Review Article

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Morning Headaches: An In-depth Review of Causes, Associated Disorders, and Management Strategies

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Abstract

Morning headaches, which are defined by occurrence upon or shortly after waking up in the morning, range from mild discomfort to severe pain and significantly impact an individual's quality of life. Although morning headaches are a prevalent and potentially debilitating condition, the criteria for defining these headaches vary. The lack of universally accepted diagnostic criteria complicates understanding their etiology, associated factors, and potential interventions. The causes of morning headaches are multifaceted, including primary headache disorders like migraines and cluster headaches, and secondary causes such as sleep disorders, hypertension, abnormal intracranial pressure, and brain parenchymal diseases. Psychological factors, including anxiety and depression, as well as substance use, further complicate the clinical presentation, often requiring a multidisciplinary approach for effective diagnosis and treatment. This review provides a comprehensive overview of morning headaches, examining their various aspects and possible treatment options, with the goal of enhancing clinicians' understanding and management of this common yet often overlooked condition.

Keywords: Depression, Morning headache, Primary headaches, Secondary headaches, Sleep apnea syndromes

INTRODUCTION

Morning headache, characterized by their occurrence upon waking, can range from mild discomfort to severe pain and have profound implications on an individual's quality of life. This prevalent and often debilitating condition affects 5% to 8% of the general population, with women reporting morning headaches more frequently than men. The prevalence is also higher among individuals aged 45 to 64 years.[1,2]

The criteria for defining morning headaches differ across studies, but various criteria have been used, including experiencing three or more morning headaches in the past year, the presence of any morning headache, having a morning headache once a week or more, and frequency descriptors such as 'always,' 'often,' or 'sometimes' having

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headaches upon waking.[1,3] Additionally, some studies specify criteria like 'often' or 'very often' experiencing headaches upon waking.[4] Since there are no universally accepted diagnostic criteria for 'morning headache,' understanding their causes, related factors, and possible treatments is essential for creating effective management strategies.

The causes of morning headaches are multifaceted and can include primary headache disorders such as migraines and cluster headaches (CH), as well as secondary causes like sleep disorders, hypertension, and brain parenchymal disease.[1] For primary headache, hormonal fluctuations such as cortisol, which peaks in the early morning, the effect of medications wearing off overnight or morning movement such as from a lying to a standing position or sudden/vigorous physical activity also can trigger morning headache. Sleep-related factors, including obstructive sleep apnea (OSA), circadian disruption, and poor sleep hygiene, are particularly significant, given their direct impact on sleep quality and overall health. A natural morning surge in blood pressure combined with or without uncontrolled hypertension can result morning headache suggesting secondary brain parenchymal disease such as hemorrhagic stroke or changes of intracranial pressure (ICP) or brain tumors.[5] Moreover, psychological aspects, including anxiety and depression, further complicate the clinical picture, often necessitating a multidisciplinary approach to diagnosis and treatment. Consulting with a professional can help identify the underlying cause and appropriate treatment.

This article aims to provide a comprehensive overview of morning headaches, exploring their various aspects and possible treatment options. We present a comprehensive review of morning headaches which can result from a combination of factors, including primary headaches like migraines or tension-type headaches (TTH), secondary headaches like brain parenchymal disease, hypertension, and linked to underlying conditions such as sleep disorders or poor sleep quality or sleep apnea, and behavioral aspects such as mood, stress levels and medication/substance overuse.

HEADACHE DISORDERS IN MORNING HEADACHE

Morning headaches are frequently reported by individuals suffering from primary and secondary headache disorders. Recent research has explored the intricate connections between morning headaches and these other types of headaches.

1. Primary headache manifesting as morning headache

1) Migraine

Migraines are common issues that significantly impact daily life. The prevalence of morning headaches among migraine sufferers varies. Studies reported that about 60% to 70% of migraine patients experience morning headaches,[6-8] suggesting that these two conditions are closely related and often share common underlying causes.[9]

Several mechanisms may explain the connection between these two types of headaches. First, changes in blood vessels, such as constriction and dilation, can influence the mechanisms behind morning headaches and migraines. Migraines are often associated with abnormal vascular expansion and contraction, which can significantly contribute to morning headaches. Recent studies have delved deeper into how these physiological changes impact the occurrence of morning headaches and migraines.[10] Second, hormonal changes play a crucial role in the relationship between morning headaches and migraines. Hormonal fluctuations are known to be major triggers for migraines, especially in women,[11-13] who may experience headaches due to menstrual cycles, pregnancy, or menopause.[14,15] These hormonal changes can be particularly pronounced in the morning, increasing the likelihood of both morning headaches and migraines.[13]

Specific genetic factors may contribute to both morning headaches and migraines.[9,16] New theories suggest that central nervous system hypersensitivity, inflammatory responses, and hormonal imbalances could be shared triggers. It is proposed that hypersensitivity and inflammatory responses may provoke both conditions, while hormonal imbalances could also play a role in their simultaneous occurrence.[17,18]

2) Cluster headache

CH is characterized by its striking circadian and circannual rhythmicity.[19] These headaches often occur at the same time each day, predominantly in the early morning hours.

Previous studies reported that about 80% of patients with CH had headache awakening and these patients reported nocturnal sleep as a trigger of attacks.[20,21]

This have been linked to disruptions in the body's internal biological clock. Research has demonstrated that the hypothalamus, which regulates circadian rhythms, plays a critical role in the pathophysiology of CH.[22,23] This connection to the hypothalamus helps explain why CH frequently occurs in the early morning, aligning with the peak of melatonin secretion and other circadian processes.[24,25]

Understanding the association between morning headaches and CH is crucial for developing effective treatment strategies. Clinicians should consider evaluating patients with CH for underlying sleep disorders, such as OSA, and address any sleep disturbances that may contribute to headache occurrence.[19] Treatments aimed at regulating circadian rhythms, such as melatonin supplementation or chronotherapy, may also be beneficial for patients with CH.[24,26] Additionally, the use of continuous positive airway pressure (CPAP) therapy in patients with comorbid sleep apnea could help reduce the frequency and severity of CH attacks.[27]

3) Tension-type headache

TTH are one of the most common forms of primary headaches and are often characterized by a bilateral pressing or tightening pain. Research indicates that up to 40% of individuals with TTH experience morning headaches, highlighting the close association between these conditions.[28] The relationship between TTH and morning headaches is clinically significant, as they share common contributing factors such as muscle tension, stress, and poor sleep quality. Morning headaches, specifically, can frequently occur in individuals with TTH, especially when muscle tension builds up during sleep or due to inadequate sleep posture. Moreover, the cyclical relationship between poor sleep and TTH is well-documented.[28] Poor sleep quality can exacerbate TTH, leading to an increased likelihood of waking with a headache. In turn, the pain and discomfort from TTH can further disrupt sleep, perpetuating a cycle that can be challenging to break without targeted interventions.

Understanding the prevalence of morning headaches in patients with TTH is critical for developing comprehensive treatment strategies. Addressing underlying issues such as sleep hygiene, stress management, and muscle relaxation can be effective in reducing the frequency and severity of both morning headaches and TTH.

4) Hypnic headache

Hypnic headache (HH), known as "alarm clock headache," is a rare condition affecting 0.07% to 0.3% of individuals, primarily those over 50, and is more common in women.[29,30] Attacks typically occur early in the morning, between 2 am and 4 am, lasting from 5 minutes to 12 hours, with pain described as dull, sharp, or throbbing. HHs and morning headaches are distinct conditions, but they can overlap in some cases. If a patient wakes up due to an HH and is unable to go back to sleep, the headache may also be categorized as a morning headache, especially if it persists into waking hours. Many patients report difficulty falling back asleep due to the intensity of the headache. Although the exact percentage of those affected is not well-documented, sleep disruption is a well-known feature of HHs.

The pathophysiology of HH is not well understood but it may share some predisposition with migraines, which thought to involve hypothalamic disruptions, particularly in areas regulating circadian rhythm, pain processing, and melatonin release, which may be related to aging.[31,32] Its connection to sleep suggests it could be a chronobiological disorder involving hypothalamic changes. Diagnosing HH involves excluding other causes, particularly sleep-related headaches. Unlike migraine sufferers, who tend to rest in a dark room, HH patients often get up to relieve pain. HH is distinct from CH, which have autonomic symptoms like tearing or nasal congestion. HH is unique as it occurs only during sleep.[30]

Treatment for HH includes abortive therapies like caffeine, effective due to its vasoconstrictive properties but potentially causing insomnia.[33] Caffeine-containing analgesics and serotonin receptor agonists (triptans) show variable results. Preventive options include caffeine before sleep, lithium, indomethacin, and melatonin, though outcomes vary.[29,34,35] Amitriptyline and anticonvulsants like topiramate, lamotrigine, and pregabalin have shown efficacy in some cases.[36,37] Other medications, such as beta-blockers, verapamil, and glucocorticoids, yield mixed results. Nonpharmacologic approaches like physical activity at onset, occipital-nerve stimulation, occipital-nerve block, and oxygen therapy may also be beneficial.[38-40]

2. Secondary headache manifesting as morning headache

1) Intracranial pressure

Cerebral autoregulation is the process by which the brain maintains a consistent blood flow despite changes in systemic blood pressure (Figure 1). Morning headaches can be associated with changes in ICP, a condition characterized by low or high cerebrospinal fluid (CSF) pressure.[41] One previous study showed 62% of patients with idiopathic intracranial hypotension documented their headache with awakening and 73% of patients reported daily headache.[42]

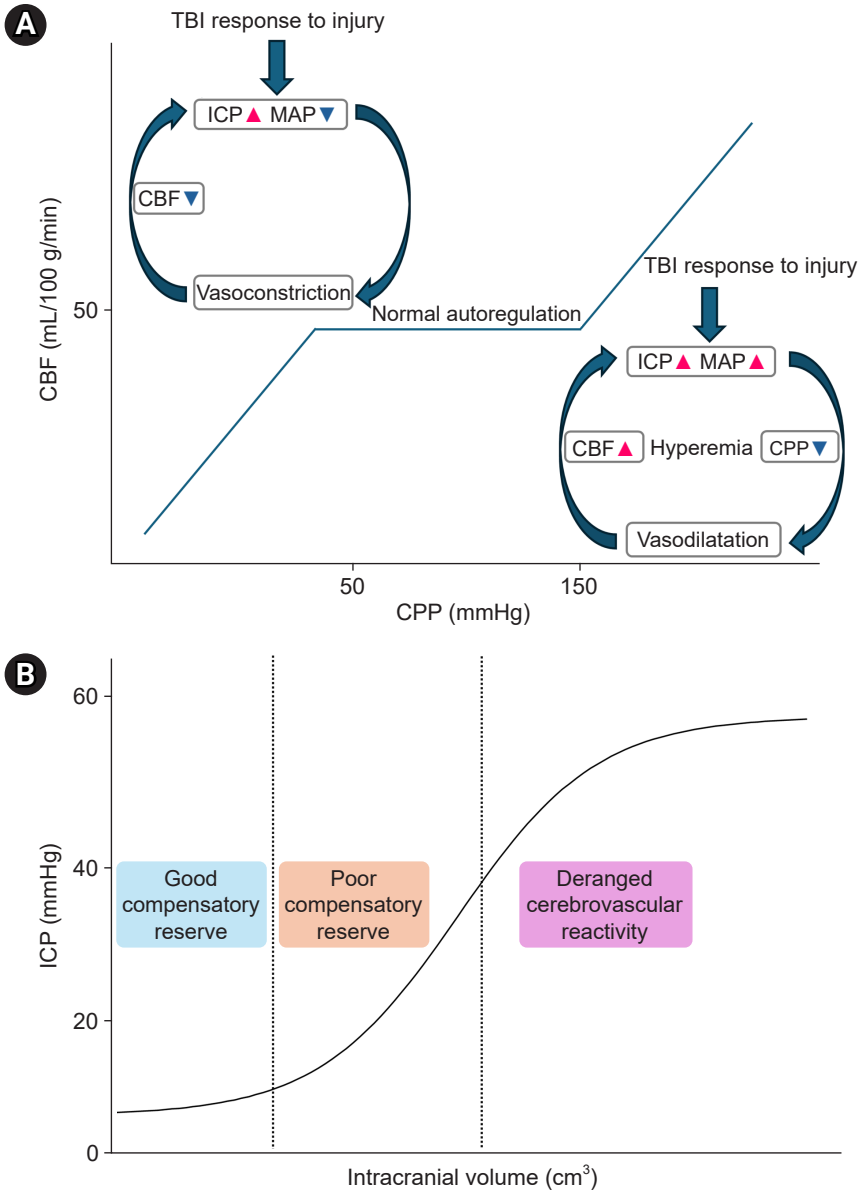

Figure 1. Cerebral autoregulation and increased ICP. (A)The Monro-Kellie doctrine states that because the cranial volume is fixed, increases in brain tissue, CSF, or blood must be offset by decreases in one or more of the others to prevent a rise in ICP. Autoregulation maintains CBF within a mean arterial pressure of 50 to 150 mmHg, with this range shifting higher in chronic hypertension. (B) ICP–volume compliance curve: When compensatory mechanisms are disrupted, the ICP rises sharply, risking brain herniation.
CBF, cerebral blood flow; CPP, cerebral perfusion pressure; CSF, cerebrospinal fluid; ICP, intracranial pressure; MAP, mean arterial pressure; TBI, traumatic brain injury.

First, Intracranial hypertension, defined as CSF opening pressure ≥250 mm H_2O, physiologically can worsen headache at morning because, during sleep, particularly in a lying down position, blood flow to the brain can increase, leading to a slight rise in ICP.[43] This can be more pronounced in individuals with conditions that already elevate ICP. Also, hormonal changes and fluid retention during lying down while sleeping can also contribute to increased ICP. Otherwise, intracranial hypotension defined as a lumbar puncture opening pressure below 60 mm H_2O.[44] It typically results from a CSF leak, which can occur spontaneously or due to trauma, medical procedures, or certain connective tissue disorders. These headaches are 'positional' or 'orthostatic,' which is typically worsen when upright and improve when lying down, so patients frequently mention that their headache is either absent or minimal upon waking and gradually worsen as the day progresses. But they can also be present upon waking due to positional changes during sleep.

Diagnosis of issues related to ICP typically involves imaging studies such as magnetic resonance imaging (MRI)[45] or computed tomography (CT) scans, lumbar punctures to measure CSF pressure, and possibly other tests to identify underlying causes. In a large study involving 568 patients who underwent imaging with either CT myelography or spinal MRI, a CSF leak was identified in 51% of the cases. Treatment varies depending on whether the problem is increased or decreased ICP. For increased ICP, treatment might include medications to reduce pressure, surgical interventions, or lifestyle changes. For decreased ICP, treatments may focus on sealing CSF leaks, bed rest, hydration, caffeine intake, or procedures like an epidural blood patch. Recognizing the connection between morning headaches and ICP can facilitate timely diagnosis and management of this potentially serious condition.

2) Hypertension and its complications

According to the International Classification of Headache Disorders (ICHD)-3, headache attributed to arterial hypertension is classified as a secondary headache disorder of hemostasis.[44] In a study of prevalence and risk factors of morning headaches in the general population, hypertension (11.0% vs. 7.2%) is one of the significant associated factors with morning headache.[1]

Guidelines specify that such headaches are linked to abruptly elevated blood pressure (systolic blood pressure 180 mmHg or higher, or diastolic blood pressure 120 mmHg or higher). Mild to moderate chronic arterial hypertension does not appear to cause of headache.[46] The relationship between headache and hypertension was first examined in 1913. Hypertensive headache was described as non-migrainous headaches that occur in the morning and gradually resolve.[47] However, these findings had limitations because they were based on patients with malignant hypertension.

A non-dipping blood pressure pattern may contribute to early morning headaches. This pattern means that blood pressure does not significantly decrease at night, leading to higher blood pressure in the early morning. Morning headache is secondary symptom of OSA.[48] A non-dipping blood pressure is independently associated with OSA.[49] This can cause increased ICP and subsequently result in headaches upon waking. Additionally, the higher blood pressure in the morning can be a trigger for these headaches due to the stress it places on the cardiovascular and cerebrovascular systems.[50]

The pathophysiology underlying the onset of headaches related to sudden rises in blood pressure appears to be at the cellular level. Abrupt high blood pressure can cause endothelial dysfunction, reducing vasodilator substances (such as nitric oxide) and increasing vasoconstrictive factors, thereby contributing to hypertension and headaches. Additionally, increased ICP, and the modulation of pain by the baroreflex system in the brainstem contribute to the complex interaction between cardiovascular regulation and pain perception (Figure 2). These mechanisms highlight the intricate relationship between cardio-cerebrovascular health and headache disorders, particularly migraines.[46,51-53]

Understanding these complex relationships is important for proper diagnosis and management of patients with both hypertension and headaches. Effective blood pressure management can alleviate headaches and reduce overall cardio and cerebrovascular risk.

3) Brain tumor

Brain tumor is rare but serious causes of secondary headaches. Headache is reported in 32.2% to 71% in patients with brain tumor,[54-58] often accompanied by various neurological symptoms. Morning headaches are one of the char-

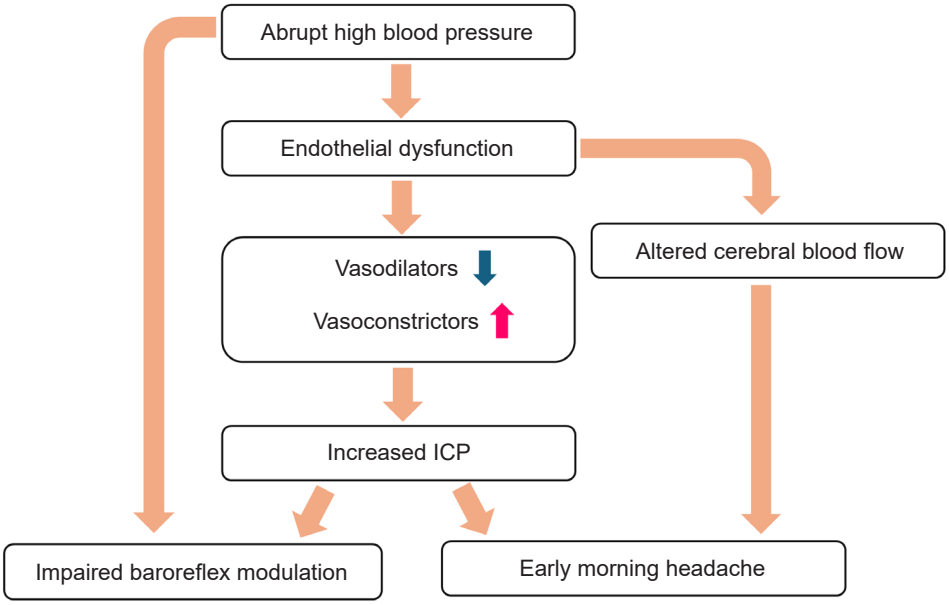

Figure 2. Pathophysiology of headache and arterial hypertension. Abrupt high blood pressure can cause endothelial dysfunction, reducing vasodilator substances (such as nitric oxide) and increasing vasoconstrictive factors, thereby contributing to hypertension and headaches. Additionally, increased intracranial pressure (ICP) and the modulation of pain by the baroreflex system in the brainstem contribute to the complex interactions between cardiovascular regulation and pain perception.

acteristic signs in brain tumors, presenting as worse headache in the early morning upon waking. Headache is often worsening during the sleep. These morning or nocturnal headaches are attributed to the exacerbation of increased ICP during sleep, through sustained recumbency and cerebral vasodilatation due to nocturnal hypoventilation with raised the partial pressure of carbon dioxide.[59] Also, tumor headache is often exacerbated by lying down or bending, and by Valsalva-like maneuvers such as cough, exercise, or straining. Nausea or vomiting is another common accompanying symptom. However, the clinical characteristics of tumor headache are heterogeneous with various severity,[57,58,60] and headache specifically occurring in the morning or night were only reported in 25.5% and 3.1% of cases, respectively.[58]

Factors associated with morning headache in patients with brain tumor headache is uncertain, but large-sized brain tumor and tumor with increased ICP showed higher prevalence of morning headache.[58] The location of tumor and the distribution of the headache do not always correlate precisely, but infratentorial tumors are associated with occipital headaches. Also, intraventricular and infratentorial tumors have higher prevalence of headache compared to supratentorial tumor.[55] Tumors with rapid-growing characteristics are more likely to cause headache. Based on the ICHD-3 diagnostic criteria for headache attributed to intracranial neoplasia, patients presenting with progressive headache, headache worsening in the morning and/or lying down, aggravated by Valsalva-like maneuvers, accompanied by nausea/vomiting or cranial nerve palsies should be promptly screened, and appropriate brain imaging studies should be performed.[44]

To alleviate headaches related to brain tumors, managing the brain tumor itself is the most important and effective approach. Specifically, for headaches that worsening in the morning, corticosteroid therapy is effective in relieving increased ICP. Among corticosteroids, dexamethasone is preferred due to its strong potency, long half-life and minimal mineralocorticoid effect.[61] If headache is not associated with brain edema or increased ICP, non-steroidal anti-inflammatory drugs and/or opioids may be used.[62]

SLEEP AND CIRCADIAN DISORDERS IN MORNING HEADACHE

Headache and sleep disorders are closely related, with a

complex and multidimensional relationship. The comorbidity of these two conditions leads to their chronification and increases the overall burden, worsening both disorders. This results in a decreased quality of life, a higher frequency of complications, and reduced treatment effectiveness. Especially, morning headache is often recognized as a common manifestation of sleep disorders.

1. Insomnia and sleep deprivation manifesting as morning headache

Population-based studies have shown an increased prevalence of sleep disorders among individuals with headache.[63,64] Among the various sleep disorders, insomnia stands out as being closely associated with headaches. Insomnia, much like headaches, is remarkably common in the general population. The prevalence of insomnia ranges from 30%–48%, and 16%–21% of the population experiences insomnia often or always, or three or more days a week.[65] This high prevalence underscores the importance of understanding the relationship between insomnia and headaches. People with insomnia have a two- to threefold increased risk of migraines,[66] TTH,[67] and chronic daily headaches.[68] This elevated risk highlights the potential causal or exacerbating role that sleep disturbances may play in headache disorders.

A comprehensive study on this topic yielded interesting results regarding the co-occurrence of headaches and sleep problems. The study found that 18.1% of people had both headaches and insomnia, 16.3% had headaches only, and 21.1% had sleep problems only.[69] In particular, the association between morning headaches and insomnia disorders or other sleep disorders involving sleep deprivation is a well-known cause of headaches.[70,71] This connection is well-established in the medical community and is recognized as a common cause of headaches. The timing of these headaches—occurring in the morning—points to the potential role of nighttime sleep disturbances in their onset.

Further emphasizing this relationship, previous study reported that morning headache is more common in patients with Diagnostic and Statistical Manual of Mental Disorders-IV insomnia disorders (18.4%) than in those without (6.9%).[1] This difference was statistically significant, providing strong evidence for the link between insomnia and morning headaches. The most recent study conducted in adults and children has provided additional insights.[72] It reported that worse sleep quality was associated with morning-onset headaches but not afternoon-onset headaches. Furthermore, the study suggested that morning-onset headaches may be more representative of a migraine phenotype rather than a TTH phenotype.

Also, disturbances in sleep quality, including insomnia and altered sleep architecture, are also commonly reported by patients with CH. Actigraphy and sleep diary studies have shown that patients with CH often experience lower rapid eye movement sleep density and longer sleep latency compared to healthy controls, indicating poor sleep quality.[73,74] This disruption in sleep may act as a trigger for CH attacks, although the exact mechanisms remain unclear.

These findings collectively underscore the complex interplay between sleep disorders, particularly insomnia, and headaches. They suggest that addressing sleep issues may be a crucial component in managing and potentially preventing certain types of headaches, especially those occurring in the morning. Further research in this area could provide valuable insights into the mechanisms underlying this relationship and inform more effective treatment strategies for both sleep disorders and headaches.

2. Sleep apnea manifesting as morning headache

Many patients with sleep apnea experience morning headaches, believed to be a secondary symptom of OSA.[44] The repeated interruptions in breathing during sleep lead to oxygen deprivation and carbon dioxide build-up in the body, which contributes to these headaches.[48] For several decades, morning headaches have been considered to be a symptom of OSA syndrome.[71,75] Research has primarily focused on the relationship between morning headaches and heavy snoring and OSA, which can cause hypoxia and blood pressure changes during sleep.[2] These conditions are believed to provoke headaches that persist upon waking. It has also been reported that patients with OSA who experience morning headaches significantly improve their morning headaches after CPAP treatment.[76] However, it is important to note that while morning headaches are similar to sleep apnea headaches (Table 1), they are not exclusively caused by OSA. This distinction highlights the complex nature of the relationship between sleep disor-

Table 1. Diagnostic criteria for sleep apnea headaches according to the International Classification of Headache Disorders 3 (ICHD-3)

1. Headache has developed in temporal relation to the onset of sleep apnea
2. Either or both of the following:
a) headache has worsened in parallel with worsening of sleep apnea
b) headache has significantly improved or remitted in parallel with improvement in or resolution of sleep apnea
3. Headache has at least one of the following three characteristics:
a) recurring on ≥15 days/mo
b) all of the following:
– bilateral location
– pressing quality
– not accompanied by nausea, photophobia or phonophobia
c) resolving within 4 hours
4. Not better accounted for by another ICHD-3 diagnosis.

Adapted from the article of Headache Classification Committee of the International Headache Society (Cephalalgia 2018;38:1-211).[44]

ders and morning headaches.

Morning headaches are a common symptom of sleep apnea, and sleep apnea headache is a specific diagnosis. The criteria for sleep apnea headaches, as set by the ICHD-3, are that they occur 15 or more days per month, typically resolve within 4 hours of waking up, and are characterized by a pressure-like sensation, usually bilateral. In contrast, morning headaches in sleep apnea also occur upon waking, but can last longer than for hours and are often accompanied by additional symptoms such as dry mouth or sore throat. These types of headaches are typically described as dull, diffuse pain.[77,78] Both types are related to the physiologic effects of sleep apnea, such as intermittent hypoxia and changes in ICP, and often improve with effective sleep apnea treatment, such as CPAP therapy.[79,80] However, improvement with treatment is a diagnosis for sleep apnea headaches, not common morning headaches. Therefore, if you have a morning headache, sleep apnea should be suspected, and further evaluation is needed to determine if you meet the criteria for sleep apnea headaches.

Several studies have investigated the prevalence and characteristics of morning headaches in relation to sleep apnea. A cross-sectional study of people suffering from snoring and OSA syndrome found that 18% experienced headache often or very often upon awakening, while only 5% of the general population experienced the same type of headache.[81] This suggests that snoring and OSA increase the risk of sleep apnea headaches three- to four-fold. A study across five European countries (Germany, Italy, Portugal, Spain, and the United Kingdom) revealed that 7.6% of the general population experienced chronic morning headaches, while this increased to 15.2% among those with breathing-related sleep disorders.[1] A Norwegian epidemiological survey using polysomnography found that 11.8% of participants with OSA had sleep apnea headaches, compared to 4.6% of those without OSA who had similar morning headaches.[82]

An older study conducted to determine whether morning headaches were a consistent symptom of sleep apnea, 18% of patients with sleep apnea experienced morning headaches frequently, compared with 21% to 38% of patients with other sleep disorders and 6% of controls.[83] Interestingly, morning headaches were most common in those with mild non-obstructive apnea, with no significant difference among patients with moderate to severe sleep apnea. These findings suggest that frequent morning headaches may be a non-specific symptom of various sleep disorders, rather than a consistent symptom of sleep apnea syndrome alone. This is further supported by another study which found that morning headaches, while frequently reported among OSA patients, may not necessarily be related to OSA itself. This study found no statistically significant association between the apnea-hypopnea index, arousal index, or oxygen saturation parameters and the probability of morning headaches.[48] These results partially confirm previous findings from a case-control study that concluded that there was no relationship between severity of OSA syndrome and headaches.[82,84] Therefore, more comprehensive research is needed to understand the complex relationship between sleep disorders and morning headaches. These results partially confirm previous case-control study findings that concluded there was no relationship between the severity of OSA and headaches.

The lack of a clear correlation between OSA severity and morning headaches suggests a more complex relationship between sleep disorders and headaches than previously thought. Given these findings, it's evident that more comprehensive research is needed to fully understand the intricate relationship between sleep disorders, particularly OSA, and morning headaches. Future studies should aim to elucidate the mechanisms underlying this relationship

and explore potential confounding factors that may influence the occurrence of morning headaches in individuals with sleep disorders.

3. Circadian rhythm disorders manifesting as morning headache

The relationship between morning headaches and circadian rhythm has been a subject of increasing interest in headache research. Several studies have shown that headache attacks, particularly migraines and CH, exhibit seasonal and circadian periodicity.[85,86] This periodicity suggests a strong link between our body's internal clock and the onset of certain types of headaches.[87,88] Notably, migraine attacks have been found to occur more frequently in the early morning hours.[87] This temporal pattern aligns with various physiological changes that occur during the transition from sleep to wakefulness, such as fluctuations in hormone levels, neurotransmitter activity, and autonomic nervous system function.[89,90] The consistency of this early morning peak in migraine occurrence across multiple studies underscores the potential role of circadian rhythm disturbances in headache pathophysiology.[28,91,92]

Understanding this connection could have significant implications for both the prevention and treatment of morning headaches. For instance, interventions targeting circadian rhythm regulation, such as light therapy or melatonin supplementation, might prove beneficial in managing these types of headaches. Furthermore, this circadian influence on headache patterns highlights the importance of considering timing in headache management strategies, potentially leading to more personalized and effective treatment approaches. As research in this area continues to evolve, it may provide new insights into the complex interplay between our body's internal clock, sleep-wake cycles, and the manifestation of morning headaches, ultimately contributing to improved quality of life for those affected by these conditions.

BEHAVIORAL PROBLEMS IN MORNING HEADACHE

1. Mood changes manifesting as morning headache

Mood may be one behavioral predictor of morning headache. Indeed, it is well-established that depression and anxiety disorders are highly comorbid with headache,[93] including migraine,[94] tension type headache,[95] and chronic daily headache.[96] Such comorbidity may reflect shared underlying brain regions between emotion and pain.[97] Although limited work has examined the association between mood and morning headache specifically, extant findings suggest a link similar to that observed for headache broadly. Consistent with the broader headache literature, a study conducted in a large community sample found chronic morning headache is likewise associated with higher prevalence of mood and anxiety disorders.[1] Similarly, in a large sample of habitual snorers, greater frequency of morning headache was associated with more severe general psychological distress.[6] Notably, mood and headache are dynamic processes that vary over time; thus, studies using prospective monitoring methods may provide more detailed insight into the relationship between mood and morning headache. One such study followed a sample of habitual snorers who monitored mood and morning headache incidence over 90 days. Results revealed that clinically significant anxiety symptoms, but not depression symptoms, predicted increased likelihood of experiencing morning headache, controlling for sleep quality.[98] In contrast, a recent study in a large sample of community adults with and without migraine who monitored mood and morning headache for 2 weeks found that worse mood and higher anxiety predicted higher incidence of morning headache in univariate models, but these effects were no longer significant when accounting for the effects of sleep quality and energy level.[72] Thus, additional research using prospective monitoring designs is needed to clarify the day-to-day association between mood and morning headache, over and above the effect of sleep.

2. Substance use manifesting as morning headache

Morning headaches are frequently linked to substance use, including alcohol, caffeine, and certain medications. Because alcohol is frequently consumed during evenings, weekends, or typically after work or school as a way to unwind and relieve stress after a long day and to socialize, excessive alcohol consumption can cause dehydration, hypoglycemia resulted from low blood sugar levels after an overnight fasting a common headache trigger, and

disrupt sleep patterns, leading to poor-quality sleep and resulting in morning headaches which is called 'hangover headache' or 'delayed alcohol-induced headache,' especially common in migraine.[99,100] Caffeine has a dual effect; while moderate intake can alleviate headaches, excessive consumption or abrupt withdrawal can cause rebound headaches, particularly upon waking.[101,102] Previous experimental studies and reports have shown that about 50% of patients experience headaches during caffeine withdrawal.[101,103,104] And higher daily caffeine intake is reported to be associated with more severe withdrawal headaches.[101,105] Even relatively low doses (around 100 mg/day) can cause withdrawal symptoms.[101,106]

Certain medications, especially those for chronic pain or psychiatric conditions, can also contribute to morning headaches.[107] Overuse of analgesics, for instance, can lead to medication overuse headaches, which are often worse in the morning. Medication overuse headaches often manifest in the morning, likely due to the decline of drug levels in the body overnight (called wearing-off).[108] Understanding the impact of substance use on morning headaches is crucial, as modifying these behaviors can significantly reduce the frequency and severity of headaches, thereby improving overall quality of life.

CONCLUSION

In conclusion, morning headache is a common condition that significantly impacts an individual's quality of life. The complex interplay of multiple factors contributing to morning headache necessitates a multidisciplinary approach to both diagnosis and treatment.

As a neurologist, your approach to morning headaches should be systematic and patient-centered (Table 2). Start

Table 2. Summary of risk factors and treatment options for morning headaches

Risk factors	Neurologist's considerations	Treatment options
Primary headaches	-Distinguish between primary headache disorders (e.g., migraine, cluster headache, hypnic headache) that may present as morning headaches -Rule out secondary causes of headaches	-Pharmacological management: pain-relieving, preventive medications -Non-pharmacological management: behavioral therapy (regular sleep, exercise, avoidance of trigger factors, Biofeedback)
Secondary headaches	-Distinguish between primary and secondary headache disorders -Rule out brain parenchymal lesion or abnormal intracranial pressure -Monitor for red flag symptoms -Evaluate stroke risk	-Imaging studies (MRI/MRA, CT) -Lumbar puncture if indicated -Medication to reduce intracranial pressure or antiplatelet therapy if indicated -Management of vascular risk factors -Monitor blood pressure regularly, lifestyle changes, medication as prescribed by a doctor
Sleep disorders	-Evaluate for secondary headaches & potential underlying neurological symptoms -Take a sleep history in detailed/assess the sleep quality -Consider polysomnography for diagnosis -Assess for mood disorders often comorbid with sleep issues	-PAP for sleep apnea -Sleep hygiene education for insomnia -Cognitive behavioral therapy for insomnia -Light therapy, chronotherapy -Melatonin or sleeping pills supplementation (*teeth grinding or sleep posture problems: use of a night guard, dental treatment, supportive pillows, physical therapy)
Cervicogenic factors	-Assess for cervical spine pathology -Consider contribution to other headache types -Evaluate for comorbid temporomandibular disorders	-Physical therapy -Occipital nerve blocks -Postural correction
Substance use (medication, caffeine/alcohol)	-Evaluate for medication-overuse headache -Assess for substance use disorders -Consider comorbid psychiatric conditions -Develop personalized withdrawal plans -Educate on caffeine's role in headaches	-Medication withdrawal under supervision -Preventive medications -Patient education on medication use -Gradual caffeine reduction -Alcohol moderation or abstinence -Hydration therapy
Psychiatric comorbidities	-Screen for psychiatric comorbidities -Consider impact on headache chronification -Evaluate need for a multidisciplinary approach	-Psychotherapy -Antidepressants with analgesic properties -Stress management

MRI, magnetic resonance imaging; MRA, magnetic resonance angiography; CT, computed tomography; PAP, positive airway pressure.

by taking a detailed history and performing a comprehensive neurological examination. If you suspect a sleep disorders, don't hesitate to recommend a sleep study. Neuroimaging can be a useful tool to rule out structural causes, so consider a brain MRI or CT scan if clinically indicated. Encourage patients to keep a detailed headache diary, as this can identify important patterns and triggers of headache. Use the information you gather to make treatment decisions, including the possibility of preventive or acute medications. Patient education is paramount, so focus on teaching lifestyle modifications and strategies for trigger avoidance. Finally, recognize that managing morning headaches is an ongoing process. Schedule regular follow-up visits to assess the effectiveness of the treatment plan and make adjustments as needed to ensure a dynamic and personalized approach to patient care. By focusing on these key areas, healthcare professionals can better understand, treat, and ultimately alleviate the burden of morning headaches on patients.

AVAILABILITY OF DATA AND MATERIAL

Not applicable.

AUTHOR CONTRIBUTIONS

Conceptualization: HJI; Data curation: YH, MKK, MSK, HM, RCC; Investigation: YH, MKK, MSK, HM, RCC; Writing–original draft: YH, MKK, MSK, HM, RCC; Writing–review and editing: YH, MKK, HJI.

CONFLICT OF INTEREST

Mi-Kyoung Kang has been the Editor of the *Headache and Pain Research* since September, 2023 and were not involved in the review process. The other authors has no other conflicts of interest to declare.

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