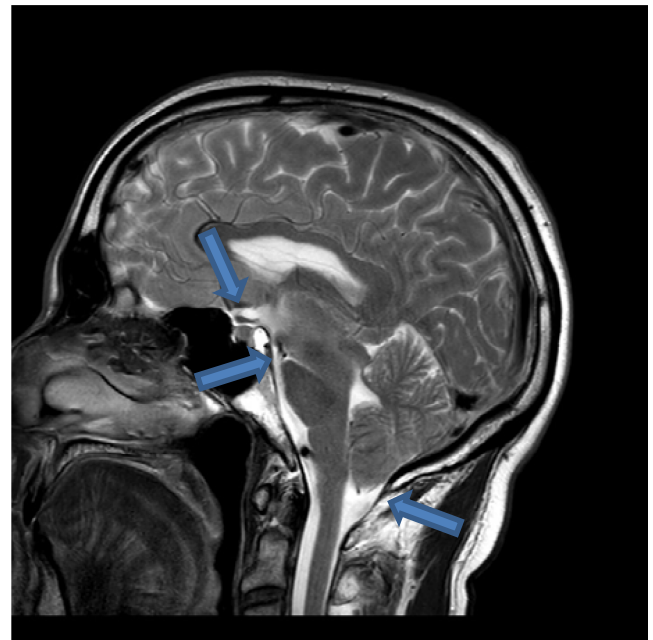
FIGURES 4 Pachymeningeal gadolinium enhancement, tapered distance between pituitary gland and chiasma



FIGURES 6 Pachymeningeal gadolinium enhancement +subdural effusion on the right side



FIGURES 5 Pachymeningeal gadolinium enhancement +subdural effusion on the right side



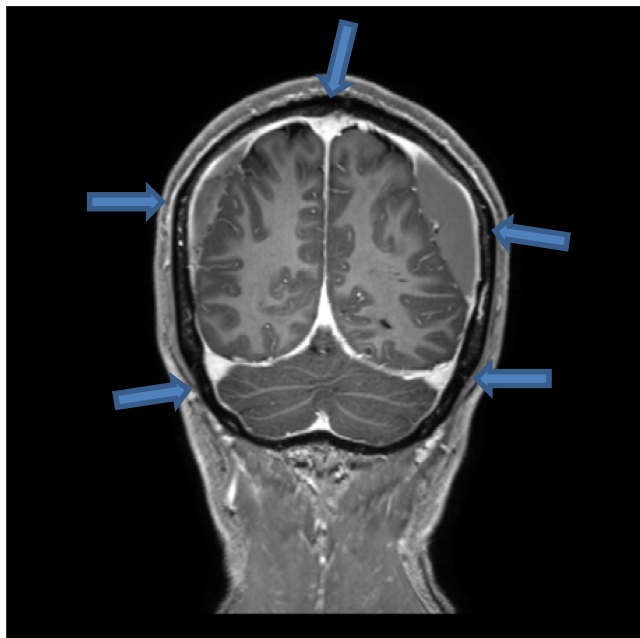
FIGURES 7 Pachymeningeal gadolinium enhancement, brain sagging, bilateral subdural effusions, signs of venous distensions

regression of the bilateral subdural effusions. The patient was discharged after 6 months of follow-up with no headache.

3.4 | Case four

The patient was a 53-year-old healthy male. Several hours after a commercial airplane flight, he experienced episodic bilateral

tinnitus, daily dizziness and continuous bilateral pressing headache with a severity of 9 on the visual analogue scale in the upright position; remarkable relief was achieved in the recumbent position. He had no other accompanying symptoms. The headache was absent in the morning but worsened, after onset, during the day over a 1 month period. The patient took daily simple analgesics and experienced no relief. MRI of the brain showed diffuse pachymeningeal gadolinium enhancement, signs of venous distension, brain sagging



FIGURES 8 Pachymeningeal gadolinium enhancement, brain sagging, bilateral subdural effusions, signs of venous distensions

and bilateral subdural effusions hyperintense on T2-weighted images, please see [Figures 7 and 8](#). The patient was treated with an epidural blood patch 6 months after onset and experienced temporary relief. The patient was then treated with a second epidural blood patch 7 months after headache onset, which resulted in complete relief of all symptoms. At the 6 months follow-up, the patient was still headache free.

4 | DISCUSSION

To the best of our knowledge, this is the first report of four cases of SIH that are possibly precipitated by airplane travel. However, a case report of a patient with worsening intracranial hypotension symptoms during airplane travel has been described.¹⁶ A close temporal relationship between airplane travel and the onset of symptoms raises suspicion that there may be a causative relationship. In three patients, the onset of symptoms occurred *de novo*, and in one patient, a relapse of symptoms occurred after previous successful SIH treatment.

According to a recent meta-analysis, the most common leak location is the thoracic spine (41% of cases), followed by the cervicothoracic junction (25%), the cervical spine (14%) and the lumbar spine (12%).⁴ Discogenic microspurs are frequently reported as causes of SIH (10). Connective tissue disorders, such as Marfan and Ehlers-Danlos syndromes, may be more commonly found in patients with SIH.^{8,9} However, none of our patients had a history or diagnosis of connective tissue disorders or clinically significant spinal deformities.

As all our patients responded well to the treatment with one or up to three epidural blood patches, but we did not perform additional diagnostic work-up, such as MRI of the spine or computed myelography, which could possibly reveal cysts or cerebrospinal fluid venous fistulas.

Sometimes, SIH occurs in patients as a result of mild trauma, such as after sneezing and coughing,⁵⁻⁷ but a clear association with these minor traumas can be difficult to determine, especially after months or years, due to recall bias. Our patients did, however, recall a clear relationship between headache onset and airplane flight.

There are several well-documented conditions associated with airplane travel. Headache attributed to airplane travel¹⁵ is a secondary headache that occurs in 90% of affected people during landing. Attacks are clinically stereotyped, presenting as a severely painful unilateral headache, usually of jabbing or stabbing pain quality, localized in the orbitofrontal region, which spontaneously improves within 30 min after ascent or descent. Sinus barotrauma has been proposed as the main cause of headache attributed to airplane travel.^{17,18} Studies have indicated that 4%–8% of air-travellers experience headache attributed to airplane travel.^{19,20} Interestingly, it has been shown that pulmonary artery pressure increases during commercial air travel in healthy passengers.²¹ Furthermore, cases of spontaneous pneumopericardium, pneumomediastinum and transient facial paresis on airline flights have been reported.²²⁻²⁵ These cases are likely due to decreased pressure within the airplane cabin, which decreases to a pressure corresponding to an altitude of ~2440 m in flight.²⁶ Furthermore, aggravation of SIH symptoms during a stay at high altitude has previously been described in two cases.^{27,28}

All four of our patients were healthy, did not suffer from connective tissue disorders nor had a history of trauma. In all the patients, the headache started in close temporal proximity to a flight on a commercial airplane but did not resolve, when compared with patients who had a headache attributed to airplane travel. The precise time of headache onset was not possible for our patients to recall; so, it is not possible to determine whether the patients developed headaches during take-off or landing. However, all four patients mentioned that their headache started in relation to the airplane flight.

Furthermore, unlike headache attributed to airplane travel, all four of our patients showed clear phenotypic and clinical signs of SIH and neuroimaging signs of pachymeningeal gadolinium enhancement. Therefore, according to the diagnostic criteria for SIH and headache attributed to airplane travel, our patients met the criteria for SIH. After treatment with epidural blood patches, the positional headache and other symptoms remitted, as well as the signs of SIH on brain imaging.

Although the diagnostic work-up in all SIH patients did not reveal the precise site or the cause of the leakage, it is likely that patients who developed SIH during flight had meningeal diverticulas. The

diverticula may be prone to rupture due to swelling associated with lower cabin pressure. A discogenic microspur may also be the cause, because the patients may have placed their heads in an unusual position while flying.

5 | CONCLUSION

To the best of our knowledge, this is the first report of four patients with spontaneous intracranial hypotension that could be related to an airplane flight. This is not proof but should alert us to a possible causal relationship, which calls for further research. Only a large multicentre case-control study could provide more data on this issue.

However, we feel that our observations are interesting, and we suggest that when taking medical history, the activities related to headache onset and location of the patient at headache onset should be considered to avoid misdiagnosing a potentially debilitating, but treatable disorder, such as SIH. Complications associated with SIH are rare but potentially serious, and early radiological diagnosis favours proper management.²⁹

ACKNOWLEDGEMENTS

No acknowledgements.

CONFLICTS OF INTEREST

Our institution does not require approval by IRB for this case series. Hereby, we declare that there are no conflicts of interest from either of the authors.


PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1111/ane.13626>.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Vlasta Vukovic-Cvetkovic  <https://orcid.org/0000-0003-4963-4541>

REFERENCES

- Kumar N, Diehn FE, Carr CM, et al. Spinal CSF venous fistula: a treatable etiology for CSF leaks in craniocervical hypovolemia. *Neurology*. 2016;86(24):2310-2312.
- Enomoto N, Mure H, Okazaki T, et al. Posttraumatic cerebrospinal fluid leak associated with an upper cervical meningeal diverticulum. *World Neurosurg*. 2018;116:50-55.
- Kranz PG, Gray L, Malinzak MD, Amrhein TJ. Spontaneous intracranial hypotension: pathogenesis, diagnosis, and treatment. *Neuroimaging Clin N Am*. 2019;29:581-594.
- D'Antona L, Jaime Merchan MA, Vassiliou A, et al. Clinical presentation, investigation findings, and treatment outcomes of spontaneous intracranial hypotension syndrome: a systematic review and meta-analysis. *JAMA Neurol*. 2021;an4:e204799.
- Lin SF, Weng HY. Postural headaches due to cerebrospinal fluid leakage through subarachnoid-pleural fistula: a case report. *Headache*. 2017;57:467-471.
- Haider MN, Leddy JJ, Hinds AL, et al. Intracranial pressure changes after mild traumatic brain injury: a systematic review. *Brain Inj*. 2018;32:809-815.
- Chen CT, Lai HY, Chang TW, Lee CY. Repeated spontaneous intracranial epidural hemorrhage after hysterical crying. *World Neurosurg*. 2018;114:34-36.
- Schievink WI, Gordon OK, Tourje J, et al. Connective tissue disorders with spontaneous spinal cerebrospinal fluid leaks and intracranial hypotension: a prospective study. *Neurosurgery*. 2004;54:65-70.
- Schrijver I, Schievink WI, Godfrey M, Meyer FB, Francke U. Spontaneous spinal cerebrospinal fluid leaks and minor skeletal features of Marfan syndrome: a microfibrilopathy. *J Neurosurg*. 2002;96:483-489.
- Beck J, Ulrik CT, Fung C, et al. Diskogenic microspurs as a major cause of intractable spontaneous intracranial hypotension. *Neurology*. 2016;20(87):1220-1226.
- Mokri B. Spontaneous low pressure, low CSF volume headaches: spontaneous CSF leaks. *Headache*. 2013;53:1034-1053.
- Kranz PG, Tanpitukpongse TP, Choudhury KR, Amrhein TJ, Gray L. Imaging signs in spontaneous intracranial hypotension: prevalence and relationship to CSF pressure. *AJNR Am J Neuroradiol*. 2016;37:1374-1378.
- Pagani-Estévez GL, Cutsforth-Gregory JK, Morris JM, et al. Procedural predictors of epidural blood patch efficacy in spontaneous intracranial hypotension suggest that the volume of injected blood. *Reg Anesth Pain Med*. 2019;13:pil: rapm-2018-000021.
- Levi V, Di Lorenzo NE, Franzini A, et al. Lumbar epidural blood patch: effectiveness on orthostatic headache and MRI predictive factors in 101 consecutive patients affected by spontaneous intracranial hypotension. *J Neurosurg*. 2019;8:1-9.
- Headache classification committee of the international headache society (IHS) the international classification of headache disorders, 3rd edition. *Cephalgia*. 2018;38:1-211.
- Kush D, Salman A. Intracranial hypotension induced due to in-flight worsening of spontaneous cerebrospinal fluid leak. *Crit Care Med*. 2018;46(suppl. 1):365.
- Bui SBD, Gazerani P. Headache attributed to airplane travel: diagnosis, pathophysiology, and treatment - a systematic review. *J Headache Pain*. 2017;18:84.
- Mainardi F, Lisotto C, Maggioni F, Zanchin G. Headache attributed to airplane travel ('airplane headache'): clinical profile based on a large case series. *Cephalgia*. 2012;32:592-599.
- Mainardi F, Maggioni F, Volta GD, et al. Prevalence of headache attributed to aeroplane travel in headache outpatient populations: an Italian multicentric survey. *Cephalgia*. 2019;39:1219-1225.
- Bui SBD, Petersen T, Poulsen JN, Gazerani P. Headaches attributed to airplane travel: a danish survey. *J Headache Pain*. 2016;17:33.
- Smith TG, Talbot NP, Chang RW, et al. Pulmonary artery pressure increases during commercial air travel in healthy passengers. *Aviat Space Environ Med*. 2012;83:673-676.
- Morgan J, Sadler MA, Yeghiayan P. Spontaneous pneumomediastinum in a patient with recent air travel. *Emerg Radiol*. 2007;14:457-459.
- Nicol E, Davies G, Jayakumar P, Green ND. Pneumopericardium and pneumomediastinum in a passenger on a commercial flight. *Aviat Space Environ Med*. 2007;78:435-439.
- White R, Shackleton D. Plane palsy: a case of transient facial weakness during an aircraft flight. *BMJ Case Rep*. 2018;6(2018):pii: bcr-2018-224593.
- Vivekananda U, Omer S. Transient facial weakness whilst on a flight. *J Neurol Sci*. 2017;375:299-300.
- Silverman D, Gendreau M. Medical issues associated with commercial flights. *Lancet*. 2008;373:2067-2077.

27. Hasiloglu ZI, Abuzayed B, Cagil E, Keser Z, Selcuk H, Albayram S. High altitude-related intracranial hypotension syndrome: unusual combined syndrome. *Clin Neurol Neurosurg*. 2011;113(9): 816-818.
28. Batsis JA, Phy MP. Intracranial hypotension: aggravation of headache at high altitude. *Headache*. 2005;45(4):380-384.
29. Girão MMV, Sousa RMP, Ribeiro MC, et al. Spontaneous intracranial hypotension and its complications. *Arquivos De Neuro-Psiquiatria (Online)*. 2018;76:507-511.

How to cite this article: Vukovic-Cvetkovic V, Schytz HW. Airplane flights triggering spontaneous intracranial hypotension: Observations from the Danish headache centre. *Acta Neurol Scand*. 2022;146:92-98. doi:[10.1111/ane.13626](https://doi.org/10.1111/ane.13626)