Table S1. Thalamic nuclei and their functions.

Nuclei	Afferent Pathways	Efferent Pathways	Function
Anterior			
Anterodorsal, anteromedial, and anteroventral	Hypothalamic medial mammillary nucleus. Cingulate gyrus. Subiculum. Mammillothalamic tract. Brain stem. Ventral globus pallidus. Cortex (23, 24, 25 Brodmann areas). Entorhinal cortex.	Mammillothalamic tract. Subiculum. Cingulate gyrus. Cortex (23, 24, 25 Brodmann areas). Entorhinal cortex.	Limbic circuits (emotions and motivation). Recent memory. Learning.
Dorsal			
Dorsal lateral (DL)	Superior colliculus. Pretectal area.	Cingulate gyrus. Subiculum. Posterior parahippocampal gyrus.	Memory. Sight. Pain modulation.
Lateral posterior (LP)	Parietal cortex. Superior colliculus.	Parietal cortex. Cingulate gyrus. Parahippocampal gyrus. Ventral posterior thalamic nuclei.	
Pulvinar (lateral)	Superior colliculus. Medial geniculate. Amygdala.	Visual cortex. Temporal association cortex. Parietal cortex. Prefrontal cortex.	Memory. Attention.
Pulvinar (inferior)		Visual cortex	
Pulvinar (medial)		Parietal and temporal association cortex. Inferior parietal cortex. Posterior cingulate gyrus. Prefrontal cortex. Orbitofrontal cortex. Entorhinal cortex.	
Intralaminar			
Central-lateral, central-medial, and paracentral	Ascending reticular formation. Superior colliculus. Cerebral cortex. Pretectal nucleus.	Cerebral cortex. Striatus.	Motor and sensitive pathways relay. Arousal. Motivation.
Central-median, and parafascicular	Ascending reticular formation. Inner globus pallidus. Substantia nigra. Cerebellar nuclei. Somatomotor cortex.	Subthalamic nucleus. External globus pallidus.	
Medial			
Mediodorsal (Parvicellular) and Mediodorsal (Magnocellular)	Amygdala. Olfactory cortex. Ventral pallidus.	Inner globus pallidus. Prefrontal cortex. Posterior parietal cortex. Lateral thalamic nuclei. Intralaminar thalamic nuclei.	Memory. Emotions. Pain modulation. Motivation. Attention. Horizontal gaze.
Midline			
Paratenial, paraventricular, reuniens, and rhomboidal	Hypothalamus. Periaqueductal grey. Locus coeruleus. Rafe magnum nuclei. Cholinergic mesencephalic nuclei. Spinal lemniscus.	Hypothalamus. Nucleus accumbens. Amygdala. Cingulate gyrus.	Arousal. Motivation. Emotions.
Reticular	Cerebral cortex. Cortical-thalamic pathway. Intralaminar thalamic nuclei. Ascending reticular formation.	Intralaminar thalamic nuclei. Midline thalamic nuclei.	Relay.
Ventral			
Posterolateral (VPL)	Spinal lemniscus. Medial lemniscus.	Primary and secondary somatosensory cortex	Specific sensitive pathways.
Posteromedial (VPM)	Trigeminal lemniscus. Gustatory lemniscus.	Primary and secondary somatosensory cortex. Gustatory cortex.	Specific sensitive pathways. Gustatory pathways.
Medial (VM)	Substantia nigra	Frontal cortex.	Movement.
Anterior ventrolateral (VLA)	Inner globus pallidus	Motor cortex.	

Posterior ventrolateral (VLP)	Cerebellum.	Motor cortex. Supplementary motor area. Prefrontal cortex.	
Anterior (VA)	Substantia nigra. Inner globus pallidus.	Premotor cortex.	
Geniculate bodies			
Medial	Optic tract.	Superior colliculus. Visual cortex.	Sight.
Lateral	Inferior colliculus.	Auditory cortex.	Hearing.

Table S2. PRISMA checklist.

Section and Topic	Item #	Checklist Item	Location Where Item Is Reported (Page)
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1,3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	1,3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5,6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	6
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	6

	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7,8
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	7,8
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	7
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	7,8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	7,8
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7,8
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7,8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	7,8
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	7,8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	7,8
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	9-10
	23b	Discuss any limitations of the evidence included in the review.	10
	23c	Discuss any limitations of the review processes used.	10
	23d	Discuss implications of the results for practice, policy, and future research.	10
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	1,5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	1,5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N.A.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	2
Competing interests	26	Declare any competing interests of review authors.	2

Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	2

N.A. = not applicable. # = number. *From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. DOI:10.1136/bmj.n71.

Table S3. Characteristics of the population included.

Parameters	n	%
Population characteristics		
Males	12	66.7
Females	6	33.3
Total	18	100.0
Clinical presentation		
speech disturbances	3	16.7
motor impairment	12	66.7
consciousness alterations	14	77.8
paresthesia	2	11.1
nausea/vomit	1	5.6
headache	2	11.1
urine incontinence	1	5.6
impaired ocular movements	3	16.7
amnesia	1	5.6
Causes		
Hypertension	11	61.1
Hypertension + coagulopathy	1	5.6
coagulopathy	1	5.6
Infection	2	11.1
Hyperperfusion syndrome	1	5.6
Intracranial arteriovenous fistula	1	5.6
Surgery complication	1	5.6
Outcome		
Optimal	2	11.1
Good	2	11.1
Poor	8	44.4
Dead	4	22.2
nd	2	11.1
Imaging techniques		
(Diagnosis)		
CT	13	72.2
MRI	4	22.2
CT + MRI	1	5.6
(Follow-up)		
CT	0	0.0
MRI	4	22.2
MRI + SPECT	1	5.6
MRI + MRIV + Angiography	1	5.6
nd	11	61.1
none	1	5.6

SPECT = single-photon emission computed tomography; MRIV = magnetic resonance imaging venography; CT = computed tomography; MRI = magnetic resonance imaging; nd = not described.

Table S4. Neurological evaluation, imaging findings, and neurological outcomes of the patients included in the systematic review.

n	Reference	Signs and Symptoms	GCS (*)	Imaging (Diagnosis, Follow Up)	Outcome	mRS	Further Specifications	Synthetic Evaluation
1	Vallejos C. et al., 2006 (case 1) [10]	Dysarthria. Right hemiparesis.	nd	CT, MRI	Discharged	2	None	Good
2	Yen C. P. et al., 2004 (case 3) [11]	Consciousness reduction. Quadriparesis.	11	CT, nd	Discharged	nd	ADL 6	Poor
3	Yen C. P. et al., 2004 (case 7) [11]	Quadriparesis	13	CT, nd	Discharged	nd	ADL 5	Poor
4	Yen C. P. et al., 2004 (case 8) [11]	Quadriparesis	11	CT, nd	Discharged	nd	ADL 4	Good
5	Takeuchi S. et al., 2011 (case 12) [12]	Consciousness reduction.	6	CT, nd	Death	6	None	Death
6	Takeuchi S. et al., 2011 (case 18) [12]	Consciousness reduction.	4	CT, nd	Death	6	None	Death
7	Ghoreishi A. et al., 2021 [13]	Right hemiparesis. Facial paresthesia. Nausea. Vomiting. Drowsiness.	nd	CT, MRI	Discharged	0	No neurological issues.	Optimal
8	Al-Shahwani Z. A. et al., 2024 [14]	Generalized headache. Drowsiness. Urine incontinence. Right upper motor facial palsy. Right hemiplegia.	10	CT + MRI, nd	Discharged	nd	None	nd
9	Dromerick A. W. Et al., 1997 [15]	Stupor. Downward eyes deviation. Flexion posturing to pain. Mild right hemiparesis. Dysnomia.	nd	CT, nd	Discharged	nd	Severe global anterograde amnesia. Moderate retrograde memory loss. Mild left spatial inattention.	Poor
10	Imai K. Et al., 2000 [16]	Drowsiness. Quadriparesis. Skew deviation.	nd	CT, MRI	Discharged	nd	Persistent skew deviation. Apallic syndrome with spontaneous movements in right arm.	Poor
11	Malandrini A. et al., 2004 [17]	Coma.	nd	MRI, nd	Death	6	None	Death
12	Turkar A. et al., 2021 [18]	Coma.	nd	CT, none	Death	6	None	Death
13	Rezende M. T. et al., 2006 [19]	Agitation alternated with apathy.	nd	MRI, nd	Discharged	0	No neurological issues.	Optimal
14	Choudhary A. et al., 2018 [20]	Sudden onset of loss of consciousness. Right hemiplegia. Right facial paresis.	nd	CT, MRI + MRIV + Ang	Discharged	4	None	Poor
15	Brenner A. et al., 2021 [21]	Headache. Loss of consciousness. Left-side paresthesia. Global aphasia. Left hemineglect. Left lip deviation.	nd	CT, nd	Discharged	nd	None	nd
16	Ng Y. S. et al., 2013 [22]	Drowsiness alternated with agitation. Anterograde amnesia.	nd	CT, Ang	Discharged	nd	Mild short-term memory deficit, impaired executive function and visual and spatial awareness	Poor

17	Vandenborre D. et al., 2015 [23]	Right hemiparesis. Right ataxia. Severe cognitive deficits. Impaired proprioception at the right side.	nd	MRI, MRI + SPECT	Discharged	nd	Severe cognitive impairment. Apraxic agraphia.	Poor
18	Schachter D. et al., 2025 [24]	Vertical gaze palsy. Left hemiparesis. Dysarthria. Drowsiness.	nd	CT, MRI	Discharged	4	None	Poor

Abbreviations: (CT) computed tomography; (MRI) magnetic resonance imaging; (MRIV) magnetic resonance venography; (Ang) angiography; (mRS) modified Rankin scale score; (ADL) activities of daily living; (nd) data not described by the author; (none) no further data described into the report that are relevant for the aim of this review; (SPECT) single-photon emission computed tomography; (*) at the initial medical evaluation; (GCS) Glasgow coma scale.

Data S1. Articles Retrieval and Bias Risk Assessment Procedures

S1. Database Search Strategies

S1.1. Pubmed

Search dates
From database inception (1953) to 28 February 2026

Query
bilateral AND (thalamic OR thalamus OR thalami) AND (hemorrhage OR hematoma OR bleeding)

Full MeSH terms
((((“bilateral”[All Fields] OR “bilaterally”[All Fields] OR “bilaterals”[All Fields]) AND (“thalamically”[All Fields] OR “thalamus”[MeSH Terms] OR “thalamus”[All Fields] OR “thalamic”[All Fields])) AND “AND”[All Fields]) AND (“blood”[MeSH Subheading] OR “blood”[All Fields] OR “blood”[MeSH Terms] OR “bloods”[All Fields] OR “haematology”[All Fields] OR “hematology”[MeSH Terms] OR “hematology”[All Fields] OR “haematoma”[All Fields] OR “hematoma”[MeSH Terms] OR “hematoma”[All Fields] OR “haemorrhage”[All Fields] OR “hemorrhage”[MeSH Terms] OR “hemorrhage”[All Fields] OR “haemorrhages”[All Fields] OR “hemorrhages”[All Fields] OR “haemorrhagic”[All Fields] OR “haemorrhaging”[All Fields] OR “hematologies”[All Fields] OR “haematomas”[All Fields] OR “hematomas”[All Fields] OR “hematoma s”[All Fields] OR “hematomae”[All Fields] OR “hemorrhaged”[All Fields] OR “hemorrhagic”[All Fields] OR “hemorrhagical”[All Fields] OR “hemorrhaging”[All Fields])) OR (“blood”[MeSH Subheading] OR “blood”[All Fields] OR “blood”[MeSH Terms] OR “bloods”[All Fields] OR “haematology”[All Fields] OR “hematology”[MeSH Terms] OR “hematology”[All Fields] OR “haematoma”[All Fields] OR “hematoma”[MeSH Terms] OR “hematoma”[All Fields] OR “haemorrhage”[All Fields] OR “hemorrhage”[MeSH Terms] OR “hemorrhage”[All Fields] OR “haemorrhages”[All Fields] OR “hemorrhages”[All Fields] OR “haemorrhagic”[All Fields] OR “haemorrhaging”[All Fields] OR “hematologies”[All Fields] OR “haematomas”[All Fields] OR “hematomas”[All Fields] OR “hematoma s”[All Fields] OR “hematomae”[All Fields] OR “hemorrhaged”[All Fields] OR “hemorrhagic”[All Fields] OR “hemorrhagical”[All Fields] OR “hemorrhaging”[All Fields]) OR (“bleedings”[All Fields] OR “hemorrhage”[MeSH Terms] OR “hemorrhage”[All Fields] OR “bleed”[All Fields] OR “bleeding”[All Fields] OR “bleeds”[All Fields])

Filters
No filters were used in the query.

S1.2. Scopus

Search dates
From database inception (2003) to 28 February 2026

Query
bilateral AND (thalamic OR thalamus OR thalami) AND (hemorrhage OR hematoma OR bleeding)

Filters
No filters were used in the query.

S1.3. Google Scholar

Search dates
From 1 January 1950 to 28 February 2026

Query
bilateral+AND+(thalamic+OR+thalamus+OR+thalami)+AND+(hemorrhage+OR+hematoma+OR+bleeding)

Filters
"Scientific papers only"

S1.4. SpringerLink

Search dates
From 1 January 1950 to 28 February 2026

Query
bilateral AND (thalamic OR thalamus OR thalami) AND (hemorrhage OR hematoma OR bleeding)

Filters
No filters were used in the query.

S1.5. Elsevier ScienceDirect

Search dates
From database inception (2003) to 28 February 2026

Query
bilateral AND (thalamic OR thalamus OR thalami) AND (hemorrhage OR hematoma OR bleeding)

Filters
No filters were used in the query.

S2. Deduplication Procedures

After retrieving the articles from databases, the following information were entered into a matrix: title, authors, date of publication, DOI (if available). Using the "search and selection" function of a spreadsheet software (*Microsoft Excel*, Microsoft Corporation, Redmond, WA, USA, 2021) the data were screened for any duplicates. Potentially duplicated articles were then analyzed individually and removed if all information (title, author list, date of publication, and DOI) were proved to be identical. In the event of a discrepancy in the data examined, the full-text of the paper was retrieved and manually verified.

S3. Non-English Articles

Given the rarity of the studied phenomena, we used extensive criteria for articles withdrawal; in particular, we chose to include non-English articles as well, provided they met the inclusion criteria. Articles written in foreign languages were translated using the on-line software Google Translate (Google LLC, https://translate.google.it, accessed on 18 February 2025).

S4. Bias Risk Assessment

The CASP checklist was used to assess the suitability of the retrieved articles for inclusion in the review.

The whole literature consisted of case reports or individual cases excerpted from interventional studies, observational studies or case series; consequently, the CASP tool was deemed unsuitable for properly assessing the risk of bias in the identified cases, as it does not include a checklist specifically designed for assessing the risk of bias in case reports. Conversely, the JBI tool is expressly designed for this purpose.

Based on this consideration, the CASP checklist was used exclusively to assess the suitability of the identified studies for inclusion in the review, while employing the JBI tool to evaluate the risk of bias of the included cases.

The original JBI tool aims to assess the risk of bias in an article by answering eight questions. To assess the bias risk in the cases included in our review, however, we chose to use a modified JBI checklist consisting of six questions; specifically, the following were excluded:

- “Were adverse events (harms) or unanticipated events identified and described?”

This section is aimed at describing potential adverse effects due to any novel treatment, intervention, or drug. However, the cases included in our review are not related to any of these; instead, they describe a distinctive case of a specific disease. Given that, this question was not deemed relevant for correctly assessing the bias risk for the cases included in our literature review.

- “Does the case report provide takeaway lessons?”

Given the rarity of the studied phenomena, we included in our review case reports or individual cases excerpted from other types of studies (case series, interventional studies, or observational studies). In the latter instances, the structure of the article may not adhere to the standard format for a case report; consequently, a specific section dedicated to "take-home messages" or “takeaway lessons” might be missing. Moreover, the original article from which the case was drawn, may have focused primarily on a different topic, thereby failing to give sufficient prominence to the condition of simultaneous bilateral thalamic hemorrhages, which is the subject of the present review.

Although it serves as a useful tool for qualitatively assessing the risk of bias of an article, the JBI checklist does not explicitly quantify it. We therefore proposed a method to quantify the risk of bias, stratified into three levels (“low”, “moderate”, or “high”) according to the responses (“yes”, “unclear”, or “no”) given to the JBI checklist questions. The rationale behind this classification was to exercise the utmost caution; only a single "partial" response is permitted for the case to remain in the low-risk category. Any further response other than "yes" consequently increases the estimated risk of bias.