Interventional procedure overview of Transvenous embolisation for spontaneous intracranial hypotension caused by a cerebrospinal fluid-venous fistula

Contents

Table 1 Abbreviations

Abbreviation	Definition
CSF	Cerebrospinal fluid
CSFVF	Cerebrospinal fluid-venous fistula
CT	Computed topography
DSM	Digital subtraction myelography
EBP	Epidural blood patch
HIT	Headache Impact Test
PGIC	Patient Global Impression of Change
QoL	Quality of life
RIH	Rebound intracranial hypertension
SIH	Spontaneous Intracranial Hypotension
VAS	Visual Analogue Scale

The condition, current treatments, unmet need and procedure

The condition

A cerebrospinal fluid-venous fistula (CSFVF) is an abnormal connection that develops between the space surrounding the spinal cord and nearby veins. The fistula allows CSF to leak into the veins. The loss of CSF can cause pressure in the brain to drop (spontaneous intracranial hypotension).

SIH can present with a variety of symptoms, including orthostatic headache, which typically worsens upon standing up and gets better when lying down, neck stiffness, nausea, vomiting, vertigo, tinnitus, visual disturbances, dizziness and imbalance.

Current practice

Initial management may include bed rest, hydration, and oral or intravenous caffeine. If symptoms persist then non-targeted epidural blood patching may be offered. If this fails, advanced imaging such as digital subtraction myelography or dynamic CT myelography is done to locate the CSF–venous fistula. Once the fistula is located, targeted treatments are considered. These may include CT-guided fibrin glue injections, which are usually done as a day-case procedure under local anaesthesia and may be offered immediately after the scan, or surgical ligation.

Unmet need

Existing treatment options may not always be feasible or suitable. When a fistula is located near an eloquent or functional nerve root, surgery is not always the best option. This is because it can damage nerves and cause muscle weakness in the arms and legs. Existing treatments can also fail, risking recurrence or the development of new CSF–venous fistulas. Transvenous embolisation offers an alternative treatment option. It could be particularly useful when nerve root ligation cannot be done, when people are unfit for or decline surgery, or when there is treatment failure or recurrence after a CT-guided fibrin glue injection. Although the procedure is more invasive than CT-guided fibrin glue injection, it is less invasive than surgery and may reduce hospital length of stay and overall patient risk.

The procedure

Transvenous embolisation is a minimally invasive endovascular procedure used to stop abnormal venous outflow responsible for SIH. However, to confirm the presence of CSFVF, accurate localisation is first required which is achieved through advanced imaging technique such as DSM, an invasive procedure. The

procedure begins with venous access, obtained via the common femoral or internal jugular vein. A guiding catheter is navigated into the superior vena cava and then into the azygous vein or other relevant venous drainage pathway. These alternative pathways can include the hemiazygos vein, ascending lumbar veins or vertebral veins depending on the location of the fistula. A hydrophilic or still wire is often needed for access. Once the catheter has reached the appropriate venous system, a microcatheter is advanced over a fine wire to selectively catheterise the foraminal or paraspinal vein that contains the fistula. Venography is done to confirm the location of the fistula and see the venous drainage pattern. Venography is an imaging technique that uses contrast dye to visualise the veins under X-ray. The fistula is then embolised using a liquid embolic agent. A high-viscosity formulation is injected to create a proximal plug and then a low-viscosity formulation is injected which flows across the fistula or fistulous network.

The procedure does not offer a way to check that the fistula has successfully sealed. So, the success of the procedure is judged by symptom resolution. A post-procedure CT scan may be done to view the distribution of the embolic agent and assess the extent to which the fistula has sealed.

Outcome measures

Efficacy and safety outcomes are included. Further details are provided below.

Efficacy

Identified outcomes relevant to efficacy include:

- Headache response. Measures the degree of resolution or improvement of headaches after treatment. It can be assessed by:
    - Resolution rate indicating complete, partial or no resolution of headache.
    - Severity of headache. Assessed using tools such as the HIT-6, a questionnaire measuring the impact of headache on daily life. Scores range from 36 to 78, with higher scores indicating a greater impact of headache on a person's life. Impact levels are categorised as: little or no impact (49 or less), some impact (50 to 55), substantial impact (56 to 69), and several impact (60 to 68). The severity of headache is also measured using VAS, where 0 represents no pain and 10 represents the worst imaginable pain.
    - Number of headache days
- Overall symptom resolution or improvement

  Captures the comprehensive spectrum of SIH-related symptoms, including headache, nausea, vomiting, and visual or cognitive disturbances, with either complete resolution or improvement. Patient-reported outcome scales such as PGIC can be used to assess overall symptom resolution or improvement. PGIC is a 7-point scale, ranging from "very much improved" to "very much worse".
- Specific symptom improvement

  Improvement in SIH related symptoms improvement beyond headache such as tinnitus, dizziness or vertigo, cognitive dysfunction, and hearing disturbances.

- Quality of life improvement. Measured using patient-reported outcome tools. These include:
    - VAS which scores from 0 to 10, where 0 represents very low quality of life and 10 represents very high quality of life.
    - SF-36 health survey which assess physical and mental health across eight domains, each scored from 0 to 100 with higher scores indicating better health status.
- Imaging improvement

  Assessed using Bern score, a brain MRI based scoring system for SIH. It classifies people into high, intermediate, or low probability of identifying CSF leak. Score ranges from 0 to 9, with 0 to 2 indicating low probability, 3 to 4 indicating intermediate, and 5 to 9 indicating high probability. Imaging improvement is reflected by a reduction in the Bern score after treatment.

  Imaging improvement can also be assessed by MRI SIH score which evaluate brain MRI findings in people with SIH. The total score ranges from 0 to 9, with a higher score indicating more severe imaging abnormalities and 0 indicates no signs of SIH.

Safety

Identified outcomes relevant to safety include:

- Rate of recurrence or retreatment

This includes recurrence or residual fistulas at the original treatment site as well as the development of new fistulas at different spinal levels requiring further treatment. Persistent or recurrent symptoms such as tinnitus, hearing disturbance and dizziness may also be present.

- Post-treatment rebound intracranial hypertension, or rebound headache

  This is a post-treatment effect presenting as new or different headaches within 24 to 48 hours after embolisation. These headaches are frequently associated with rebound intracranial hypertension and may require medication such as acetazolamide, and occasionally, invasive intervention, until resolution.

- Perioperative technical complications

  These are intra and perioperative issues related to embolic material or catheter use. These include embolic agent migration, such as onyx migration into azygos vein or contamination of epidural or paraspinal veins. Other complications may include inadequate or unintended embolic agent deposition, including insufficient penetration, reflux, or extravasation into adjacent muscle, vessel injury and contrast leakage.

- Localised pain at the embolisation site

Evidence summary

Population and studies description

This interventional procedures overview is based on evidence from 1 systematic review and meta-analysis and 5 observational studies. The systematic review included a total of 321 people, 190 had the procedure. Observational studies included a total of 229 people, but there may be significant overlap between the study populations as three studies included in the evidence summary were also included in the systematic review. This is a rapid review of the literature ,and a flow chart of the complete selection process is shown in figure 1. This overview presents 6 studies as the key evidence in table 2 and table 3, and lists 9 other relevant studies in appendix B, table 5.

Among the 5 observational studies, 2 were retrospective case series from the USA (Brinjikji, 2024; Parizadeh, 2023). The other 3 were prospective case series conducted in France (Cagnazzo, 2024; Cagnazzo, 2025; Goapper, 2025). All of these studies were single-centre studies, and none of them included UK centres. The 3 key studies (Brinjikji,2024; Parizadeh 2023; and Cagnazzo, 2024) included in the evidence summary were also included in the systematic review (Jazayeri, 2025). Additionally, there may be an overlap between the populations in 3 studies (Cagnazzo 2024; Cagnazzo, 2025; Goapper, 2025).

Follow-up varied among studies. Most studies reported both imaging follow-up and clinical follow-up (Brinjikji, 2024; Parizadeh, 2023; Cagnazzo, 2024; Cagnazzo, 2025). Clinical follow-up ranged from 3 months (Parizadeh, 2023) to 15 months (Brinjikji, 2024), and imaging follow-up ranged from 3.3 months (Parizadeh, 2023) to 8 months (Cagnazzo, 2025).

Study populations ranged from 18 people (Parizadeh, 2023) to 100 people (Brinjikji, 2023). All studies included people with SIH and confirmed CSFVFs. Female sex was the majority in all studies, ranging from 65% (Cagnazzo, 2025) to 72% (Parizadeh, 2023). Median or mean ages were consistently in the late 50s to early 60s, ranging from 59.2 years (Brinjikji, 2024) to 63 years (Cagnazzo, 2024). Four studies reported prior treatment before transvenous embolisation, either surgery or targeted or non-targeted EPB (Brinjikji, 2024; Parizadeh, 2023; Cagnazzo, 2024; Cagnazzo, 2025). Three studies reported presence of multiple fistulas (Brinjikji, 2023; Cagnazzo, 2024; Cagnazzo 2025). Table 2 presents study details.

Figure 1 Flow chart of study selection

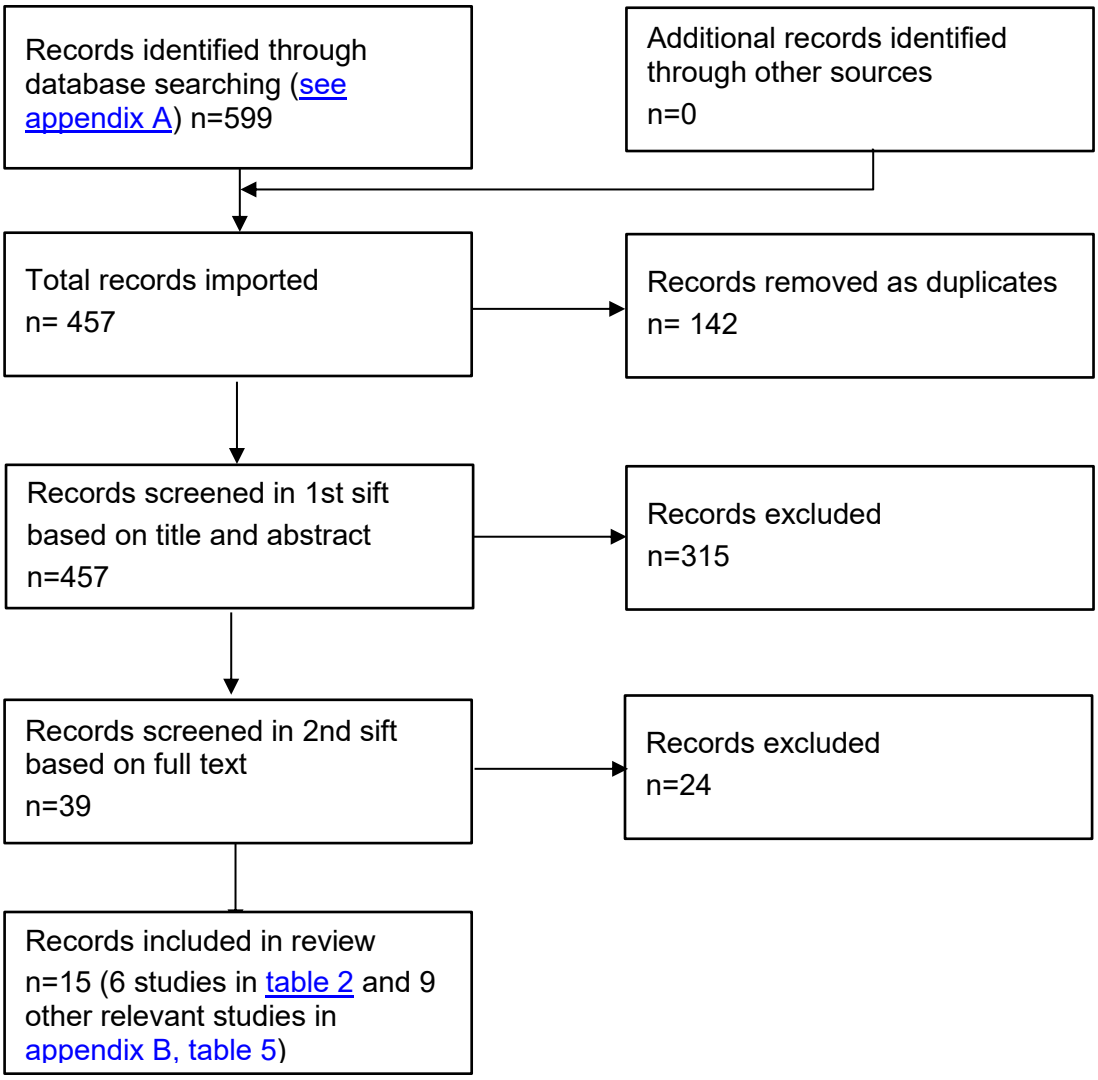

Table 2 Study details

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
1	Brinjikji 2024 USA	N=100 Mean age=59.2 (SD 10.9) Female sex=68 (68%) Number of fistulas=105 Prior treatment: Surgical treatment=9 Epidural blood patch=59	Retrospective case series (June 2020 to June 2022)	People with SIH confirmed to have CSFVF evaluated by brain MRI with and without gadolinium contrast, spine MRI, and advanced myelography including either DSM or CT myelography	Transvenous embolisation Paraspinal vein catheterisation and embolisation of fistula using Onyx (Onyx 34 and Onyx 18)	Mean clinical follow-up 15 months (range 6.8 months) Mean imaging follow-up 8.3 months (range 7.7 months)
2	Parizadeh 2023 USA	N=18 Median age 60 (IQR range 50 to 65)	Retrospective case series	People with SIH having CSFVF. SIH diagnosed based on clinical and/or brain MRI findings	Transvenous embolisation Transvenous catheterisation and embolisation at foraminal venous plexus using Onyx	Clinical follow-up 3 months (range 2.3 to 5.0)

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Female sex=13 (72%) Number of fistulas=18 Prior treatment: Targeted or non-targeted epidural blood/fibrin patches=11 Surgery for Chiari I malformation=3			(18 and 34), often with balloon and/or coil assisted “pressure cooker” method for improved penetration and reduce reflux	Imaging follow-up 3.3 months (range 2.3 to 4.7)
3	Cagnazzo 2024 France	N=21 Median age=63 (IQR range 58 to 71) Female sex=15 (71.5%) Number of fistulas=30 Prior treatment:	Prospective case series November 2022 to January 2024	People with SIH having confirmed CSFVF through DSM. SIH diagnosed based on clinical symptoms and MRI	Transvenous embolisation Transvenous catheterisation and embolisation of CSFVF using Onyx 18, with coverage of target and adjacent epidural plexus levels.	Mean clinical follow-up 9 months (SD 6.4) Mean imaging follow-up 7 months (SD 5.1)

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Epidural blood patching=7				
4	Cagnazzo, 2025 France	N=60 Mean age=61 years (SD 13) Female sex=26 (65%) Prior treatment: Non-targeted EBP=13	Prospective case series November 2022 to December 2024	People with SIH having confirmed through DSM. SIH diagnosed based on clinical symptoms and brain MRI signs based on SIH score	Transvenous embolisation Transvenous catheterisation and embolisation of CSFVF using Onyx 18, with coil occlusion of venous connection to prevent Onyx migration	Mean clinical follow-up 12 months (SD 4.4) Mean imaging follow-up 8 months (SD 4.1)
5	Goapper 2025 France	N= 30 Mean age= 60.4 years (SD 14.1) Female sex=20 (66.6%)	Prospective case series	People with SIH and a definitive diagnosis of CSFVF through DSM. SIH diagnosed based on clinical symptoms and brain MRI	Transvenous embolisation Transvenous catheterisation and embolisation of CSFVF using Onyx 18, with coil to blog high-risk venous connection.	Mean clinical and imaging follow-up 10 months (range 6 to 24) QoL follow-up 3 months

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Number of fistulas=10 people with multiple fistulas				
6	Jazayeri 2025 Multiple countries	6 studies relevant to CSFVF, n=190 people There is likely overlap with other studies included in this overview. The following studies reported in this systematic review have also been included separately in this overview: Brinjikji (2024) Parizadeh (2023) Cagnazzo (2024)	Systematic review and Meta-analysis	Adults with confirmed CSFVSs on imaging treated either surgically or through transvenous embolisation	Transvenous embolisation	3 to 15 months

Table 3 Study outcomes

First author, date	Efficacy outcomes	Safety outcomes
Brinjikji 2024	**Headache response** • Resolution/improvement of headache: Resolution of headache=75% (72/96) Improvement of headache=19.8% (19/96) No change/ worsening=5.2% (5/96) **Overall symptom resolution/improvement** • Complete symptom resolution=58% (58/100) • Significant improvement=37% (37/100) • No improvement=5% (5/100) • Sub-group analysis Resolution by sex: Male=43.1%; improvement=16.2%; no improvement=20%, p=0.02 No history of headache before leak onset: Resolution=82.8%; improvement=62.2%; no improvement=40%, p=0.0004 Mean duration of symptoms before treatment:	**Rate of recurrence/retreatment** • Retreatment: 17/100; Development of new CSFVF at new level: 10 people Recurrent/residual leak at site of embolisation: 7 people **Post-treatment rebound intracranial hypertension/rebound headache** • Total with suspected RIH: 19/100 (all required acetazolamide, 2 further needed invasive treatment **Perioperative technical complications** • Paraspinal or epidural vein perforation: 5/100 • Severe postoperative pain requiring narcotic, gabapentin or steroid injection: 3/100 • Radiculopathy/numbness: 1/100

First author, date	Efficacy outcomes	Safety outcomes
	Resolution=32 months (SD 39.4); improvement=49.2 (SD 16.6); no improvement=82.6 (SD 81.2) Suspected RIH requiring acetazolamide at 3 months: Resolution=5.2%; improvement=29.7%; no improvement=60%, p=0.001 **Specific symptom improvement** • Tinnitus Resolution=64% (35/55) Improvement=29% (16/55) • Cognitive dysfunction Resolution=66% (29/44) Improvement=27% (12/44) • Impaired hearing Resolution=71% (25/35) Improvement=23% (8/35) • Dizziness/vertigo	

First author, date	Efficacy outcomes	Safety outcomes
	Resolution=76% (22/29) Improvement=17% (5/29) • Visual alteration Resolution=60% (9/15) Improvement=40% (6/15) • Gait disturbance Resolution=83% (10/12) Improvement=0 **Imaging improvement** • Bern SIH score: Mean post-treatment score=0.9 (SD 1.6) Improved Bern score=81% No change=3% Worsening = 0 Bern SIH score of 0 at baseline=14%	
Parizadeh 2023	**Headache response** • Severity of headache HIT-6 score change: Before treatment=68 (range 62 to 72) After treatment=36 (range 36 to 38), p <0.001	**Rate of recurrence/retreatment**: 2/18 **Post-treatment rebound intracranial hypertension/rebound headache** • Post-embolisation headache (suggestive of RIH): 13/18; 9 treated with acetazolamide

First author, date	Efficacy outcomes	Safety outcomes
	HIT-6 improvement in 94% and significantly improved in 81% post-embolisation. **Overall symptom resolution/improvement** • Patient Global Impression of Change (PGIC) Scale Any improvement=94% (17/18) Very much/much improvement=89% (16/18) **Imaging improvement** • Bern score change: Before treatment=8 (range 6 to 8) At follow-up= 3 (range 1.5 to 3.5), p< 0,001	**Perioperative technical complications** • Complication rate: 22% (4/18) • Intramuscular extravasation of Onyx: 2/18 • Transient epidural contrast extravasation identified on microcatheter injection: 1/18 • Mild Onyx reflux into the azygos vein: 1/18 **Localised pain at the site of embolisation**: 15/18
Cagnazzo 2024	**Headache response** • Severity of headache Mean HIT-6 score: Before treatment=67 (SD 15) After treatment=38 (SD 9), p< 0.0001 Mean VAS score: Before treatment=8 (SD 1.9) After treatment=1.2 (SD 2), p<0.0001	**Rate of recurrence/retreatment**: 2/21 **Post-treatment rebound intracranial hypertension/rebound headache** • Post-treatment RIH: 7/21; 6 treated with acetazolamide **Perioperative technical complications** • Complication rate: 28% (6/21) • Inadequate penetration of embolic material: 2

First author, date	Efficacy outcomes	Safety outcomes
	• Number of headache days in a month Before treatment=23.5 (SD 10) After treatment=3.2 (SD 6.6), p<0.0001 **Overall symptom resolution/improvement** • Complete clinical recovery=67% (14/21) • Substantial/partial improvement=28% (6/21) **Specific symptom improvement** • Dizziness/vertigo=69% (improved) (11/16) • Fatigue=82% (resolved) (14/17) • Tinnitus=60% (resolved) (9/15) **Quality of life** • Mean VAS score for QoL Before treatment=2.6 (SD 2.5) After treatment=8.6 (SD 1.8), p<0.0001 **Imaging improvement** • Mean SIH score: Before treatment=6 (SD 2.5) After treatment=1.4 (SD 1.6), p< 0.0001	• Asymptomatic migration of embolic material into the azygos vein: 2 **Localised pain at the site of embolisation**: 4

First author, date	Efficacy outcomes	Safety outcomes
Cagnazzo, 2025	**Headache response** Resolution/improvement at follow-up (3 months) • Orthostatic headache=89% (25/28) • Non-orthostatic headache=50% (2/4) • Activity related headache=83% (24/29) • Valsalva related headache=84% (21/25) **Overall symptom resolution/improvement** • Follow up (3 months): Significant clinical recovery=95% (38/40); Complete clinical recovery=86.8% (33/38) **Specific symptom improvement** Resolution/improvement at follow-up (3 months) • Fatigue=91% (32/35) • Tinnitus=61% (11/18) • Dizziness=77% (20/26) **Imaging improvement** • Median SIH score: Before treatment=6 (IQR range 4 to 8)	**Rate of recurrence/retreatment** • Retreatment: 4/40 New CSFVF: 3 patients Incomplete occlusion from initial procedure: 1 patient **Post-treatment rebound intracranial hypertension/rebound headache** • Post-treatment rebound headache: 32.5% (13/40), 9 treated with acetazolamide **Perioperative technical complications** • Asymptomatic migration of embolic material into the azygos vein: 2/40 • Microcatheter perforation of epidural plexus: 2/40 **Localised pain at the site of embolisation**: 9/40

First author, date	Efficacy outcomes	Safety outcomes
	After treatment (24 hours)=3.5 (IQR range 2 to 5) (p=0.01) 3 months follow-up=2 (IQR range 0 to 4) (p=0.004)	
Goapper, 2025	**Headache response** • Resolution of headache Complete headache resolution=64% (18/30) Partial headache resolution=35% (10/30) • Severity of headache VAS score (0 to 100): Before treatment (mean)=74.3 (SD 27.6) At follow-up (mean)=9.0 (SD 15.6) Significant reduction (p<0.0001) • Number of headache days per month Before treatment (mean)=25 (SD 9.2) At follow-up (mean)=2.8 (SD 7.4) Significant reduction (p<0.0001) **Specific symptom improvement** • Dizziness/Vertigo: Complete resolution=42% (8/19)	**Rate of recurrence/retreatment** • Recurrent symptoms: 3/30 New CSFVF requiring second embolisation **Post-treatment rebound intracranial hypertension/rebound headache** • Post-treatment rebound headache: 40% (12/30) **Perioperative technical complications** • Asymptomatic migration of embolic material into the azygos vein: 1/30 • Epidural plexus perforation: 2/30 **Localised pain at the site of embolisation**: 7/30

First author, date	Efficacy outcomes	Safety outcomes
	Partial resolution=37% (7/19) • Tinnitus: Complete resolution=38% (5/13) Partial resolution=23% (3/13) • Hearing disturbance: Complete resolution=25% (3/12), Partial resolution=33% (4/12) **Quality of life** • Physical health (SF-36 physical domain): Before treatment=82.3% rated their physical QoL as poor At follow-up (3 months)=70.6% rated their physical QoL as excellent • Mental health (SF-36 mental domain): Before treatment=76.4% rated their mental health as poor At follow-up (3 months)=100% rated their mental health as good to excellent	

First author, date	Efficacy outcomes	Safety outcomes
	• Overall quality of life (VAS-QoL): Before treatment = Mean score: 23.5 (SD 25.8) After treatment = Mean score: 88.7 (SD 15.5) High statistical significance (p<0.001)	
Jazayeri SB, 2025	**Headache response** • Resolution of headache: Complete or partial resolution of headache 93.9% (95% CI: 88.3%–96.9%); Complete headache resolution rate 73.3% (95% CI: 65.1% to 80.2%) Partial headache response 20.6% (95% CI14.5% to 28.4%) • Severity of headache: HIT-6 score mean change -29.1 points (95% CI -32.7 to -25.5) **Overall symptom resolution** • Complete or partial resolution 93.9% (CI 88.3% to 96.9%); Complete resolution of all symptoms 59.1% (95% CI 50.5% to 67.1%)	**Rate of recurrence/retreatment:** 15.3% (95% CI 10.3% to 22.1%) **Post-treatment rebound intracranial hypertension/rebound headache** • Suspected RIH: 48.9% (95% CI 21.5% to 76.9%)

First author, date	Efficacy outcomes	Safety outcomes
	Partial response to all symptoms 34.8% (95% CI 27.2% to 43.3%) **Imaging improvement** • Bern score mean change - 4.7 points (95% CI -5.3 points to -4.2 points) (p<0.01)	

Procedure technique

Of the 5 observational studies, all provided at least some detail of the transvenous embolisation technique, with four giving comprehensive detail, including devices used (Brinjikji, 2024; Parizadeh, 2023; Cagnazzo, 2024; Cagnazzo, 2025). Across all studies, the procedure was performed under general anaesthesia. The venous access was obtained through the common femoral vein (Brinjikji,2024; Cagnazzo,2024; Cagnazzo, 2025; Goapper, 2025) or upper extremity veins (Parizadeh, 2023). Microcatheter, such as the Headway Duo or Scepter XC was used for microcatheterisation. Embolisation was predominantly performed with Onyx 2018 across all studies. In 2 studies (Brinjikji, 2024; Parizadeh,2023), Onyx 34 was first used to create a plug near the vein and then switched to Onyx 18 to continue embolisation. Three studies reported using adjunctive techniques such as balloon microcatheters and coils to reduce reflux in some cases (Cagnazzo, 2025; Goapper, 2025) and optimise embolic penetration, referred to as the “pressure cooker” technique (Parizadeh, 2023). This technique creates a proximal plug to prevent reflux, enabling controlled forward injection of embolic agent into the targeted fistula.

Efficacy

Headache response

Headache response after transvenous embolisation was reported across all studies.

Resolution or improvement in headache was reported in 4 studies. The pooled analysis of 4 studies (N=131) in Jazayeri (2025) reported complete or partial resolution of headache in 93.9% (95% CI 88.3% to 96.9%), with complete resolution rate in 73.3% (95% CI 65.1% to 80.2%) and partial headache

resolution in 20.6% (95% CI 14.5% to 28.4%). Three observational studies also reported similar headache resolution results.

Brinjikji (2024) observed complete resolution in 75% (72/96), partial improvement in 19.8% (19/96), and no change in 5.2% (5/96) over a mean follow-up period of 15 months (SD 6.8). Goapper (2025) reported complete resolution in 64% (18/30) and partial resolution in 35% (10/30) over a mean follow-up of 10 months (range 6 to 24). Cagnazzo (2025) found orthostatic headache resolved or improved in 89% (25/28), activity-related headache in 83% (24/29), Valsalva-related headache in 84% (21/25), and non-orthostatic headache in 50% (2/4) at 3-month follow-up.

Headache severity improvement was reported in 4 studies. The pooled mean HIT-6 score change from three studies (N=76) in Jazayeri (2025) was –29.1 (95% CI –32.7 to –25.5). Parizadeh (2023) reported a statistically significant reduction (p less than 0.001) in HIT-6 score from 68 (range 62 to 72) to 36 (range 36 to 38). HIT-6 score was improved in 94% of people and significantly improved in 81% post-procedure at a median follow-up of 3 months (range 2.3 to 5). Cagnazzo (2024) also observed a statistically significant decrease (p less than 0.0001) in HIT-6 score from 67 (SD 15) to 38 (SD 9). Similarly, mean VAS score significantly decreased (p less than 0.0001) from 8 (SD 1.9) to 1.2 (SD 2) over a mean follow-up period of 9 months (SD 6.4). Goapper reported a significant decrease (p less than 0.0001) in VAS (0-100) score from 74.3 (SD 27.6) to 9.0 (SD 15.6).

Reduction in headache per month was reported in two studies. Cagnazzo (2024) reported a statistically significant decrease (p less than 0.0001) in headache days per month from 23.5 (SD 10) to 3.2 (SD 6.6). This was consistent with Goapper

(2025), who reported a statistically significant decrease (p less than 0.0001) in headache days per month from 25 (SD 9.2) to 2.8 (SD 7.4).

Overall symptom resolution/improvement

Overall symptom resolution or improvement of SIH following transvenous embolisation was reported in 5 studies. The pooled analysis of 4 studies (N =132) in Jazayeri (2025) reported a combined complete or partial symptoms resolution rate of 93.9% (CI 88.3% to 96.9%), with complete resolution in 59.1% (95% CI 50.5% to 67.1%) and partial improvement in 34.8% (95% CI 27.2% to 43.4%).

Brinjikji (2024) reported complete symptom resolution in 58% (58/100) of patients, improvement in 37% (37/100) and no improvement in 5 people over a mean clinical follow-up of 15 months (SD 6.8).

Brinjikji (2024) performed subgroup analysis to identify predictors of better outcomes (symptom resolution). People with complete resolution were more often male (43.1%), more likely to have no history of headache before the onset of the leak (82.8%). Mean symptom duration before treatment was shorter in the resolution group, 32 months (SD 39.4), compared with the improvement group, 49.2 months (SD 61.6) and the no improvement group, 82.6 months (SD 81.2). RIH requiring medication occurred in 5.2% of resolution patients, 29.7% in the improvement group and 60% in the no improvement group.

Parizadeh (2023) assessed overall symptom resolution using the PGIC scale. The study reported 94% (17/18) of people experienced some improvement in SIH symptoms, with “much or very much improvement” in 89% (16/18) at 3 months follow-up.

In Cagnazzo (2024), complete symptom resolution was achieved in 67% (14/21) and partial improvement in 28% (6/21) at a mean follow-up of 9 months (SD 6.4). One patient with no overall improvement had a chronic headache with a history of SIH for more than 15 years.

Cagnazzo (2025) reported overall symptom improvement in 95% of people (38/40), with complete resolution in 86.8% (33/38) at 3 months follow-up. The two people without any improvement had a longstanding non-orthostatic headache and tinnitus for over 3 years.

Specific symptom resolution/ improvement

Specific symptom resolution/improvement after transvenous embolisation was reported in 4 studies.

Tinnitus was the most frequently reported symptom. Resolution rates were 64% (35/55) in Brinjikji (2024), 60% (9/15) in Cagnazzo (2024), 61% (11/18) in Cagnazzo (2025) and 38% (3/13) in Goapper (2025). Improvement without complete resolution occurred in 29% (16/55) in Brinjikji (2024), 23% (3/13) in Goapper (2025).

Dizziness or vertigo was reported to be completely resolved in 76% (22/29) in Brinjikji (2024), 69% (11/16) in Cagnazzo (2024), 77% (20/26) in Cagnazzo (2025), and 42% (8/19) in Goapper (2025). Partial resolution was reported in 17% (5/29) and 37% (7/19) in Goapper (2025).

Fatigue was assessed in 2 studies, with resolution rates of 82% (14/17) in Cagnazzo (2024) and 91% (32/35) in Cagnazzo (2025).

Hearing disturbance resolved in 71% (25/35) in Brinjikji (2024) and 25% (3/12) in Goapper (2025), with partial improvement in 23% (8/35) in Brinjikji (2024) and 33% (4/12) in Goapper (2025).

Brinjikji (2024) also reported other symptom resolution/improvement. Cognitive dysfunction was resolved in 66% (29/44) and improved in 27% (12/44). Visual alteration was resolved in 60% (9/15) and improved in 40% (6/15), and gait disturbance was resolved in 83% (10/12).

Quality of life

Quality of life outcomes after transvenous embolisation were reported in 2 studies.

Cagnazzo (2024) assessed QoL using the VAS score (scale 0 to 10). There was significant improvement (p less than 0.0001) from a mean baseline VAS score of 2.6 (SD 2.5) to 8.6 (SD 1.8) post-procedure.

Goapper (2025) assessed both physical and mental health domains using the SF-36 at baseline and at 3 months follow-up. In the physical health domain, 82.3% rated their physical QoL as poor at baseline compared with 70.6% rating it as excellent after treatment. In the mental health domain, 76.4% reported poor mental health at baseline, whereas 100% rated their mental health as good or excellent at follow-up. Additionally, an overall QoL was measured by the VAS scale (0 to 100). The mean VAS score significantly increased (p less than 0.001) from 23.5 (SD 25.8) to 88.7 (15.5) after treatment.

Imaging improvement

Imaging improvement after transvenous embolisation was reported in 5 studies. The pooled data from 4 studies (N=145) in Jazayeri (2025) reported a significant

reduction (p less than 0.01) in post-treatment Bern score. (mean change -4.7, 95% CI –5.3 to –4.2).

Out of 4 observational studies reporting imaging improvement, 3 studies evaluated changes in the Bern SIH score. Brinjikji (2024) found a reduction of 5.9 (SD 3.3) to 0.9 (SD 1.6) at a mean imaging follow-up of 8.3 months (SD 7.7). 14 out of 100 people had a score of 0 at baseline, 81 showed improvement and 3 had no change in their Bern SIH score.

Parizadeh (2023) reported a statistically significant (p less than 0.001) decrease from a median of 8 (range 6 to 8) to 3 (range 1.5 to 3.5) at a median follow-up of 3.3 months (range 2.3 to 4.7). Post-treatment, 83% (15/18) of people had improvement in SIH findings, while the score did not change in 3 people among whom one already had a low Bern SIH score.

Cagnazzo (2024) observed a statistically significant (p less than 0.0001) reduction from 6 (SD 2.5) to 1.4 (SD 1.6) over a mean imaging follow-up period of 7 months (SD 5.1).

One study used the SIH score. Cagnazzo (2025) reported a statistically significant (p = 0.004) reduction from a median of 6 (IQR 4 to 8) to 2 (IQR 0 to 4) at 3 months follow-up.

Safety

Rate of recurrence/retreatment

The rate of recurrence/ retreatment was reported across all studies. Four studies in Jazayeri (2025) reported the rate of recurrence/retreatment. An overall rate of

recurrence/retreatment after transvenous embolisation was 15.3% (95% CI 10.3% to 22.1%).

Brinjikji (2024) reported a retreatment rate of 17% (17/100) during a mean follow-up of 15 months (SD 6.8). Among these 17 patients, 10 developed new CSFVFs at different spinal levels, while 7 had recurrent or residual leaks at the site of embolisation.

Parizadeh (2023) reported a treatment failure rate of 11% (2/18) during 3 months of follow-up.

Cagnazzo (2024) reported a recurrence/retreatment rate of 9.5% (2/21) over a mean clinical follow-up period of 9 months (SD 6.4). Both required additional treatment; one for recurrent symptoms due to a small fistula, and one for incomplete symptom resolution after the initial procedure.

Cagnazzo (2025) reported the recurrence or retreatment rate of 10% (4/40) during a mean clinical follow-up of 12 months (SD 4.4). All 4 underwent a second embolisation. 3 developed new CSFVFs, and one required an additional Onyx injection for incomplete occlusion from the initial procedure.

Goapper (2025) reported a recurrence rate of 10% (3/30) during a mean follow-up of 10 months. All 3 required a second embolisation due to new CSFVFs.

Post-treatment rebound intracranial hypertension/ rebound headache

Post-treatment RIH/ rebound headache was reported across all studies. Four studies (N=131) in Jazayeri (2025) reported a rate of suspected RIH of 48.9% (95% CI 21.5% to 76.9%).

Brinjikji (2024) reported a suspected RIH rate of 19% (19/100). All 19 people had acetazolamide for a median duration of 3 weeks, and 2 required additional invasive treatment.

Parizadeh (2023) reported that 72% of people (13/18) developed post-treatment headache suggestive of RIH. 9 people were treated with acetazolamide, and symptoms were resolved within 3 months in all except 2 people.

Cagnazzo (2024) reported a post-treatment RIH rate of 33% (7/21). Headaches typically appeared within 24 to 48 hours after treatment and lasted a mean of 7.4 days (SD 3.7). Among 7 people, 6 were treated with acetazolamide for about 7 days until symptom regression. The other person was at high risk due to a large T12-L1 fistula and longstanding symptoms and received acetazolamide 3 days before and 14 days after the procedure.

Cagnazzo (2025) reported a post-treatment rebound headache rate of 32.5% (13/40). Headache appeared within 24 to 48 hours after treatment and lasted a mean of 7 days (SD 3.5). Among 13 people, 9 were treated with acetazolamide for approximately a week until symptom resolution.

Goapper (2025) reported a post-treatment rebound headache rate of 40% (12/30).

Perioperative technical complications

Technical complications during or after transvenous embolisation were reported across all 5 observational studies.

The most frequent complication was asymptomatic Onyx migration into the azygos vein: Parizadeh (2023) in 1/18 patients, Cagnazzo (2024) in 2/21 patients, Cagnazzo (2025) in 2/40 patients, and Goapper (2025) in 1/30.

Microcatheter or epidural plexus perforation was reported in Cagnazzo (2025) in 2/40 and Goapper (2025) in 2/30 people, without any long-term complications.

Extravasation or leakage of Onyx or contrast was reported in Parizadeh (2023) with intramuscular Onyx extravasation in 2 people and transient epidural contrast leakage in 1 patient. Cagnazzo (2024) reported inadequate Onyx penetration in 2 patients.

Other complications were reported in Brinjikji (2024). In 100 patients, paraspinal or epidural vein perforation was observed in 5 people, severe postoperative pain requiring medication in 3 people and postoperative radiculopathy or numbness in 1 patient.

Localised pain at the site of embolisation

Localised pain at the site of embolisation was reported in 4 studies. Parizadeh (2023) observed a high rate of localised pain at 83% (15/18). In cases where the adjunctive “pressure cooker” technique was used, transient localised back pain was significantly more frequent compared with conventional embolisation (100% versus 50%, p=0.02).

Cagnazzo (2024) reported a localised pain rate of 19% (4/21), which resolved within 2 weeks. In Cagnazzo (2025), 22.5% of people (9/40) experienced localised pain, with a mean duration of 3 days. Goapper (2025) reported a rate of 23% (7/30).

Anecdotal and theoretical adverse events

Expert advice was sought from consultants who have been nominated or ratified by their professional society or royal college. They were asked if they knew of any other adverse events for this procedure that they had heard about (anecdotal), which were not reported in the literature. They were also asked if

they thought there were other adverse events that might possibly occur, even if they had never happened (theoretical).

They listed the following anecdotal adverse events:

- Localised pain to the site of injection
- Rebound intracranial hypertension
- Rebound headache
- CSFVF recurrence
- Need for retreatment
- Venous perforation
- Pulmonary emboli
- Unintended extensive embolic agent embolisation of the venous plexus near fistula.
- General risks of endovascular procedures, including bleeding, infection, risk of general anaesthesia and vessel injury.

7 professional expert questionnaires for this procedure were submitted. Find full details of what the professional experts said about the procedure in the https://www.nice.org.uk/guidance/ipg10318/documents.

Validity and generalisability

- Sample sizes were small across all studies, reflecting the recent recognition of CSFVF in SIH and the limited use of this procedure in clinical practice. The largest sample size was 100 in Brinjikji (2024), while the smallest sample size was 18 in Parizadeh (2023).
- None of the studies were conducted in the UK. Study centres were based in the USA (Brinjikji, 2024; Parizadeh, 2023) and France (Cagnazzo, 2024;

Cagnazzo, 2025; Goapper, 2025). All 3 French studies originated from the same institute, Montpellier University Hospital, raising the possibility of patient overlap between the studies.

- All the included studies had early to mid-term follow-up ranging from 3 months to 15 months. Parizadeh (2023) only included people with more than 3 months of clinical and imaging follow-up. Similarly, Cagnazzo (2024) and Cagnazzo (2025) mandated complete baseline and 3-month follow-up MRI and clinical data. There was a lack of long-term follow-up.
- Across all studies, people selection was based on a confirmed diagnosis of SIH and definite CSFVF identified on advanced imaging (DSM or CT myelography) before undergoing transvenous embolisation. Cagnazzo (2024) and Cagnazzo (2025) required multidisciplinary team approval before treatment, which was not explicitly mentioned in other studies.
- All studies were observational studies, either retrospective or prospective case series and did not involve random assignment. None of the studies reported adjustment to potential confounders (symptom duration, baseline severity, comorbidities), making them susceptible to bias. Additionally, there was a difference in measurement tools for assessing clinical and imaging outcomes. For example, imaging improvement was assessed using the Bern SIH score in 2 studies (Brinjikji, 2024; Parizadeh, 2023) and the MRI SIH score in 2 studies (Cagnazzo, 2024; Cagnazzo, 2024). There was no standardised outcome definition across studies.
- The overall procedure of transvenous embolisation, including transvenous access, microcatheter navigation, and use of embolic agent (primarily Onyx 18), was consistent across studies. Parizadeh (2023) used a “pressure cooker” technique with balloon catheters and coils to enhance embolic penetration. In some cases, coils were also used to prevent Onyx migration (Cagnazzo 2024; Cagnazzo 2025; Goapper 2025).

- Across the included studies, no external funding sources or manufacturer involvement was reported, except in Brinjikji (2024). In that study, one author disclosed multiple industry affiliations, including with Medtronic, and financial interests, while all other authors declared no conflicts. The same author was also involved in Jazayeri (2025).
- Parizadeh (2023) reported a high rate of localised pain at the site of embolisation 83% compared with other studies, which ranged from 19% to 23% (Cagnazzo, 2024; Cagnazzo, 2025; Goapper, 2025). Additionally, Parizadeh (2023) observed local pain in all cases who underwent treatment using the “pressure cooker” technique. The study identified transient localised back pain as a side effect of this technique.
- Parizadeh (2023) reported a high rate of RIH post-treatment, occurring in 72% (13/18), which was higher than rates reported in other studies, where RIH ranged from 19% to 40% (Brinjikji,2024; Cagnazzo,2024; Cagnazzo, 2025; Goapper, 2025). This increased incidence was associated with the “pressure cooker” technique, which resulted in RIH in 67% compared to17% with the conventional technique. The study suggested that the higher rate of RIH may be due to more complete CSFVF occlusion, leading to stronger rebound headaches. Another contributing factor could be a lowered threshold for treating RIH with acetazolamide over time, resulting in a higher number of recorded cases.
- All included studies reported that transvenous embolisation was a safe and effective treatment for CSFVF. The one systematic review (Jazayeri, 2025), which compared transvenous embolisation with surgery reported the procedure to have comparable safety and efficacy outcomes when compared with surgery. Technical refinement, such as the pressure cooker technique, might potentially improve the completeness of embolisation. Early diagnosis and treatment were found to be associated with a better likelihood of complete

recovery (Brinjikji, 2024; Goapper, 2025). There is a lack of RCTs, and current evidence is based on small-sized prospective and retrospective case series with early to mid-term follow-up.

Ongoing trials

- A Clinical Registry of Spontaneous Intracranial Hypotension. NCT05922514 . N= 200. USA. Expected completion: July 2026

- Transvenous Approach for the Treatment of Cerebral Arteriovenous Malformations. NCT03691870 . N = 77. Canda. Completion: July 2025. (Completed)

Professional societies

Relevant Societies and Organisations:

- Association of British Neurologists
- British Association for the Study of Headache
- British Neuroscience Association
- Vascular Society
- British Institute of Radiology
- The Society of Radiographers
- Brain Research UK
- Royal College of Physicians of London
- Royal College of Surgeons of England
- Royal College of Edinburgh
- Royal College of Physicians and Surgeons of Glasgow
- Society of Neurological Surgeons

Patient Organisations:

- The Brain Charity
- CSF Leak Association
- Brain and Spine Foundation
- Circulation Foundation
- SameYou

- Brainkind

Societies/Organisations for consultation:
- NHS England
- NHS Scotland

Evidence from people who have had the procedure and patient organisations
NICE received 1 submission from a patient organisation about transvenous embolisation. NICE also received 15 questionnaires from people who have had the procedure (or their carers). The views of people who have had the procedure were consistent with the published evidence and the opinions of the professional experts.

Company engagement

NICE asked companies who manufacture a device potentially relevant to this procedure for information on it. NICE received one completed submission from Medtronic, manufacturer of Onyx™ liquid embolic system (LES). This was considered by the interventional procedures technical team, and any relevant points have been taken into consideration when preparing this overview.

References

1. Kranz PG, Amrhein TJ, Gary L. (2017) SF Venous Fistulas in Spontaneous Intracranial Hypotension: Imaging Characteristics on Dynamic and CT Myelography. AJR Am J Roentgenol 209(6):1360-1366.
2. Wang TY, Karikari IO, Amrhein TJ et al. (2020) Clinical outcomes following surgical ligation of cerebrospinal fluid-venous fistula in patients with spontaneous intracranial hypotension: a prospective case series. *Operative Neurosurgery* 18(3): 239-245.
3. Brinjikji W, Madhavan A, Garza I et al. (2024) Clinical and imaging outcomes of 100 patients with cerebrospinal fluid-venous fistulas treated by transvenous embolization. Journal of neurointerventional surgery 16(12), 1256-1263.

4. Parizadeh D, Fermo O, Vibhute P et al. (2023) Transvenous embolization of cerebrospinal fluid-venous fistulas: Independent validation and feasibility of upper-extremity approach and using dual-microcatheter and balloon pressure cooker technique. Journal of neurointerventional surgery, 15(12) 1234-1241.
5. Cagnazzo F, Ducros A, Risi G et al. (2024) Safety and efficacy of transvenous embolization of cerebrospinal fluid-venous fistula in patients with spontaneous intracranial hypotension. Interventional Neuroradiology 15910199241247698.
6. Cagnazzo F, Risi G, Lonjon N et al. (2025) Early brain MRI changes following transvenous embolization of cerebrospinal fluid-venous fistulas in spontaneous intracranial hypotension. Journal of neurointerventional surgery.
7. Goapper M, van Dokkum LE, Costalat V et al. (2025) The impact of CSF venous fistula embolization on patient's quality of life, a longitudinal clinical-radiological exploration. The Journal of Headache and Pain 26(1) 120.
8. Jazayeri SB, Eraghi MM, Ognard J et al. (2025) Transvenous Embolization vs. Surgical Intervention for cerebrospinal fluid Venous Fistulas: A Systematic Review and Meta-analysis. American Journal of Neuroradiology.

Appendix A: Methods and literature search strategy

Methods and literature search strategy

NICE has identified studies and reviews relevant to transvenous embolisation for the treatment of cerebrospinal fluid-venous fistula (CSFVF), a cause of spontaneous intracranial hypotension (SIH).

Search strategy design and peer review

This search report is informed by the Preferred Reporting Items for Systematic reviews and Meta-Analyses literature search extension (PRISMA-S).

A NICE information specialist ran the literature searches on 02 June 2025. See the search strategy history for the full search strategy for each database. Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The principal search strategy was developed in MEDLINE ALL (Ovid interface). It was adapted for use in each of the databases listed in Table 4, taking into account the database's size, search functionality and subject coverage. The MEDLINE ALL strategy was quality assured by a NICE senior information specialist. All translated search strategies were peer reviewed to ensure their accuracy. The quality assurance and peer review procedures were adapted from the Peer Review of Electronic Search Strategies (PRESS) 2015 evidence-based checklist.

Review management

The search results were managed in EPPIReviewer version 5 (EPPIR5). Duplicates were removed in EPPIR5 using a 2 step process. First, automated

deduplication was done using a high-value algorithm. Second, manual deduplication was used to assess low-probability matches. All decisions about inclusion, exclusion and deduplication were recorded and stored.

Limits and restrictions

The search was not limited by date or language. The CENTRAL database search removed trial registry records and conference material. The Embase search excluded conference material.

The limit to remove animal studies in the searches is standard NICE practice, which has been adapted from Dickersin K, Scherer R, Lefebvre C (1994) Systematic Reviews: Identifying relevant studies for systematic reviews. BMJ 309(6964): 1286.

Main search

Table 4 Main search results

Database	Date searched	Database platform	Database segment or version	Number of results downloaded
Cochrane Central Register of Controlled Trials (CENTRAL)	02/06/2025	Wiley	Issue 4 of 12, April 2025	10

Cochrane Database of Systematic Reviews (CDSR)	02/06/2025	Wiley	Issue 6 of 12, June 2025	4
Embase	02/06/2025	Ovid	<1974 to 2025 May 30>	269
INAHTA International HTA Database	02/06/2025	https://database.inahta.org/		2
MEDLINE ALL	02/06/2025	Ovid	<1946 to May 29, 2025>	314

Search strategy history

MEDLINE ALL search strategy

1 Cerebrospinal Fluid Pressure/ 1948

2 Cerebrospinal Fluid Leak/ 2308

3 Intracranial Hypotension/ 1711

4 headache/ 32977

5 (cerebrospinal fluid* venous fistula* or CSF-VF or CSFVF or CVF).tw. 1334

6 ((CSF or cerebrospinal fluid*) adj4 (leak* or drainage* or hypotension* or hypovolemia* or fistula*)).tw. 13767

7 (spontaneous adj4 intracranial adj4 hypotension*).tw. 1375

8 (low pressure adj4 headache*).tw. 91

9 (cerebrospinal fluid* adj4 volume adj4 depletion*).tw. 9

10 ((tear or rupture) adj4 (dura mater or dural or pachymeninx or tentorium cerebelli or falx cerebri or falx cerebelli)).tw. 1207

11 or/1-10 50858

12 Embolization, Therapeutic/ 38808

13 ((transvenous or paraspinal vein*) adj10 emboli?ation*).tw. 1122

14 embolotherap*.tw. 814

15 (endovascular adj4 transvenous).tw. 170

16 (endovascular adj4 therap*).tw. 8674

17 liquid embolic*.tw. 829

18 or/12-17 47524

19 Onyx Liquid Embolic System*.tw. 33

20 11 and 18 281

21 19 or 20 314

22 animals/ not humans/ 5307605

23 21 not 22 314

Embase search strategy

1 cerebrospinal fluid pressure/ 4683

2 *liquorrhea/ 2574

3 intracranial hypotension/ 3333

4 cerebrospinal fluid fistula/ 3911

5 *headache/ 35399

6 (cerebrospinal fluid* venous fistula* or CSF-VF or CSFVF or CVF).tw. 2174

7 ((CSF or cerebrospinal fluid*) adj4 (leak* or drainage* or hypotension* or hypovolemia* or fistula*)).tw. 18966

8 (spontaneous adj4 intracranial adj4 hypotension*).tw. 1782

9 (low pressure adj4 headache*).tw. 151

10 (cerebrospinal fluid* adj4 volume adj4 depletion*).tw. 11

11 ((tear or rupture) adj4 (dura mater or dural or pachymeninx or tentorium cerebelli or falx cerebri or falx cerebelli)).tw. 1658

12 or/1-11 64939

13 artificial embolization/ 74225

14 ((transvenous or paraspinal vein*) adj10 emboli?ation*).tw. 1379

15 embolotherap*.tw. 1239

16 (endovascular adj4 transvenous).tw. 222

17 (endovascular adj4 therap*).tw. 14105

18 liquid embolic*.tw. 1259

19 or/13-18 88111

20 Onyx Liquid Embolic System*.tw. 51

21 12 and 19 320

22 20 or 21 371

23 Nonhuman/ not Human/ 5733174

24 22 not 23 369

25 (conference abstract* or conference review or conference paper or conference proceeding).db,pt,su. 6275024

26 24 not 25 274

27 limit 26 to "remove clinical trial (clinicaltrials.gov) records" 269

Cochrane Library (CDSR and CENTRAL) search strategy

#1 MeSH descriptor: [Cerebrospinal Fluid Pressure] explode all trees 525

#2 MeSH descriptor: [Cerebrospinal Fluid Leak] explode all trees 94

#3 MeSH descriptor: [Intracranial Hypotension] explode all trees 9

#4 MeSH descriptor: [Headache] explode all trees 3184

#5 (cerebrospinal fluid* venous fistula* or CSF-VF or CSFVF or CVF) 129

#6 ((CSF or cerebrospinal fluid*) near/4 (leak* or drainage* or hypotension* or hypovolemia* or fistula*)) 2062

#7 (spontaneous near/4 intracranial near/4 hypotension*) 6

#8 (low pressure near/4 headache*) 106

#9 (cerebrospinal fluid* near/4 volume near/4 depletion*) 0

#10 ((tear or rupture) near/4 (dura mater or dural or pachymeninx or tentorium cerebelli or falx cerebri or falx cerebelli)) 82

#11 {or #1-#10} 6036

#12 MeSH descriptor: [Embolization, Therapeutic] explode all trees 1299

#13 ((transvenous or paraspinal vein*) near/10 emboli?ation*) 182

#14 embolotherap* 46

#15 (endovascular near/4 transvenous) 1

#16 (endovascular near/4 therap*) 1617

#17 liquid embolic* 35

#18 {or #12-#17} 3019

#19 Onyx Liquid Embolic System* 6

#20 #11 and #18 12

#21 #19 or #20 17

#22 "conference":pt or (clinicaltrials or trialsearch):so 824537

#23 #21 not #22 14

INAHTA HTA Database search strategy

#1 "Cerebrospinal Fluid Pressure"[mh] 1

#2 "Cerebrospinal Fluid Leak"[mh] 0

#3 "Intracranial Hypotension"[mh] 0

#4 "Headache"[mh] 44

#5 (cerebrospinal fluid* venous fistula* or CSF-VF or CSFVF or CVF) 0

#6 ((CSF or cerebrospinal fluid*) AND (leak* or drainage* or hypotension* or hypovolemia* or fistula*)) 29

#7 (spontaneous AND intracranial AND hypotension*) 0

#8 (low pressure AND headache*) 3

#9 (cerebrospinal fluid* AND volume AND depletion*) 0

#10 ((tear or rupture) AND (dura mater or dural or pachymeninx or tentorium cerebelli or falx cerebri or falx cerebelli)) 0

#11 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 76

#12 "Embolization, Therapeutic"[mh] 72

#13 ((transvenous or paraspinal vein*) AND or emboli?ation*) 2

#14 (embolotherap*) 43

#15 (endovascular AND transvenous) 0

#16 (endovascular AND therap*) 38

#17 liquid embolic* 2

#18 #12 or #13 or #14 or #15 or #16 or #17 103

#19 #11 and #18 2

#20 Onyx Liquid Embolic System* 2

#21 #19 or #20 2

Inclusion criteria

The following inclusion criteria were applied to the abstracts identified by the literature search.

- Publication type: clinical studies were included with emphasis on identifying good quality studies. Abstracts were excluded if they did not report clinical outcomes. Reviews, editorials, and laboratory or animal studies, were also excluded and so were conference abstracts, because of the difficulty of appraising study methodology, unless they reported specific adverse events not available in the published literature.
- People with [insert indication].
- Intervention or test: [Insert intervention].

- Outcome: articles were retrieved if the abstract contained information relevant to the safety, efficacy, or both.

If selection criteria could not be determined from the abstracts the full paper was retrieved.

Potentially relevant studies not included in the main evidence summary are listed in Appendix B: Other relevant studies.

Find out more about how NICE selects the evidence for the committee.

Appendix B: Other relevant studies

Other potentially relevant studies that were not included in the main evidence summary (tables 2 and 3) are listed in table 5 below.

Table 5 additional studies identifiedStudy	**Number of people and follow up**	**Direction of conclusions**	**Reason study was not included in main evidence summary**
Orscelik, A., Senol, Y.C. et al. (2024) Endovascular embolization of cerebrospinal fluid-venous fistula: a comprehensive systematic review on its efficacy and safety for the management of spontaneous intracranial hypotension. *Neurosurgical Review*, *47*(1), p.28	Systematic review N=9 studies, 77 people	Suggests endovascular embolisation is a safe and effective treatment; larger prospective studies are needed to validate initial findings	Deprioritised due to availability of a systematic review and meta-analysis with a larger sample size. 4 out of 5 included studies had sample size less than 5.
Orscelik A, Cutsforth-Gregory JK et al. (2024) Endovascular embolization techniques for cerebrospinal fluid-venous fistula in the treatment of spontaneous intracranial hypotension. Radiologic Clinics,62(2):345-54.	Review N=7 studies	Suggests the treatment to be effective with low complication rates but requires careful patient selection and multidisciplinary collaboration between health professionals for successful	Deprioritised due to the availability of a systematic review and meta-analysis with a larger sample size.

		management of CVFs; prospective and multicenter studies required to confirm its safety and efficacy.	
Houk JL, Dennison JV et al. (2022) Spontaneous intracranial hypotension: a review of pathogenesis, presentation, diagnosis, and treatment. Advances in Clinical Radiology, 4(1): 231-41.	Narrative review	Suggests comprehensive understanding of the pathophysiology of SIH and imaging characteristics for accurate diagnosis and precise localisation of underlying spinal pathology.	Deprioritised due to review presented overview of SIH and available treatment including transvenous embolisation.
Brinjikji W, Savastano LE et al (2021) A novel endovascular therapy for CSF hypotension secondary to CSF-venous fistulas. American Journal of Neuroradiology, 42(5):882-7.	Case series N=5 people Follow-up = 3 months	3 had complete resolution of SIH related symptoms. One had persistent tinnitus.	Deprioritised due to the study having small sample size and availability of new evidence from same centre with a larger sample which is included in main evidence summary.
Brinjikji W, Garza I et al. (2022) Clinical and imaging outcomes of	Retrospective studies	Transvenous embolisation	Deprioritised due to

cerebrospinal fluid-venous fistula embolization. Journal of neurointerventional,14(10):953-6.	N=40 people Follow-up: 3 months	resulted in clinical and radiographic improvement in 90% with no permanent complication; further studies required to validate the technique and assess long term durability of the treatment.	availability of new evidence from same centre with a larger sample which is included in main evidence summary.
Ellens NR, Schartz D et al (2023) Efficacy of transvenous embolization of CSF-venous fistula in spontaneous intracranial hypotension: case-series. Interventional Neuroradiology,15910199231221449.	Case series N=6 people Follow up=3 months	3 out of 6 people had complete resolution of symptoms; further studies required to assess long term durability of the treatment.	Deprioritised due to small sample size.
Jesse CM, Schär RT, Petutschnigg T, et al (2024) Improvement of health-related quality of life after closure of spinal CSF leaks in patient with spontaneous intracranial hypotension. Journal of Neurosurgery: Spine, 41(3):452-8.	Prospective cohort study N=21 people Follow up=3 months	Transvenous embolisation or microsurgery can enhance health-related quality of life (HRQOL), patients' subjective health perception, and headache severity.	Deprioritised due to the study including only 6 people who were managed by transvenous embolisation, the evidence presented in the study does not distinguish which outcomes

			are attributed to microsurgery and which are the result of embolisation.
Noufal M, Liang CW et al (2022) Transvenous embolization for cerebrospinal fluid-venous fistula. A case series from a single community-academic center. World Neurosurgery, 168:e613-20.	Case series N=5 people Follow-up= 8 months	Transvenous embolisation seems safe and effective in short term; RCT would would help standardise care and evaluate long-term outcomes for CSF-venous fistula	Deprioritised due to small sample size.
McRae-Posani B, Kim A et al (2025). Spinal CSF Leaks in Spontaneous Intracranial Hypotension: A Single-Institution Analysis of Incidence, Typology and Treatment Outcomes. Clinical Neurology and Neurosurgery, 108978.	Retrospective N=32 people	Targeted endovascular or surgical approaches are more likely to provide definitive treatment than epidural blood patches.	People treated with epidural blood patches as first line of treatment) and 10 people with treatment failure had transvenous embolisation.