CONDITION

Brain herniation

Learn how brain herniation develops, which symptoms require emergency care, and how clinicians diagnose and treat dangerous pressure inside the skull.

WHAT IT IS
Movement of brain tissue within the skull

BODY SYSTEM
Nervous system

MAIN SYMPTOMS
Severe headache, repeated vomiting, reduced consciousness, unequal pupils

WHAT CAUSES IT
Pressure from swelling, bleeding, blocked fluid, or a mass

HOW IT IS DIAGNOSED
Neurologic examination and urgent CT or MRI

MAIN TREATMENT
Emergency pressure reduction and cause-specific treatment

CAN IT BE CURED?
Sometimes - if pressure and cause treated

IS IT AN EMERGENCY?
Yes, acute brain herniation

LONG-TERM OUTLOOK
Outcome varies widely, with permanent disability, coma, or death possible

Overview

Brain herniation is the movement of brain tissue from its normal position into another space within the skull. It happens when pressure inside the skull becomes dangerously uneven. The displaced tissue can compress the brainstem, blood vessels, and nerves that control breathing, alertness, heart rate, and other vital functions.

The skull is a rigid, enclosed space containing the brain, blood, and cerebrospinal fluid. Cerebrospinal fluid is the clear liquid that surrounds and cushions the brain and spinal cord. Swelling, bleeding, a tumor, or another problem can increase the volume inside the skull. Because the skull cannot expand, rising pressure may push brain tissue past firm internal structures or through the opening at the base of the skull.

Doctors describe herniation according to the direction in which tissue moves. Common

patterns include:

These patterns can overlap, and the names are mainly useful to the medical team. For patients and families, the key point is that acute brain herniation is a medical emergency. Rapid treatment may reduce pressure, protect blood flow, and address the underlying cause.

- Subfalcine herniation: Tissue moves beneath a firm membrane separating the brain's two halves.
- Transtentorial herniation: Tissue moves through an opening between the upper and lower parts of the brain. This includes uncal and central herniation.
- Tonsillar herniation: The lowest part of the cerebellum moves toward or through the opening where the spinal cord leaves the skull.
- Upward herniation: Tissue in the lower part of the skull moves upward.

Symptoms

Symptoms depend on how quickly pressure rises and which structures are compressed. A person who is already in the hospital may show changes on a neurologic examination before family members notice an obvious symptom.

Possible warning signs include:

A pattern of high blood pressure, a slow heart rate, and abnormal breathing is called the Cushing response . It can occur with severely increased pressure inside the skull, but not everyone develops all three findings.

Call emergency services immediately if someone has a sudden change in consciousness, a seizure lasting several minutes, new paralysis, unequal pupils with reduced alertness, or abnormal breathing. These symptoms can have several causes, but all require urgent assessment. Do not drive an unconscious or rapidly deteriorating person to the hospital. Do not give food, drink, or medicine by mouth.

- A new or rapidly worsening severe headache
- Repeated vomiting
- Increasing sleepiness, confusion, agitation, or difficulty waking
- Loss of consciousness
- New weakness, numbness, or inability to move part of the body
- Trouble speaking or understanding speech

- A seizure
- One pupil becoming larger than the other
- Pupils that respond poorly or do not respond to light
- Abnormal body stiffening or posturing
- Irregular, unusually slow, or difficult breathing
- Loss of normal brainstem reflexes

Causes and risk factors

Brain herniation is not usually a disease by itself. It is a consequence of another condition that causes swelling, bleeding, blocked fluid flow, or a large mass inside the skull.

Potential causes include:

Risk depends more on the cause and speed of pressure change than on a single personal characteristic. A rapidly expanding blood clot may lead to sudden deterioration. A slower-growing mass may allow the brain to adjust for a time, although it can still become dangerous.

A lumbar puncture, sometimes called a spinal tap, removes fluid from the lower back. It is useful for diagnosing some infections and other conditions. However, clinicians may delay it when examination or imaging suggests a large mass or dangerous pressure difference, because removing fluid could worsen tissue shift.

- Traumatic brain injury: A blow to the head may cause bleeding, bruising, or widespread brain swelling.
- Stroke: A blocked artery can cause a large area of brain swelling. A ruptured blood vessel can create a collection of blood that compresses nearby tissue.
- Brain tumor or another mass: A growing mass and the swelling around it may increase pressure.
- Brain infection: Encephalitis, meningitis, or an abscess can cause swelling or a localized collection of infected material.
- Hydrocephalus: Cerebrospinal fluid can build up when its normal circulation or drainage is blocked.
- Low oxygen to the brain: Cardiac arrest, drowning, or another period of severe oxygen loss can cause widespread swelling.

- Liver failure or other metabolic illness: Severe chemical changes in the body can sometimes lead to brain swelling.
- Complications after brain surgery: Bleeding, swelling, or changes in fluid flow may increase pressure.

Diagnosis

Brain herniation is diagnosed through the clinical examination and urgent brain imaging. If signs strongly suggest herniation, treatment may begin before imaging is completed.

The medical team first checks breathing, oxygen level, circulation, and level of consciousness. Clinicians examine pupil size and response to light, eye movements, limb strength, reflexes, and abnormal posturing. They may use a standardized scale, such as the Glasgow Coma Scale, to record how well a person opens their eyes, speaks, and moves.

A noncontrast computed tomography, or CT , scan is usually the fastest imaging test in an emergency. It can show bleeding, swelling, hydrocephalus, tumors, compressed fluid spaces, and movement of structures away from the brain's center.

Magnetic resonance imaging, or MRI , provides more detail but takes longer and may not be suitable for an unstable patient. It can help identify a tumor, infection, stroke, or brainstem injury after the immediate situation is controlled.

Other tests are selected according to the suspected cause. They may include blood tests, vessel imaging, toxicology testing, or an electroencephalogram to look for ongoing seizure activity. In some critically ill patients, a neurosurgeon places a device inside the skull to measure intracranial pressure. Certain devices can also drain cerebrospinal fluid.

Treatment and management

Treatment takes place in an emergency department, operating room, or intensive care unit. The goals are to maintain oxygen and blood flow, lower dangerous pressure, and treat the cause. The exact approach depends on the examination, imaging findings, and overall condition.

Initial care may include supporting the airway and breathing. A breathing tube and ventilator may be needed if a person cannot protect their airway or breathe effectively. Clinicians also work to prevent low oxygen levels, fever, very low blood pressure, and major changes in blood sugar because these can add to brain injury.

The head may be raised and kept in a neutral position to support blood drainage from the brain. Tight equipment around the neck and other barriers to venous drainage are corrected when possible.

Hyperosmolar medicines, such as hypertonic saline or mannitol, draw water out of swollen brain tissue. These medicines require close monitoring of blood pressure, fluid balance, kidney function, and blood chemistry. The choice between them is individualized by the critical care team.

Brief, controlled hyperventilation can lower intracranial pressure by narrowing blood vessels in the brain. Because it may also reduce brain blood flow, it is generally used as a short-term measure during acute deterioration while more definitive treatment is arranged.

Surgery may be necessary. Depending on the cause, a neurosurgeon may:

Steroid medicines can reduce swelling around some brain tumors. They are not a general treatment for every type of brain swelling and are not recommended for lowering pressure after traumatic brain injury. Antibiotics or antiviral medicines may be used when an infection is responsible. Seizures, stroke, hydrocephalus, and other causes receive condition-specific treatment.

Family members can help by providing the time symptoms began, details about recent injuries, a medication list, and information about blood thinners or bleeding disorders. Treatment decisions should remain with the emergency and specialist teams.

- Remove a blood clot or mass
- Drain cerebrospinal fluid through a ventricular catheter
- Remove infected material
- Repair a bleeding blood vessel
- Remove part of the skull temporarily to give a swollen brain more room

Complications

Brain herniation can reduce blood flow and oxygen delivery to brain tissue. It may injure the brainstem or block the normal circulation of cerebrospinal fluid. Possible complications include stroke, permanent weakness, problems with speech or memory, seizures, impaired swallowing, and changes in behavior or alertness.

Severe injury can lead to coma, inability to breathe without support, or death. The likely outcome varies widely. Important factors include the underlying cause, how long vital structures were compressed, the amount of brain injury, and how quickly effective treatment

began.

Treatment can also carry risks. Surgery may be followed by bleeding or infection. Pressure-lowering medicines can affect blood pressure, kidney function, or salt levels. Intensive monitoring allows the medical team to identify and manage these problems.

Follow up

Follow-up depends on the cause and the effects of the brain injury. After hospital care, some people need repeat CT or MRI scans, medication review, wound checks, or appointments with neurosurgery, neurology, stroke, cancer, or infectious disease specialists.

Rehabilitation may involve physical therapy, occupational therapy, speech and swallowing therapy, and cognitive rehabilitation. Recovery can continue over months, and progress may be uneven. Families may also need guidance about supervision, return to work or school, driving, seizure precautions, and emotional or behavioral changes.

During routine follow-up, report ongoing headaches, sleep changes, problems with concentration, weakness, balance difficulty, medication side effects, or changes in mood. These concerns may need assessment, but they are not always signs of renewed herniation.

Seek emergency care rather than waiting for a routine appointment if there is a new seizure, sudden severe headache, repeated vomiting, rapidly worsening confusion, new weakness, unequal pupils, loss of consciousness, or trouble breathing.

Sources

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