



CONTINUUM AUDIO  
INTERVIEW AVAILABLE  
ONLINE

# Unusual Headache Disorders

By Amaal Jilani Starling, MD, FAHS

## CITE AS:

CONTINUUM (MINNEAP MINN)  
2018;24(4, HEADACHE):1192-1208.

Address correspondence to  
Dr Amaal Jilani Starling, Mayo  
Clinic, 13400 East Shea Blvd,  
Scottsdale, AZ 85259,  
[starling.amaal@mayo.edu](mailto:starling.amaal@mayo.edu).

## RELATIONSHIP DISCLOSURE:

Dr Starling has received personal compensation for serving on the medical advisory boards of Alder BioPharmaceuticals, Inc; Amgen Inc; Eli Lilly and Company; and eNeura Inc and as a consultant for Amgen Inc and Eli Lilly and Company. Dr Starling receives research/grant support from the Mayo Clinic and the Migraine Research Foundation.

## UNLABELED USE OF PRODUCTS/INVESTIGATIONAL USE DISCLOSURE:

Dr Starling discusses the unlabeled/investigational use of acetazolamide, beta-blockers including nadolol and propranolol, caffeine, celecoxib, clomipramine, clonazepam, cyclobenzaprine, ergotamine, flunarizine, gabapentin, indomethacin, lithium, melatonin, nifedipine, nonsteroidal anti-inflammatory drugs, onabotulinumtoxinA, topiramate, and tricyclic antidepressants including amitriptyline for the treatment of unusual headache disorders.

© 2018 American Academy  
of Neurology.

## ABSTRACT

**PURPOSE OF REVIEW:** Unusual headache disorders are less commonly discussed and may be misdiagnosed. These headache disorders frequently have a benign natural history; however, without reassurance, therapeutic education, and treatment, they can negatively affect the health and function of patients.

**RECENT FINDINGS:** This article reviews the clinical features, diagnosis, workup, and proposed treatments for several unusual headache disorders including primary cough headache, primary headache associated with sexual activity, primary exercise headache, cold-stimulus headache, primary stabbing headache, nummular headache, hypnic headache, and headache attributed to travel in space. Exploding head syndrome is also discussed, which is a sleep disorder commonly confused with a headache disorder.

**SUMMARY:** Unusual headache disorders are usually benign, yet without the correct diagnosis can be very worrisome for many patients. Through greater awareness of these headache disorders, neurologists can evaluate and effectively manage unusual headache disorders, which offers significant benefits to patients and practice satisfaction to neurologists.

## INTRODUCTION

Although most patients with headache disorders have migraine or tension-type headache (because of the high lifetime prevalence of these disorders), more unusual headache disorders also present to the general neurologist. Fortunately, the natural history of most unusual headache disorders is benign. However, any type of new-onset head pain or sensation can be alarming for patients. In addition, every new-onset headache should be considered a secondary headache until proven otherwise. Knowledge of these unusual headache disorders will guide the neurologist's ability to identify, evaluate, and treat these disorders. Oftentimes, treatment may include education and reassurance of a benign course, although, at times, pharmacologic measures are essential to meet the needs of the patient. The purpose of this article is to discuss the clinical features, diagnosis, recommended workup, and treatment for primary cough headache, primary headache associated with sexual activity, primary exercise headache, cold-stimulus headache, primary stabbing headache, nummular headache, hypnic headache, headache attributed to travel in space, and exploding head syndrome.

## PRIMARY COUGH HEADACHE

Primary cough headache is a benign headache precipitated by coughing or straining that is not attributed to a secondary cause, such as an intracranial lesion.

### Clinical Features and Diagnostic Criteria

Primary cough headache is rare, with an estimated prevalence of about 1%.<sup>1,2</sup> Given that primary cough headache is rare, when a patient presents with a headache triggered by cough or some other Valsalva maneuver that may raise intracranial pressure, the most essential first step is to rule out a secondary cause based on red flags identified on history and examination. In some studies, more than 50% of cases of headache triggered by cough or Valsalva maneuvers are secondary headache disorders, most commonly a headache attributed to an Arnold-Chiari malformation type I.<sup>2</sup>

To meet *International Classification of Headache Disorders, Third Edition (ICHD-3)* diagnostic criteria for primary cough headache, at least two sudden-onset headache attacks must occur that are brought on by coughing, straining, and/or other Valsalva maneuvers and last from 1 second to 2 hours, and it must not be better accounted for by another *ICHD-3* diagnosis.<sup>3</sup> (Refer to the open access online version of the *ICHD-3* for a complete listing of the diagnostic criteria discussed in this article.<sup>3</sup>) Primary cough headache is more common in women (64%) compared to men, with an average age of onset of 60 years of age (range of 22 to 80 years of age).<sup>2</sup> Clinically, it can be bilateral or unilateral, most commonly with a mixed quality of pain (electrical, explosive, or pressing), lasting for only seconds in 78% of cases.<sup>2</sup>

### Differential Diagnosis and Recommended Workup

The differential diagnosis includes posterior fossa structural lesions, Arnold-Chiari malformation type I, etiologies of thunderclap headache including reversible cerebral vasoconstriction syndrome (RCVS), cervical artery dissection, and perturbations in CSF pressure. Typically, patients with a secondary cause will have symptoms in addition to headache (eg, dizziness, unsteadiness, facial or upper limb numbness, vertigo, or syncope).<sup>2</sup>

Workup to assess for causes of secondary headache should include diagnostic neuroimaging with a brain MRI with and without contrast and a magnetic resonance angiogram (MRA) of the head and neck. If increased CSF pressure is suspected, a magnetic resonance venogram (MRV) of the head and lumbar puncture (if no contraindications) are indicated.

### Proposed Mechanism

The mechanism for primary cough headache is unknown; however, it is suspected to be related to a sudden increase in intracranial venous pressure, hypersensitivity of mechanoreceptors located in venous structures, or crowding of the posterior fossa.<sup>4-6</sup>

### Treatment

Since primary cough headaches are benign attacks of short duration, often reassurance is the only treatment needed. However, if symptoms are bothersome and affect daily function, treatments known to reduce CSF pressure appear to be effective, including indomethacin, high-volume lumbar puncture, and acetazolamide.<sup>2,4,7,8</sup> Primary cough headache is an indomethacin-responsive

## KEY POINTS

- Given that primary cough headache is rare, when a patient presents with a headache triggered by cough or some other Valsalva maneuver that may raise intracranial pressure, the most essential first step is to rule out a secondary cause based on red flags identified on history and examination.
- Since primary cough headaches are benign attacks of short duration, often reassurance is the only treatment needed.

headache. Indomethacin titrated up to 50 mg/d to 100 mg/d is an effective treatment.<sup>2</sup> In cases where indomethacin is ineffective or not tolerated, acetazolamide is an option. Based on previous observations, Raskin<sup>7</sup> demonstrated that a large-volume lumbar puncture (removal of 40 mL of CSF) may have a therapeutic long-lasting benefit in primary cough headache.<sup>9</sup> In this author's practice, a therapeutic high-volume lumbar puncture, if effective, can often allow patients to avoid medications including indomethacin, which has gastrointestinal complications, and acetazolamide, which is typically poorly tolerated.

### PRIMARY HEADACHE ASSOCIATED WITH SEXUAL ACTIVITY

Primary headache associated with sexual activity was previously called benign sex headache, coital headache, preorgasmic headache, or orgasmic headache. However, clinical studies were unable to differentiate between preorgasmic and orgasmic headaches; therefore, all subtypes now fall into the more inclusive single diagnosis of primary headache associated with sexual activity.

#### Clinical Features and Diagnostic Criteria

Primary headache associated with sexual activity is rare, with an estimated lifetime prevalence of about 1%.<sup>1</sup> To meet *ICHD-3* diagnostic criteria, there must be at least two attacks brought on by and occurring only during sexual activity that last anywhere from 1 minute to 24 hours with severe intensity and/or up to 72 hours with mild intensity.<sup>3</sup> These attacks can increase in intensity with increasing sexual arousal or can occur suddenly with explosive intensity just before or with orgasm.<sup>3</sup> Clinically, the headache location can vary, although it is commonly bilateral.<sup>10</sup> The pain is typically pulsating or throbbing and lasts for minutes to hours.<sup>11</sup>

This headache disorder has been described in adults<sup>12,13</sup> but can occur in adolescents as soon as the capacity to have an orgasm is achieved.<sup>14</sup> There is a male predominance.<sup>10,15</sup> For many patients, remission may occur after several months; however, some may have a more chronic course or experience recurrence.<sup>11-13,15</sup> Primary headache associated with sexual activity is comorbid with primary exertional headache (about 30% to 40%) and migraine (about 30%).<sup>3</sup>

#### Differential Diagnosis and Recommended Workup

It is essential to remember that a new-onset headache associated with sexual activity is a secondary headache until proven otherwise. An explosive attack just before or with orgasm is a thunderclap headache, which is a headache red flag and a neurologic emergency. A thunderclap headache, which is a severe sudden-onset headache that reaches peak intensity within 60 seconds, is concerning for intracranial bleeding, most commonly a subarachnoid hemorrhage from an aneurysmal rupture and other vascular entities. Because of the high rate of morbidity and mortality, a subarachnoid hemorrhage must be ruled out as soon as possible. However, if intracranial bleeding is not present, other causes of a thunderclap headache should be investigated as well. Other causes of thunderclap headache include RCVS, cerebral venous sinus thrombosis, or cervical artery dissection.<sup>16</sup> All patients with a thunderclap headache must undergo a noncontrast head CT. If the head CT does not reveal the cause of the thunderclap headache, a lumbar puncture is indicated. A lumbar puncture helps to evaluate for a possible subarachnoid hemorrhage or other causes of a

thunderclap headache. If both the head CT and lumbar puncture are unrevealing, additional neurovascular head and neck imaging (MRA/MRV or CT angiography/CT venography) is recommended to rule out other causes of a thunderclap headache.<sup>16</sup> Once more alarming causes of headache have been ruled out, a diagnosis of primary headache associated with sexual activity can be considered. Thus, it is a diagnosis of exclusion.

### Proposed Mechanism

The pathophysiology of primary headache associated with sexual activity is largely unknown; however, it is suspected to be related to sudden changes in hemodynamics and abnormal cerebrovascular autoregulation.<sup>17,18</sup> In one study, 12 out of 19 patients were found to have venous stenosis via MRV of the head, suggesting that venous blood flow abnormalities may contribute to the mechanism or at least be a risk factor for the disorder.<sup>19</sup>

### Treatment

Treatment starts with education and reassurance of the benign, self-limiting natural history of this headache disorder. Anticipatory treatment 30 minutes prior to sexual activity with indomethacin can be an effective treatment plan for most patients.<sup>10,12,13,15</sup> However, if longer term prevention is needed, beta-blockers have also been used successfully.<sup>2,10,12,15</sup>

## PRIMARY EXERCISE HEADACHE

Primary exercise headache is a benign primary headache disorder that was previously termed primary exertional headache.

### Clinical Features and Diagnostic Criteria

Although clinically similar to primary cough headache and primary headache associated with sexual activity, primary exercise headache is unique in that it is precipitated by sustained physically strenuous activity rather than short-duration precipitating factors such as cough, Valsalva maneuver, or orgasm.<sup>3</sup> Primary exercise headache typically lasts less than 48 hours, has a pulsating quality, occurs particularly in hot weather or high altitudes, and is self-limited, requiring treatment for 2 to 6 months.<sup>2</sup> To meet *ICHD-3* diagnostic criteria for primary exercise headache, there must be at least two headache episodes brought on by and occurring only during or after strenuous physical exercise that last for less than 48 hours and are not better accounted for by another *ICHD-3* diagnosis.<sup>3</sup>

### Prevalence

Primary exercise headache is thought to be a relatively uncommon primary headache disorder, although prevalence has varied in studies from 1% to 26%.<sup>1,2</sup> A prospective series performed in a headache clinic found that 11 out of 6412 patients with headache met the criteria for primary exercise headache.<sup>2</sup> Low prevalence, high comorbidity with migraine, and self-limited prognosis was confirmed in this prospective study.<sup>2</sup> However, in a study performed in highly athletic cyclists, the prevalence was much higher (26%), which may be a result of exposure to hot weather, extreme exertion, or dehydration.<sup>20</sup> Given the high prevalence in athletes, this entity should be considered when evaluating an athlete with headache.

## KEY POINTS

- An explosive attack just before or with orgasm is a thunderclap headache, which is a headache red flag and a neurologic emergency.
- A diagnosis of primary headache associated with sexual activity can be considered once more alarming causes of headache have been ruled out; thus, it is a diagnosis of exclusion.
- Anticipatory treatment 30 minutes prior to sexual activity with indomethacin can be an effective treatment plan for most patients with primary headache associated with sexual activity. However, if longer term prevention is needed, beta-blockers have also been used successfully.
- Primary exercise headache is unique in that it is precipitated by sustained physically strenuous activity rather than short-duration precipitating factors such as cough, Valsalva maneuver, or orgasm.
- Given the high prevalence in athletes, primary exercise headache should be considered when evaluating an athlete with headache.

### Proposed Mechanism

The pathophysiology of primary exercise headache is unclear, although internal jugular vein valve incompetence has been proposed based on a study demonstrating that 70% of subjects with primary exercise headache had retrograde venous flow in the jugular vein compared to 20% of healthy controls.<sup>21</sup> It has been suggested that pain-sensitive venous sinus dilatation secondary to incompetent valves and retrograde flow may have a nociceptive and causative role in primary exercise headache.<sup>21</sup> However, this does not explain why primary exercise headache is typically a self-limited disorder, since internal jugular vein valve incompetence does not resolve spontaneously.

### CASE 12-1

A 54-year-old man with obesity, untreated hypertension, hyperlipidemia, and a family history of coronary artery disease at a young age had been instructed by his primary care physician to begin an exercise regimen to better control his vascular risk factors. After 4 weeks, he reported that he was unable to exercise because of severe headaches that developed toward the end of a 40-minute aerobic workout. The headaches lasted about 1 to 2 days. He also noted neck pain since he started exercising, but he denied any other associated features. He denied a sudden thunderclap headache.

He was referred for a neurologic evaluation. Examination showed an elevated blood pressure of 151/85 mm Hg; neurologic examination was normal. Because the patient's headaches were precipitated by exercise, and considering the patient's vascular risk factors, additional investigations were performed. MRI of the brain, magnetic resonance angiography (MRA) of the head and neck, and stress echocardiogram were all within normal limits.

After ruling out a secondary headache, primary exercise headache was diagnosed. He had a history of gastritis, and therefore indomethacin was avoided. Although the headache disorder was felt to be benign, prevention was discussed to enable him to exercise, lose weight, and reduce his vascular risk factors. Propranolol was titrated to 60 mg twice a day, which was effective for headache prevention and reduced his blood pressure to an acceptable range.

### COMMENT

Headache precipitated by exercise is a secondary headache until proven otherwise, especially in a patient with vascular risk factors. Cardiac cephalalgia is caused by myocardial ischemia, and headache may be the sole manifestation. A stress test is diagnostic, and revascularization is curative. In this case, cardiac cephalalgia and other causes of secondary exercise-induced headaches were appropriately considered and excluded. Primary exercise headache can be effectively treated with indomethacin, if tolerated, or beta-blockers for those who cannot use nonsteroidal anti-inflammatory drugs because of gastrointestinal or other contraindications.



However, one proposed hypothesis is that incompetent internal jugular vein valves are a risk factor for primary exercise headache, and that the self-limited course of primary exercise headache may be a result of transient circulating metabolic substrates triggering symptoms in the setting of the incompetent valves.<sup>18,21</sup>

### Differential Diagnosis and Recommended Workup

A secondary headache must be ruled out in all patients with new-onset headache by evaluating red flags in the history and on examination. Precipitation of headache by exercise or exertion is a headache red flag and should raise concern for a secondary cause of headache. Thus, a detailed headache history and comprehensive neurologic examination with appropriate neurovascular imaging and other tests may be required prior to the diagnosis of primary exercise headache. Secondary headache disorders that should be considered include intracranial hemorrhage (subarachnoid hemorrhage), RCVS, cervical artery dissection, cerebral venous sinus thrombosis, intracranial hypertension or hypotension, Arnold-Chiari malformation type I, cardiac cephalalgia, or pheochromocytoma.

A noncontrast head CT will help assess for intracranial hemorrhage in the acute setting with consideration for a lumbar puncture depending on the clinical scenario. In addition, neurovascular imaging using a CT angiogram or MRA should be completed to rule out other vascular causes of secondary headache when precipitated by exertion or exercise.

Cardiac cephalalgia should be considered in older adults with vascular risk factors, as demonstrated in **CASE 12-1**. The headache in cardiac cephalalgia is a result of myocardial ischemia and can be the sole manifestation of cardiac ischemia.<sup>22</sup> A cardiac stress test is diagnostic, and revascularization of coronary vessels is curative.<sup>23</sup> Pheochromocytoma is a rare, non-neurologic cause of exertional headache that can be investigated with blood and urinary work, which is especially sensitive during the headache episode.

Although the clinician must look for secondary causes of exercise or exertion-triggered headache onset, the majority of these headaches are concluded to be primary and benign.<sup>24</sup>

### Treatment

Given that primary exercise headache is a self-limited benign disorder, once a workup has been completed, treatment is often as simple as trigger avoidance.<sup>25</sup> However, exercise is essential for healthy living, and if primary exercise headache is a barrier to exercise, then pharmacotherapy is available and typically effective. Primary exercise headache is an indomethacin-responsive headache. Indomethacin can be taken on a scheduled basis or prior to exercise.<sup>25</sup> For patients who do not respond to or are unable to tolerate indomethacin, beta-blockers such as nadolol or propranolol have been effective.<sup>10</sup>

### HEADACHE ATTRIBUTED TO INGESTION OR INHALATION OF A COLD STIMULUS

An “ice cream headache” or “brain freeze,” as is commonly referred to, is classified by the *ICHD-3* as a headache attributed to ingestion or inhalation of a cold stimulus.<sup>3</sup>

### KEY POINTS

- Precipitation of headache by exercise or exertion is a headache red flag and should raise concern for a secondary cause of headache.
- Cardiac cephalalgia should be considered in older adults with vascular risk factors who present with a headache precipitated by exercise. The headache is a result of myocardial ischemia and can be the sole manifestation of ischemia. A stress test is diagnostic, and revascularization of coronary vessels is curative.
- Given that primary exercise headache is a self-limited, benign disorder, once a workup has been completed, treatment is often as simple as trigger avoidance. However, exercise is essential for healthy living, and if primary exercise headache is a barrier to exercise, then pharmacotherapy is available and typically effective.

### Clinical Features and Diagnostic Criteria

To meet *ICHD-3* diagnostic criteria for headache attributed to ingestion or inhalation of a cold stimulus, there must be at least two episodes of acute frontal or temporal headache brought on by and occurring immediately after a cold stimulus to the palate and/or posterior pharyngeal wall that resolve within 10 minutes after removal of the cold stimulus and which are not better accounted for by another *ICHD-3* diagnosis.<sup>3</sup> Although this type of headache typically occurs in the setting of eating or drinking something very cold, it has also been reported during surfing in the winter and during ice-skating; thus, the inhalation of cold air was added to the criterion.<sup>26,27</sup> Typically, intense pain begins within a few seconds of the rapid ingestion or inhalation of cold material and is short lasting, persisting only seconds. Two large survey studies have demonstrated that the majority of cold-stimulus headache episodes last less than 30 seconds.<sup>28,29</sup> Rapid passage is important. In a study that compared placing an ice cube on the palate compared to the ingestion of 200 mL of ice water as fast as possible, rapid ice water ingestion more consistently provoked a cold-stimulus headache in 51% versus 12% of subjects.<sup>30</sup> The speed at which waters cooled down the entire oral cavity was thought to be a differentiating factor. In addition, a randomized trial of accelerated (consumption of 100 mL of ice cream in less than 5 seconds) versus cautious (consumption of 100 mL of ice cream in greater than 30 seconds) ice cream eating demonstrated that eating ice cream quickly was about 2 times more likely to trigger a cold-stimulus headache.<sup>31</sup> The reported prevalence of cold-stimulus headache varies, largely based on study population demographics, ranging from 7.6% to 93%.<sup>28,31-34</sup> It is more common in people with migraine.<sup>32-34</sup>

### Proposed Mechanism

The underlying mechanism of cold-stimulus headache is thought to be vascular and is similar to when a person runs his or her icy cold hands under hot water, resulting in hand pain. Cold-induced pain of the hand is correlated with reduced arterial pulses in the hand<sup>35</sup> followed by erythema of the hands, which is correlated with vasodilation. The exposure of the palate or the posterior pharyngeal wall to a very cold substance may trigger rapid constriction and dilation of vessels, thus activating the nociceptors in the vessel wall. In addition, cold-stimulus headache is an example of referred pain where cold stimulation of the palate or posterior pharyngeal wall results in frontal or temporal head pain.<sup>35</sup>

### Treatment

Aside from trigger avoidance, no specific treatment is required. Patients should ingest cold substances slowly and avoid rapid exposure of cold substances to the posterior aspect of the palate if possible. Most importantly, these headaches are benign and short lasting, thus the abstinence of ingesting cold substances, such as ice cream, is not necessary or recommended by this author; just savor it slowly.

### PRIMARY STABBING HEADACHE

Primary stabbing headache, commonly referred to as ice pick headache, is characterized by ultrashort localized jabs, jolts, or stabs of pain usually lasting 1 to 2 seconds.<sup>36</sup>

## Clinical Features and Diagnostic Criteria

Primary stabbing headache is likely very common. Some studies have estimated up to 35% of the general population has experienced at least one episode of primary stabbing headache.<sup>37</sup> The true estimate may be even higher given that individuals with one or two episodes may have forgotten about these benign symptoms. Interestingly, in patients with migraine, the prevalence of primary stabbing headache is high at about 40%.<sup>38</sup> Primary stabbing headache is more common in females, and onset is typically in adulthood.<sup>37</sup>

To meet *ICHD-3* diagnostic criteria for primary stabbing headache, each stab must last for up to a few seconds and occur at an irregular frequency, from a single stab to a series of stabs and from one to many episodes per day.<sup>3</sup> No cranial autonomic features are present.<sup>3</sup> Clinically, primary stabbing headaches are headaches with the shortest duration, with studies demonstrating that 80% of stabbing pains last 3 seconds or less.<sup>36</sup> These episodes are not triggered by mechanical stimuli such as touch, eating, or talking. No migrainelike features or sensory sensitivities are associated with the stabbing pains. Based on the trigeminal distribution of pain, trigeminal nerve hyperexcitability is hypothesized, but the mechanism of primary stabbing headache remains unknown.<sup>24</sup>

## Differential Diagnosis and Recommended Workup

The differential diagnosis for primary stabbing headache includes trigeminal neuralgia and trigeminal autonomic cephalalgias, specifically short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing (SUNCT) and short-lasting unilateral neuralgiform headache attacks with cranial autonomic symptoms (SUNA). Trigeminal neuralgia is typically localized to one trigeminal branch distribution (usually V<sub>3</sub> or V<sub>2</sub>), is easily triggered by mechanical stimuli, and is responsive to treatment with carbamazepine. SUNCT is typically localized to one trigeminal branch distribution (usually V<sub>1</sub>), is often triggerable, and is associated with unilateral cranial autonomic features.<sup>39</sup> These distinguishing features should narrow the differential diagnosis. However, new-onset primary stabbing headache, especially in a patient without a history of migraine, should first prompt a workup for a secondary cause. Short stabs of pain have been described with trauma, glaucoma, increased intracranial pressure secondary to mass lesions, pituitary lesions, and herpes zoster.<sup>24,36,40,41</sup> In addition to a thorough history and examination, neuroimaging may be indicated depending on headache red flags.

## Treatment

Idiopathic primary stabbing headache is benign and typically does not require any specific treatment aside from reassurance. However, if the stabbing pains are more frequent, indomethacin is the medication of choice.<sup>36,42</sup> Melatonin, celecoxib, and gabapentin have also been used when indomethacin is ineffective, not well tolerated, or contraindicated.<sup>24</sup>

## NUMMULAR HEADACHE

Nummular headache is an unusual primary headache disorder characterized by head pain that occurs in a small, fixed, very well-circumscribed coin, oval, or elliptical shape.

## KEY POINTS

- In headache attributed to ingestion or inhalation of a cold stimulus, intense pain typically begins within a few seconds of the rapid ingestion or inhalation of cold material and is short lasting, persisting only for seconds.
- In headache attributed to ingestion or inhalation of a cold stimulus, the exposure of the palate or the posterior pharyngeal wall to a very cold substance may trigger rapid constriction and dilation of vessels, thus activating the nociceptors in the vessel wall, resulting in referred pain to the head.
- Aside from trigger avoidance, no specific treatment is required for headache attributed to ingestion or inhalation of a cold stimulus. Cold substances should be ingested slowly while avoiding rapid exposure of cold substances to the posterior aspect of the palate if possible.
- Clinically, primary stabbing headaches are headaches with the shortest duration, with studies demonstrating that 80% of stabbing pains last 3 seconds or less.
- The differential diagnosis for primary stabbing headache includes trigeminal neuralgia and trigeminal autonomic cephalalgias, specifically short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing and short-lasting unilateral neuralgiform headache attacks with cranial autonomic symptoms.



### Clinical Features and Diagnostic Criteria

Because of its rarity, its true prevalence is unknown, although one hospital series estimated 6.4 out of 100,000 patients per year experience nummular headache.<sup>43</sup> Nummular headaches are more common in females, about 1.8:1, with a mean age of onset at 45.4 years of age (range of 4 to 82 years of age). About 13% of patients report prior head trauma. Interestingly, limited correlation typically exists between the site of trauma and the location of the focal, well-circumscribed head pain. Others have not identified any potential precipitating factors. Almost 50% of patients have a preexisting headache diagnosis, most commonly migraine.<sup>44</sup>

To meet *ICHD-3* diagnostic criteria for nummular headache, the head pain should be felt in one area of the scalp and be sharply contoured, fixed in size and shape, round or elliptical, and 1 cm to 6 cm in diameter. The pain can either be continuous or episodic.<sup>3</sup> Clinically, the pain quality is described as pressurelike, sharp, or stabbing. The pain remains focal and well circumscribed and never radiates. Exacerbation of pain can be triggered by mechanical stimuli and can occur spontaneously. The pain will rarely awaken a patient from sleep.<sup>43</sup> About 50% of patients endorse not only pain but also sensory dysfunction (paresthesia, allodynia, hypoesthesia, or hyperesthesia) in the coin-shaped area of pain.<sup>44</sup> Although the diagnostic criteria allow for pain of variable duration, two-thirds of patients have chronic, continuous head pain. Typically, associated features including photophobia, nausea, vomiting, or unilateral cranial autonomic features are not present.

### Differential Diagnosis and Recommended Workup

Given the focal nature of nummular headache, it is essential to rule out a secondary headache disorder with a detailed history and neurologic examination, laboratory studies, and neuroimaging. The examination must include careful inspection of the epicranial tissues. Laboratory studies should include a complete blood cell count, basic metabolic panel, liver function tests, thyroid function tests, erythrocyte sedimentation rate, antinuclear antibodies, and rheumatoid factor.<sup>43</sup> In the setting of well-circumscribed pain, an underlying structural lesion must be ruled out with imaging studies. A skull x-ray, CT head, or MRI brain without contrast can be performed to rule out a structural lesion.<sup>43</sup> Once a secondary headache or underlying structural lesion has been ruled out, other entities to consider in the differential diagnosis include primary stabbing headache, although this is typically multifocal and not unifocal as in nummular headache; epicrania fugax,<sup>45</sup> although this head pain is in motion rather than a single focal, coin-shaped area as occurs in nummular headache; and other cranial neuralgias, although a cranial neuralgia would follow the relevant nerve distribution and respond to anesthetic blocks, both of which do not occur in nummular headache.

### Proposed Mechanism

It is unclear if the mechanism underlying nummular headache is peripheral or central. The evidence for a more peripheral process includes a small, fixed area of pain and associated sensory dysfunction in the same location.<sup>46</sup> However, nummular headache has not responded consistently to peripheral nerve blocks and does not follow a particular nerve distribution. In addition, centrally acting treatment options have been effective.<sup>44</sup> It has been hypothesized that nummular headache may be a focal form of complex regional pain syndrome, particularly when onset is temporally correlated with injury or surgery to

the head.<sup>43</sup> In addition, trophic changes have been reported, such as focal skin depression, hair loss, reddish color, or increased temperature as seen in complex regional pain syndrome.<sup>47,48</sup>

### Treatment

Unfortunately, because of the rarity of nummular headache, little evidence exists upon which to base clinical treatment recommendations. About 60% of patients respond to simple analgesics and nonsteroidal anti-inflammatory drugs, but preventive options are considered for patients with more severe refractory pain.<sup>44</sup> In this author's practice, patients with severe, refractory, continuous pain can be difficult to treat effectively. Gabapentin, tricyclic antidepressants, and onabotulinumtoxinA injections have at least been partially effective in 45% to 92% of patients.<sup>44</sup> Surprisingly, anesthetic blocks of the symptomatic area have been largely ineffective.<sup>44</sup> Other treatment options have been reported to be helpful in case reports including cyclobenzaprine,<sup>49</sup> indomethacin,<sup>50,51</sup> and even transcutaneous electrical nerve stimulation.<sup>52</sup>

### HYPNIC HEADACHE

Hypnic headache is a recurrent primary headache disorder of short duration that typically occurs in older persons, typically after the age of 50.

#### Clinical Features and Diagnostic Criteria

Hypnic headache occurs only during sleep and will cause the person to awaken. It is commonly referred to as an "alarm clock headache" because of its untimely occurrence at the same time every night. Its epidemiology is unknown but is likely rare.<sup>24</sup> Hypnic headache is more prevalent in females (65%) than males.<sup>24</sup> To meet *ICHD-3* diagnostic criteria for hypnic headache, symptoms must include recurrent headaches lasting 15 minutes to 4 hours that develop only during sleep, cause awakening, and occur on 10 or more days per month for more than 3 months.<sup>3</sup> These headache attacks are not associated with unilateral cranial autonomic features, restlessness, or sensory sensitivities. The pain is constant, of mild to moderate intensity, and can be bilateral or unilateral.<sup>53</sup> The mechanism is unknown, although age-related dysfunction of the suprachiasmatic nucleus of the hypothalamus is hypothesized.<sup>54,55</sup>

#### Differential Diagnosis and Recommended Workup

Given that a new-onset headache in older patients is a headache red flag, secondary causes of headache must be ruled out before the diagnosis of hypnic headache can be made, as demonstrated in **CASE 12-2**. The differential diagnosis for nocturnal headaches includes nocturnal hypertension, increased intracranial pressure (mass lesion or idiopathic intracranial hypertension), trigeminal autonomic cephalalgias (specifically cluster headache), caffeine withdrawal headache, medication-overuse (rebound) headache, and sleep apnea headache. Cluster headache attacks occur at nightly intervals; however, the presence of autonomic features should guide the diagnosis. Caffeine withdrawal or medication-overuse headaches frequently occur at night or in the early morning; however, these headaches are typically present upon awakening rather than the headache attack itself waking the patient. In addition to a careful history and examination, neuroimaging, laboratory studies (including an erythrocyte sedimentation rate), lumbar puncture, ambulatory blood pressure

### KEY POINTS

- Idiopathic primary stabbing headache is benign and typically does not require any specific treatment aside from reassurance. However, if the stabbing pains are more frequent, indomethacin is the medication of choice.
- Nummular headache is an unusual primary headache disorder characterized by head pain that occurs in a small, fixed, very well-circumscribed coin, oval, or elliptical shape.
- Entities to consider in the differential diagnosis for nummular headache include primary stabbing headache, although this is typically multifocal and not unifocal as in nummular headache; epicrania fugax, although this head pain is in motion and not a focal, coin-shaped area as occurs in nummular headache; and other cranial neuralgias, although these would follow the relevant nerve distribution and respond to anesthetic blocks, both of which do not occur in nummular headache.
- Hypnic headache is a recurrent primary headache disorder of short duration that typically occurs in older persons, typically after the age of 50. These headaches occur only during sleep and will cause the person to awaken.

monitoring, or a sleep study, depending on the red flags present, may be needed to further narrow the differential diagnosis.

### Treatment

Treatment options for hypnic headache include caffeine (100 mg to 200 mg), melatonin (3 mg to 12 mg), or lithium (200 mg to 600 mg); these medications should be given prior to bedtime.<sup>56</sup> Although effective, lithium may be problematic especially for older patients because of the possibility for lithium toxicity, narrow therapeutic window, altered pharmacokinetics, reduced renal function, drug-drug interactions, and adverse effects that can affect mental status or balance. Fortunately, caffeine and/or melatonin are typically effective, thus avoiding use of lithium altogether.<sup>56,57</sup>

## CASE 12-2

A 68-year-old woman presented to the neurology clinic for evaluation of new-onset headaches. The headaches had occurred almost every night for the past 4 months at about 4:00 AM and had been waking her up. The headache was a bilateral, moderate intensity, pressurelike pain that lasted for about 20 minutes. She usually woke up, went to the bathroom, and got a drink of water; by that time, the headache would be gone; and she would try to go back to sleep. This affected her sleep, and she felt that it was impairing her ability to function during the day because of fatigue. She had no significant past medical history.

She denied daytime headache, scalp tenderness, jaw claudication, visual symptoms, body aches and pains out of the ordinary, or any other systemic symptoms. She denied any autonomic features or restlessness. She endorsed fatigue, and she snored quite heavily, although her bed partner denied any obvious apneic spells. She had no prior history of headaches.

Her general and neurologic examination was essentially normal, except for obesity and some reduced range of active motion of her neck with extension, lateral flexion, and horizontal rotation. Pertinent negative findings included normal blood pressure, intact temporal artery pulsations, no temporal artery or scalp tenderness or scalp allodynia, and normal cranial nerves, including funduscopic examination. Complete blood cell count, erythrocyte sedimentation rate, C-reactive protein, ambulatory blood pressure monitor, sleep study, and noncontrast head CT were all within normal limits.

She was diagnosed with hypnic headache and was advised to drink a strong cup of coffee prior to bedtime. This treatment regimen immediately stopped her nightly headaches, and she was able to sleep despite the caffeine prior to bedtime.

### COMMENT

Older patients with a new-onset headache should be investigated for a secondary cause of headache. However, once secondary causes are ruled out, a nocturnal headache that wakens the patient is likely hypnic headache. Caffeine prior to bedtime can be both diagnostic and therapeutic.

## HEADACHE ATTRIBUTED TO TRAVEL IN SPACE

Headache attributed to travel in space, or space headache, was previously attributed to space motion sickness syndrome.<sup>58</sup> More recently, it has been identified as a separate entity from space motion sickness syndrome and is included in the appendix of the *ICHD-3*. With more scientific evidence, this diagnosis may move into the main body of the classification on the next revision.<sup>3</sup>

### Clinical Features and Diagnostic Criteria

Headache attributed to travel in space is a secondary headache classified as a *headache attributed to disorder of homeostasis* based on the presumed pathophysiology.<sup>3</sup> The *ICHD-3* diagnostic criteria do not provide characteristics of the headache itself or associated clinical features but simply describe a temporal relationship to travel in space. It is a headache that occurs exclusively during space travel and remits spontaneously on return to earth.<sup>3</sup>

A 2009 study demonstrated that 12 out of 17 (71%) astronauts reported headache episodes during a space mission.<sup>58</sup> Among this small sample size, headache was reported as occurring in all phases of space flight (launch, docking, extravehicular activity, and landing). It typically has a moderate to severe intensity with an exploding or heavy quality of pain requiring analgesics.<sup>58</sup> None of the astronauts had a history of recurrent headache on earth. Studies using head-down-tilted bed rest, which simulates space microgravity on earth, have demonstrated headache episodes in the absence of symptoms associated with space motion sickness syndrome.<sup>59</sup>

### Proposed Mechanism and Treatment

In a study of head-down-tilted bed rest, counter measures, including 30 minutes of upright aerobic exercise and enhanced artificial gravity, reduced the severity of space headache.<sup>59</sup> This may serve as a model for space headache on earth to further elucidate the pathophysiology and treatment. It is well-known that significant fluid shifts occur in microgravity, resulting in elevated intracranial pressure.<sup>60</sup> Another pathophysiologic consideration for space headache is hypoxia in microgravity. Microgravity reduces the hypoxic drive but not the hypercapnic drive to ventilate.<sup>61</sup> With further prospective studies, both in space and simulated microgravity, a better understanding of the underlying disorder of homeostasis will hopefully guide effective treatment for this common but debilitating headache during space flight.

## EXPLODING HEAD SYNDROME

Exploding head syndrome is a sleep disorder commonly confused for a headache disorder by both patients and clinicians.

### Clinical Features and Diagnostic Criteria

During an acute attack of exploding head syndrome, the patient has a perception of a loud, explosive noise in the absence of objective acoustic stimulation that usually occurs during sleep transitions when going to sleep or awakening. It is sudden, causes fear, but is not associated with head pain, as is demonstrated in **CASE 12-3**. The actual attack is very brief, lasting less than 1 second; however, the frequency is highly variable, ranging from one attack every few days to several attacks per night. Exploding head syndrome is classified as a sensory parasomnia; however, because of its sudden onset and other clinical characteristics, both

## KEY POINTS

- The differential diagnosis for nocturnal headaches includes nocturnal hypertension, increased intracranial pressure (mass lesion or idiopathic intracranial hypertension), trigeminal autonomic cephalalgias (specifically cluster headache), caffeine withdrawal headache and medication-overuse (rebound) headache, or sleep apnea headache.
- Treatment options for hypnic headache include caffeine, melatonin, and lithium. Although effective, lithium may be problematic especially for older patients because of the possibility for lithium toxicity. Fortunately, caffeine and/or melatonin are typically effective, thus avoiding use of lithium altogether.
- Space headache has been reported in all phases of space flight. It typically has a moderate to severe intensity with an exploding or heavy quality of pain requiring analgesics.
- During an acute attack of exploding head syndrome, the patient has a perception of a loud, explosive noise in the absence of objective acoustic stimulation that usually occurs during sleep transitions when going to sleep or awakening. It is sudden, causes fear, but is not associated with head pain.

primary and secondary headache disorders should be included in the differential diagnosis. The *ICHD-3* diagnostic criteria include three components: (1) a complaint of a sudden loud noise or sense of explosion in the head at the wake-sleep transition or upon awakening during the night, (2) abrupt arousal following the event, often with a sense of fright, and (3) not associated with significant pain.<sup>62</sup> In addition to the perception of a loud noise or explosion and fear, patients have also reported flashes of light or other visual phenomena, tachycardia, sweating, and, rarely, myoclonic jerks.<sup>63,64</sup>

Because of misdiagnosis, lack of adequate assessment tools, and patient reluctance to report symptoms to medical providers, the true prevalence of exploding head syndrome is unknown. Based on recent studies, rough prevalence estimates suggest 10% to 14%.<sup>63</sup> Females are more affected than males.<sup>63,65</sup> Exploding headache syndrome occurs predominately in older people with a median age of onset of 54 years.<sup>63</sup> Although the natural history of the syndrome is variable, more recent case series and review of the literature support a more chronic course with a variable attack frequency.<sup>63</sup>

#### Proposed Mechanism

The pathophysiology of exploding head syndrome is unknown, but possibilities include middle ear dysfunction, brief focal seizures, drug withdrawal, calcium channel dysfunction, or abnormal function of the brainstem reticular formation.<sup>64</sup> Cortical EEG recordings have not demonstrated epileptiform

### CASE 12-3

A 50-year-old woman presented to the emergency department in a panic. She had been falling asleep when she suddenly heard a loud “pop” or “explosion” in her head. She worked as a nurse, and she requested a head CT as she was concerned that a blood vessel had exploded. She denied any head pain. She had experienced two or three similar events over the prior week. She was very worried these were warning signs of impending aneurysmal rupture and a subarachnoid hemorrhage. She had no significant past medical history.

She was tachycardic at 108 beats/min and her blood pressure was 141/85 mm Hg, but her general and neurologic examinations were otherwise normal.

A noncontrast head CT was performed and was negative for any acute abnormalities including intracranial bleeding. The patient was discharged from the emergency department without a diagnosis with a neurology referral.

At her outpatient neurology visit, she was diagnosed with exploding head syndrome. With her background as a health care professional, reading the diagnostic criteria for the syndrome provided her with the necessary education and reassurance. Other treatment options were deferred because of the benign condition and side effects of medications.

#### COMMENT

Attacks of exploding head syndrome can be very alarming for patients. Appropriate diagnosis and patient education are the mainstays for treatment in this benign self-limited syndrome.



activity.<sup>66</sup> However, depth electrode recordings have not been done, and thus subcortical seizures have not been definitively ruled out. Acute attacks have occurred in the setting of rapid withdrawal from benzodiazepines and antidepressant medications.<sup>67</sup> Similar to familial hemiplegic migraine and episodic ataxia, mutations in the *CACNA1A* gene on chromosome 19 have been identified, which could result in calcium channel dysfunction.<sup>66,68,69</sup> Although EEGs and polysomnograms have not provided definitive etiologies, they have demonstrated that just prior to the acute attack, there is a short alerting effect consisting of alpha blocking and beta activity on the EEG and an increase in EMG activity.<sup>68</sup> This may be related to the most commonly accepted hypothesis of delayed inhibition of the brainstem reticular formation during sleep transitions.<sup>70</sup>

### Recommended Workup

Because of the sudden onset of the attack, associated fear, and occurrence during sleep transitions that can be associated with poor recall of historical details, a secondary headache disorder may need to be ruled out. Neuroimaging studies, EEG, or a sleep study can be completed depending on the clinical scenario. These studies should be normal in patients with exploding head syndrome.<sup>63,68,71</sup> Of note, in the setting of a clear-cut history and normal neurologic examination, no additional testing may be needed for the diagnosis.

### Treatment

Exploding head syndrome is benign, and reassurance is the cornerstone of treatment. Treatment with clomipramine,<sup>68,72</sup> topiramate,<sup>69</sup> clonazepam,<sup>73</sup> amitriptyline,<sup>63</sup> and nifedipine<sup>74</sup> have been reported. However, since it is a benign condition that remits over time in most patients, the risks and side effects of medications should be weighed against the potential benefits of a medication.

---

## CONCLUSION

Although the unusual headache disorders discussed in this article commonly have a benign, self-limiting course, headache red flags should prompt a thorough workup looking for a secondary cause of the headache. Once a symptomatic lesion has been ruled out, the accurate identification of clinical features, diagnosis, and treatment can provide patients with reassurance and relief. Understanding the potential pathophysiology and various treatment options allows for therapeutic education and an individualized treatment regimen for the patient. Not only does this meet the needs of the patient, but it also improves the practice satisfaction of the treating neurologist.

---

## USEFUL WEBSITE

### INTERNATIONAL CLASSIFICATION OF HEADACHE DISORDERS, THIRD EDITION (ICHD-3)

The online version of the ICHD-3 is a useful resource for accessing a complete listing of the unusual headache disorder diagnostic criteria discussed in this article.

[ichd-3.org/wp-content/uploads/2018/01/The-International-Classification-of-Headache-Disorders-3rd-Edition-2018.pdf](http://ichd-3.org/wp-content/uploads/2018/01/The-International-Classification-of-Headache-Disorders-3rd-Edition-2018.pdf)

## KEY POINT

● Exploding head syndrome is benign, and reassurance is the cornerstone of treatment.

## REFERENCES

- 1 Rasmussen BK, Olesen J. Symptomatic and nonsymptomatic headaches in a general population. *Neurology* 1992;42(6):1225-1231. doi:10.1212/WNL.42.6.1225.
- 2 Pascual J, González-Mandly A, Martín R, Oterino A. Headaches precipitated by cough, prolonged exercise or sexual activity: a prospective etiological and clinical study. *J Headache Pain* 2008; 9(5):259-266. doi:10.1007/s10194-008-0063-5.
- 3 Headache Classification Committee of the International Headache Society (IHS). The international classification of headache disorders, 3rd edition. *Cephalalgia* 2018;38(1): 1-211. doi:10.1177/0333102417738202.
- 4 Wang SJ, Fuh JL, Lu SR. Benign cough headache is responsive to acetazolamide. *Neurology* 2000; 55(1):149-150. doi:10.1212/WNL.55.1.149.
- 5 Raskin NH. Short-lived head pains. *Neurol Clin* 1997;15(1):143-152.
- 6 Chen YY, Lirng JF, Fuh JL, et al. Primary cough headache is associated with posterior fossa crowdedness: a morphometric MRI study. *Cephalalgia* 2004;24(9):694-699. doi:10.1111/j.1468-2982.2004.00739.x.
- 7 Raskin NH. The cough headache syndrome: treatment. *Neurology* 1995;45(9):1784.
- 8 Förderreuther S, Straube A. Indomethacin reduces CSF pressure in intracranial hypertension. *Neurology* 2000;55(7):1043-1045.
- 9 Symonds C. Cough headache. *Brain* 1956;79(4): 557-568. doi:10.1212/WNL.45.9.1784.
- 10 Allena M, Rossi P, Tassorelli C, et al. Focus on therapy of the Chapter IV headaches provoked by exertional factors: primary cough headache, primary exertional headache and primary headache associated with sexual activity. *J Headache Pain* 2010;11(6):525-530. doi:10.1007/s10194-010-0261-9.
- 11 Pascual J, Iglesias F, Oterino A, et al. Cough, exertional, and sexual headaches: an analysis of 72 benign and symptomatic cases. *Neurology* 1996;46(6):1520-1524. doi:10.1212/WNL.46.6.1520.
- 12 Anand KS, Dhikav V. Primary headache associated with sexual activity. *Singapore Med J* 2009;50(5):e176-e177.
- 13 Yeh YC, Fuh JL, Chen SP, Wang SJ. Clinical features, imaging findings and outcomes of headache associated with sexual activity. *Cephalalgia* 2010;30(11):1329-1335. doi:10.1177/0333102410364675.
- 14 Gelfand AA, Goadsby PJ. Primary sex headache in adolescents. *Pediatrics* 2012;130(2):e439-e441. doi:10.1542/peds.2011-2624.
- 15 Frese A, Rahmann A, Gregor N, et al. Headache associated with sexual activity: prognosis and treatment options. *Cephalalgia* 2007;27(11): 1265-1270. doi:10.1111/j.1468-2982.2007.01449.x.
- 16 Schwedt TJ, Matharu MS, Dodick DW. Thunderclap headache. *Lancet Neurol* 2006;5(7): 621-631. doi:10.1016/S1474-4422(06)70497-5.
- 17 Silbert PL, Edis RH, Stewart-Wynne EG, Gubbay SS. Benign vascular sexual headache and exertional headache: interrelationships and long term prognosis. *J Neurol Neurosurg Psychiatry* 1991;54(5):417-421.
- 18 Heckmann JG, Hiltz MJ, Mück-Weymann M, Neundörfer B. Benign exertional headache/ benign sexual headache: a disorder of myogenic cerebrovascular autoregulation? *Headache* 1997;37(9):597-598. doi:10.1046/j.1526-4610.1997.3709597.x.
- 19 Donnet A, Valade D, Houdart E, et al. Primary cough headache, primary exertional headache, and primary headache associated with sexual activity: a clinical and radiological study. *Neuroradiology* 2013;55(3):297-305. doi:10.1007/s00234-012-1110-0.
- 20 van der Ende-Kastelijin K, Oerlemans W, Goedegebuure S. An online survey of exercise-related headaches among cyclists. *Headache* 2012;52(10):1566-1573. doi:10.1111/j.1526-4610.2012.02263.x.
- 21 Doepp F, Valdueza JM, Schreiber SJ. Incompetence of internal jugular valve in patients with primary exertional headache: a risk factor? *Cephalalgia* 2008;28(2):182-185. doi:10.1111/j.1468-2982.2007.01484.x.
- 22 Lipton RB, Lowenkopf T, Bajwa ZH, et al. Cardiac cephalgia: a treatable form of exertional headache. *Neurology* 1997;49(3):813-816.
- 23 Wei JH, Wang HF. Cardiac cephalgia: case reports and review. *Cephalalgia* 2008;28(8): 892-896. doi:10.1111/j.1468-2982.2008.01590.x.
- 24 Pascual J. Other primary headaches. *Neurol Clin* 2009;27(2):557-571. doi:10.1016/j.ncl.2009.01.005.
- 25 Halker RB, Vargas BB. Primary exertional headache: updates in the literature. *Curr Pain Headache Rep* 2013;17(6):337. doi:10.1007/s11916-013-0337-8.
- 26 Harries M. Ice cream headache. Ice cream headache occurred during surfing in winter. *BMJ* 1997;315(7108):609.
- 27 Jankelowitz SK, Zagami AS. Cold-stimulus headache. *Cephalalgia* 2001;21(10):1002. doi: 10.1046/j.1468-2982.2001.00301.x.
- 28 Fuh JL, Wang SJ, Lu SR, Juang KD. Ice-cream headache—a large survey of 8359 adolescents. *Cephalalgia* 2003;23(10):977-981. doi:10.1046/j.1468-2982.2003.00620.x.
- 29 Zierz AM, Mehl T, Kraya T, et al. Ice cream headache in students and family history of headache: a cross-sectional epidemiological study. *J Neurol* 2016;263(6):1106-1110. doi:10.1007/s00415-016-8098-z.

- 30 Mages S, Hensel O, Zierz AM, et al. Experimental provocation of 'ice-cream headache' by ice cubes and ice water. *Cephalalgia* 2017;37(5): 464-469. doi:10.1177/0333102416650704.
- 31 Kaczorowski M, Kaczorowski J. Ice cream evoked headaches. Ice cream evoked headaches (ICE-H) study: randomised trial of accelerated versus cautious ice cream eating regimen. *BMJ* 2002; 325(7378):1445-1446. doi:10.1136/bmj.325.7378.1445.
- 32 de Oliveira DA, Valença MM. The characteristics of head pain in response to an experimental cold stimulus to the palate: an observational study of 414 volunteers. *Cephalalgia* 2012;32(15): 1123-1130. doi:10.1177/0333102412458075.
- 33 Selekler HM, Erdogan MS, Budak F. Prevalence and clinical characteristics of an experimental model of 'ice-cream headache' in migraine and episodic tension-type headache patients. *Cephalalgia* 2004;24(4):293-297. doi:10.1111/j.1468-2982.2004.00674.x.
- 34 Raskin NH, Knittle SC. Ice cream headache and orthostatic symptoms in patients with migraine. *Headache* 1976;16(5):222-225. doi:10.1111/j.1526-4610.1976.hed1605222.x.
- 35 Wolf S, Hardy JD. Studies on Pain. Observations on Pain Due to Local Cooling and on Factors Involved in the "Cold Pressor" Effect. *J Clin Invest* 1941;20(5):521-533. doi:10.1172/JCI101245.
- 36 Pareja JA, Ruiz J, de Isla C, et al. Idiopathic stabbing headache (jabs and jolts syndrome). *Cephalalgia* 1996;16(2):93-96. doi:10.1046/j.1468-2982.1996.1602093.x.
- 37 Sjaastad O, Pettersen H, Bakketeig LS. The Vågå study; epidemiology of headache I: the prevalence of ultrashort paroxysms. *Cephalalgia* 2001;21(3):207-215. doi:10.1046/j.1468-2982.2001.00189.x.
- 38 Raskin NH, Schwartz RK. Icepick-like pain. *Neurology* 1980;30(2):203-205. doi:10.1212/WNL.30.2.203.
- 39 Weng HY, Cohen AS, Schankin C, Goadsby PJ. Phenotypic and treatment outcome data on SUNCT and SUNA, including a randomised placebo-controlled trial. *Cephalalgia* 2017; 333102417739304. doi:10.1177/0333102417739304.
- 40 Levy MJ, Matharu MS, Goadsby PJ. Prolactinomas, dopamine agonists and headache: two case reports. *Eur J Neurol* 2003; 10(2):169-173. doi:10.1046/j.1468-1331.2003.00549.x.
- 41 Mascellino AM, Lay CL, Newman LC. Stabbing headache as the presenting manifestation of intracranial meningioma: a report of two patients. *Headache* 2001;41(6):599-601. doi:10.1046/j.1526-4610.2001.041006599.x.
- 42 VanderPluym J. Indomethacin-responsive headaches. *Curr Neurol Neurosci Rep* 2015;15(2): 516. doi:10.1007/s11910-014-0516-y.
- 43 Grosberg BM, Solomon S, Lipton RB. Nummular headache. *Curr Pain Headache Rep* 2007;11(4): 310-312.
- 44 Schwartz N, Mitnick HJ, Nowatzky J. Headaches related to rheumatologic disease. *Curr Pain Headache Rep* 2013;17(12):381. doi:10.1007/s11916-013-0381-4.
- 45 Pareja JA, Cuadrado ML, Fernández-de-las-Peñas C, et al. Epicrania fugax: an ultrabrief paroxysmal epicranial pain. *Cephalalgia* 2008;28(3):257-263. doi:10.1111/j.1468-2982.2007.01515.x.
- 46 Pareja JA, Montojo T, Alvarez M. Nummular headache update. *Curr Neurol Neurosci Rep* 2012;12(2):118-124. doi:10.1007/s11910-011-0247-2.
- 47 Porta-Etessam J, Lapeña T, Cuadrado ML, et al. Multifocal nummular headache with trophic changes. *Headache* 2010;50(10):1612-1613. doi:10.1111/j.1526-4610.2010.01773.x.
- 48 Pareja JA, Cuadrado ML, Fernández-de-las-Peñas C, et al. Nummular headache with trophic changes inside the painful area. *Cephalalgia* 2008;28(2):186-190. doi:10.1111/j.1468-2982.2007.01490.x.
- 49 Robbins MS, Grosberg BM. Menstrual-related nummular headache. *Cephalalgia* 2010;30(4): 507-508. doi:10.1111/j.1468-2982.2009.01947.x.
- 50 Baldacci F, Nuti A, Lucetti C, et al. Nummular headache dramatically responsive to indomethacin. *Cephalalgia* 2010;30(9):1151-1152. doi:10.1177/0333102410361539.
- 51 Man YH, Yu TM, Li LS, et al. A new variant nummular headache: large diameter accompanied with bitrigeminal hyperalgesia and successful treatment with carbamazepine. *Turk Neurosurg* 2012;22(4):506-509. doi:10.5137/1019-5149.JTN.3960-10.0.
- 52 Tayeb Z, Hafeez F, Shafiq Q. Successful treatment of nummular headache with TENS. *Cephalalgia* 2008;28(8):897-898. doi:10.1111/j.1468-2982.2007.01456.x.
- 53 Dodick DW, Mosek AC, Campbell JK. The hypnic ("alarm clock") headache syndrome. *Cephalalgia* 1998;18(3):152-156. doi:10.1046/j.1468-2982.1998.1803152.x.
- 54 De Simone R, Marano E, Ranieri A, Bonavita V. Hypnic headache: an update. *Neurol Sci* 2006;27 (suppl 2):S144-S148. doi:10.1007/s10072-006-0590-2.
- 55 Holle D, Naegel S, Krebs S, et al. Hypothalamic gray matter volume loss in hypnic headache. *Ann Neurol* 2011;69(3):533-539. doi:10.1002/ana.22188.
- 56 Tariq N, Estemalik E, Vij B, et al. Long-term outcomes and clinical characteristics of hypnic headache syndrome: 40 patients series from a tertiary referral center. *Headache* 2016;56(4): 717-724. doi:10.1111/head.12796.
- 57 Lanteri-Minet M. Hypnic headache. *Headache* 2014;54(9):1556-1559. doi:10.1111/head.12447.
- 58 Vein AA, Koppen H, Haan J, et al. Space headache: a new secondary headache. *Cephalalgia* 2009;29(6):683-686. doi:10.1111/j.1468-2982.2008.01775.x.

- 59 van Oosterhout WP, Terwindt GM, Vein AA, Ferrari MD. Space headache on Earth: head-down-tilted bed rest studies simulating outer-space microgravity. *Cephalalgia* 2015;35(4):335-343. doi:10.1177/0333102414536058.
- 60 Jennings T. Space adaptation syndrome is caused by elevated intracranial pressure. *Med Hypotheses* 1990;32(4):289-291. doi:10.1016/0306-9877(90)90108-Q.
- 61 Prisk GK. Microgravity and the lung. *J Appl Physiol* (1985) 2000;89(1):385-396. doi:10.1152/jappl.2000.89.1.385.
- 62 Sateia MJ. International classification of sleep disorders-third edition: highlights and modifications. *Chest* 2014;146(5):1387-1394. doi:10.1378/chest.14-0970.
- 63 Frese A, Summ O, Evers S. Exploding head syndrome: six new cases and review of the literature. *Cephalalgia* 2014;34(10):823-827. doi:10.1177/0333102414536059.
- 64 Sharpless BA. Exploding head syndrome. *Sleep Med Rev* 2014;18(6):489-493. doi:10.1016/j.smrv.2014.03.001.
- 65 Pearce JM. Clinical features of the exploding head syndrome. *J Neurol Neurosurg Psychiatry* 1989;52(7):907-910.
- 66 Bhatt M, Quinto C, Sachdeo R, Chokoverly S. Exploding head syndrome misdiagnosed as nocturnal seizures. *Neurology* 2000; 54(suppl 3):A403.
- 67 Ganguly G, Mridha B, Khan A, Rison RA. Exploding head syndrome: a case report. *Case Rep Neurol* 2013;5(1):14-17. doi:10.1159/000346595.
- 68 Sachs C, Svanborg E. The exploding head syndrome: polysomnographic recordings and therapeutic suggestions. *Sleep* 1991;14(3):263-266. doi:10.1093/sleep/14.3.263.
- 69 Palikh GM, Vaughn BV. Topiramate responsive exploding head syndrome. *J Clin Sleep Med* 2010;6(4):382-383.
- 70 Evans RW. Exploding head syndrome followed by sleep paralysis: a rare migraine aura. *Headache* 2006;46(4):682-683. doi:10.1111/j.1526-4610.2006.00416.x.
- 71 Feketeova E, Buskova J, Skorvanek M, et al. Exploding head syndrome—a rare parasomnia or a dissociative episode? *Sleep Med* 2014;15(6):728-730. doi:10.1016/j.sleep.2014.02.011.
- 72 Chakravarty A. Exploding head syndrome: report of two new cases. *Cephalalgia* 2008;28(4):399-400. doi:10.1111/j.1468-2982.2007.01522.x.
- 73 Salih F, Klingebiel R, Zschenderlein R, Grosse P. Acoustic sleep starts with sleep-onset insomnia related to a brainstem lesion. *Neurology* 2008; 70(20):1935-1937. doi:10.1212/01.wnl.0000312336.92028.9b.
- 74 Jacome DE. Exploding head syndrome and idiopathic stabbing headache relieved by nifedipine. *Cephalalgia* 2001;21(5):617-618. doi:10.1046/j.1468-2982.2001.00227.x.