

Headaches and Exercise

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Abstract

Exercise-related headache is one of the most common medical problems affecting the modern-day athlete. Despite the high prevalence of headache in community populations, the epidemiology of sports-related headache is unclear. In certain collision sports, up to 50% of athletes report regular headaches as a consequence of their athletic participation.

The classification of the different types of sport-related headache by the International Headache Society (IHS) and in previously published articles does not adequately encompass the clinical problem faced by team physicians. Confusion exists where terms such as 'effort headache' and 'exertional headache' may be used to describe similar entities. In this review, the specific headache entities discussed include benign exertional headache, effort headache, acute post-traumatic headache and cervicogenic headache.

For the sports physician, an understanding of the variety of specific headache syndromes that occur with particular sports is necessary for everyday clinical practice. This article reviews the common exercise-related headache syndromes and attempts to provide a framework for their overall management. Team physicians also need to be cognisant that many of the standard preparations used to

treat headaches may be banned drugs under International Olympic Committee (IOC) rules.

Headache is a common complaint in society and athletes are no exception to this rule. Few headaches fail to evoke some anxiety in the sufferer, which may in turn distort the clinical symptoms. Confronted by an athlete with exertional headaches, the sports physician needs to be accurate in diagnosis, clear in the direction of treatment and reassuring to the individual concerned.

Compared with migraine and the other headache syndromes, where much research has been performed delineating the pathophysiology and management of such problems, sports-related headaches have attracted little research interest. Our understanding of many of these problems is anecdotal at best.^[1]

1. History

The association between headache and exercise has been known since the time of ancient Greece. In 450BC, Hippocrates wrote: '*... one should be able to recognise those who have headaches from gymnastic exercises or running or walking or hunting or any other unseasonable labour or from immoderate venery . . .*'.^[2]

Prior to that time, headache and its treatment had been described in the literature of the ancient world. The first recorded mention of headache was in an ancient Mesopotamian (ca 4000BC) incantation.^[3] The Ebers papyrus (ca 1550BC) from ancient Egypt describes treatment for headache that included 'binding' the temples and the use of herbal preparations.^[4,5]

By the first century AD, Aretus of Cappadocia (30 to 90AD) termed headache as 'heterocrania'. This concept was further developed in the following century by Galen of Pergammon (138 to 201AD), who was the first to use the term 'hemicrania', from which the terms 'megrim' and 'migraine' were subsequently derived.^[6,7]

2. The Epidemiology of Sports-Related Headache

The prevalence of headache in different sports is largely unknown. The only published study on sports-related headaches found that headaches were reported by 35% of all respondents, with no gender effect evident.^[8,9] The headache prevalence by headache type is set out in table I. It is worth noting that this study did not utilise the International Headache Society (IHS) criteria and the diagnostic categories are somewhat blurred.^[10]

In this study, effort migraine and effort-exertion headaches were more common in women than in men. The sports noted to cause the problem included running/jogging, weights/gym, aerobics and rugby football. Post-traumatic headaches were seen almost universally in males due to participation in rugby football.

Community studies also note exercise as a potent trigger of migraine and other forms of headache. However, the precise epidemiology of this phenomenon is unknown.^[11]

There have been anecdotal reports of migraine with aura in particular sports such as soccer^[12] and rugby league.^[13] In a recent study in Australian football,^[14] approximately 50% of players reported regular headaches, with 22% of all players fulfilling the IHS criteria for migraine.

3. Classification of Exercise-Related Headache

The IHS, in conjunction with the World Health

Table I. Headache prevalence in athletes (adapted from Williams and Nukada^[8,9])

Headache type	Headache prevalence (%)
Effort migraine	9
Trauma-induced migraine	6
Effort/exertion headache	60
Post-traumatic headache	22
Miscellaneous	3

Table II. International Headache Society criteria for the diagnosis of migraine without aura (IHS 1.1)^[10]

A. At least 5 attacks fulfilling criteria B-D below
B. Headache attacks lasting 4-72 hours
C. Headache has at least 2 of the following characteristics: <ol style="list-style-type: none"> 1. Unilateral location 2. Pulsating quality 3. Moderate or severe intensity (inhibits or prohibits daily activities) 4. Aggravation by walking stairs or similar routine physical activity
D. During headache at least 1 of the following: <ol style="list-style-type: none"> 1. Nausea and/or vomiting 2. Photophobia and phonophobia

Organization, has proposed an overall classification for headache.^[10] While this classification system is used mainly for research purposes, it nevertheless provides a framework to assist in clinical management. As an example, the IHS criteria for the diagnosis of migraine without aura are shown in table II.

4. Causes of Headache

Intrinsic to the understanding of the causation of headache are the intracranial pain pathways and their interconnections, especially the trigemino-cervical pathway. The most important structures that register pain within the skull are the blood vessels, particularly the proximal part of the cerebral arteries, as well as the large veins and venous sinuses.^[15] These structures form part of the pain pathway loop.

Neurotransmitter control in this pain pathway includes serotonin, peptides and acetylcholine. These may provide the pharmacological basis of drug therapy. For example, sumatriptan and methysergide both directly affect the serotonin receptor to modulate migraine. Recent advances in the field of molecular biology have suggested a causative role for other vasoactive agents in the genesis of headache that may have important treatment implications.^[16]

5. Clinical Approach to Headache

The majority of cases do not require detailed radiological investigations, but rather a thorough history and physical examination. When seeing an

athlete complaining of headache for the first time, a sports physician may follow the simple diagnostic clinical algorithm set out below.

- Exclude possible intracranial causes on history and physical examination. If intracranial pathology is suspected then an urgent workup is required, which may include neuroimaging studies and laboratory investigations.
- Exclude headaches associated with viral or other infective illness.
- Exclude a drug-induced headache (see below) or headache related to alcohol and/or substance abuse.
- Consider an exercise-related (or sex-related) headache syndrome.
- Differentiate between vascular, tension, cervicogenic or other cause of headache.

Many commonly used drugs can provoke headaches. Some of these drugs, such as nonsteroidal anti-inflammatory drugs (NSAIDs), are in widespread use by athletes. If not recognised, this may be the reason for treatment failure. A list of commonly used drugs that can cause headaches in athletes is set out in table III.

6. A Headful of Symptoms

As with many aspects of clinical medicine, the history is the most important component of the assessment of the athlete with headache. Many headache syndromes such as migraine can be diagnosed with a degree of confidence on history alone. The typical qualities of the headache which should be sought on history are set out in table IV. Particular

Table III. Commonly used drugs that may cause headache in athletes

Alcohol	NSAIDs
Anabolic steroids	Nicotine
Analgesics	Nitrazepam
Antibiotics	Oral contraceptives
Antihypertensives	Sympathomimetics
Caffeine	Theophylline
Corticosteroids	Vasodilator agents
Dipyridamole	

NSAIDs = nonsteroidal anti-inflammatory drugs.

Table IV. Clinical history of headache

Age of onset of the headaches
Frequency and duration
Time of onset of headache
Mode of onset
Site of pain and radiation
Headache quality
Associated symptoms
Precipitating factors
Aggravating and relieving factors
Previous treatments
General health
Past medical history
Family history
Social and occupational history
Drug and medication use

emphasis should be placed on recent changes in neurological function, such as the development of focal or systemic symptoms.

In all patients presenting with headache, a full neurological and general physical examination is required. Particular attention should be paid to the cervical spine as a potential source of headache. The examination should consist of some or all of the following components of a focused and thorough neurological examination, depending on the presence or absence of specific symptoms in the patient's history. The main examination points should include general appearance (including skin lesions such as rashes), vital signs (pulse, blood pressure and temperature), mental status and speech, gait, balance and coordination, cranial nerve and long tract examination, visual fields, acuity and ophthalmoscopic fundus exam, and skull palpation.

7. Key Symptoms to Flag

The majority of headaches are due to benign causes. Nevertheless, certain symptoms may indicate the presence of more serious pathology, such as a mass lesion or infective process, and require urgent neurological assessment. These new symptoms which should be sought by specific questioning in all cases are set out in table V.

8. Exercise-Related Headache Syndromes

As in the general population, the common headache syndromes such as migraine, episodic tension-type headache and cervicogenic headache will occur in athletes. These will be discussed briefly below. Readers are referred to more general headache textbooks for a greater understanding of these syndromes.^[17,18] In addition, a group of headache syndromes unique to exercise need to be considered, and will be described in more detail.

8.1 Migraine (IHS 1.1 to 1.7)

Given that the prevalence of migraine is approximately 12 to 18% in community populations, it follows that migraine will be commonly seen in exercising athletes. Migraine is essentially an episodic headache that is usually accompanied by nausea and photophobia and may be preceded by focal neurological symptoms. Symptoms may vary considerably between individuals. Migraine represents an inherited tendency to headache with a lowered threshold of susceptibility to a variety of headache triggers such as exercise and head trauma.

At present, there is no simple 'cure' for migraine and an individualised management strategy needs to be developed for each patient. This may incorporate nonpharmacological as well as pharmacological strategies.

The accurate diagnosis of headache syndromes in sport has important treatment implications.^[19] In elite athletes, there are specific management considerations related to the use of 'banned' drugs. Many conventional headache medications (such as β -blockers, caffeine, codeine-containing preparations, dextropropoxyphene, narcotics and opioids) are banned agents and their use, if detected, may result in severe penalties for the athlete concerned.

8.2 Tension-Type Headache (IHS 2.1 to 2.3)

Tension-type headache results in a constant tight or pressing sensation that may initially be episodic and related to stress, but can recur almost daily in its chronic form without regard to any ob-

vious psychological factors. In general, these headaches are distinguished from migraine by their milder severity and longer duration, although a precise separation may not always be possible. Treatment is usually multifactorial and by necessity includes psychological and physical therapy, physiological intervention and pharmacological treatment.

8.3 Cervicogenic Headache (IHS 11.2)

Abnormalities of the various structures within the neck have been implicated as the cause of cervicogenic headache. These structures include the synovial joints, the intervertebral disks, ligaments, muscles, nerve roots and the vertebral artery.^[20,21] What remains extremely controversial is the relationship of functional (rather than structural) cervical abnormalities and headache.^[22]

Cervicogenic headache shares many of the clinical features of chronic tension-type headache. It is usually occipital in onset and may radiate to the anterior aspect of the skull and face. The headache is usually constant in nature, lasts for days to weeks and has a definite association with movement or manipulation of cervical structures. Treatment usually involves physical or manipulative therapy to the cervical spine as well as consideration of anti-inflammatory drug therapy.

8.4 Benign Exertional Headache (IHS 4.5)

Benign exertional headache (BEH) has been recognised as a separate entity for over 50 years. In 1932, Tinel^[23] first described severe but short lasting headaches following exercise. Since that time, various authors have described similar headaches in association with exercises such as weightlifting and wrestling, and Dalessio^[24] drew attention to this form of headache in an editorial. In a number of articles and indeed the IHS criteria, the distinction of BEH as a manifestation of straining-type exercise is often not clearly delineated from effort or exertional migraine, whereby the headache syndrome follows exercise but is not related to 'straining' valsalva manoeuvres. This in turn leads to confusion in the terminology utilised by different authors in describing these headaches phenomenologi-

Table V. Key symptoms of intracranial pathology

Sudden onset of severe headache
Headache increasing over a few days
New or unaccustomed headache
Persistently unilateral headaches
Chronic headache with localised pain
Stiff neck or other signs of meningism
Focal neurological symptoms or signs
Atypical headache/change in the usual pattern of headache
Headaches that wake then patient during the night or early morning
Local extra-cranial symptoms (e.g. sinus, ear or eye disease)
Systemic symptoms (e.g. weight loss, fever and malaise)

cally. It is likely that these are distinct headache subtypes that are as yet not separated by the existing IHS classification.

In the largest series to date, Rooke^[25] followed 103 patients with this complaint and found that approximately 10% went on to develop an organic cause for the pain, usually a skull base anomaly. Recent studies^[26-29] have delineated a clearcut syndrome.

The IHS criteria include:

- the headache is specifically brought on by physical exercise
- the headache is bilateral, throbbing in nature at onset and may develop migrainous features in those patients susceptible to migraine
- lasts from 5 minutes to 24 hours
- is prevented by avoiding excessive exertion
- is not associated with any systemic or intracranial disorder.

The onset of the headache is with straining and valsalva type manoeuvres such as those seen in weightlifting^[30] and competitive swimming.^[31] Clearly, the major differential diagnosis to be considered in this situation would be a subarachnoid haemorrhage which needs to be excluded by the appropriate investigations. It has been postulated that exertional headache is due to dilatation of pain-sensitive venous sinuses at the base of the brain as a result of increased cerebral arterial pressure due to the exertion. Studies of weightlifters demonstrate that systolic blood pressure may reach levels

above 400mm Hg and diastolic pressures above 300mm Hg with maximal lifts.^[32]

The implication that these headaches have a vascular basis is supported by the migrainous nature of the headache, and one interesting study^[33] that utilised intravenous dihydroergotamine to relieve the headache. A similar type of vascular headache is described in relation to sexual activity and has been termed benign sex headache or orgasmic cephalgia (IHS 4.6). Angiographic studies of both BEH (and benign sex headache) have demonstrated arterial spasm, further implicating the vascular tree in the basis of this condition.^[34] However, it is worth noting that despite their vascular nature, no convincing association with migraine is demonstrable.

Treatment strategies include NSAIDs such as indomethacin at a dose of 25mg, 3 times per day.^[26] Other pharmacological strategies that have anecdotal support include the prophylactic use of ergotamine, methysergide or propranolol before exercise. In practice, the headaches tend to recur over weeks to months and then slowly resolve, although some cases may be lifelong. In the recovery period, a graduated symptom-limited weightlifting programme is appropriate.

8.5 Effort Headache

As mentioned in the previous section, the IHS separation of BEH from effort headache is unclear. In clinical practice, these types of headache can be seen as migraine headaches triggered by aerobic exercise. As such there is no specific IHS category.

Effort headaches have been reported to be the most common type of headache in athletes.^[8,9] These differ from the exertional headaches in that they are not necessarily associated with a power or straining type of exercise, and a variety of sports have been associated with these headaches. Jokl^[35] described running-induced migraine in athletes participating in the 1968 Mexico Olympic games. Other authors describe similar problems associated with running, especially in hot weather.^[24,36] The clinical features of this effort headache syndrome include:

- onset of mild to severe headache with aerobic type exercise

- more frequent in hot weather
- vascular type headache (ie: throbbing)
- short duration of headache (4 to 6 hours)
- provoking exercise may be maximal or submaximal
- patient may have prodromal 'migrainous' symptoms
- headache tends to recur in individuals with exercise
- athlete may have a past history of migraine
- normal neurological examination and investigations.

There has been an interesting case report^[37] of postexercise migraine occurring in a postmenopausal woman who developed her symptoms only with a transdermal estrogen patch and never with oral hormone replacement therapy. The authors implicated the increased skin blood flow during exercise resulting in increased transdermal absorption of estrogen, which in turn triggered her migraines.

These episodes of effort migraine are not necessarily benign, with at least 1 case of hemispheric cerebral infarction associated with an episode of effort headache.^[38] Treatment strategies for effort headaches are anecdotal and include the use of indomethacin or various antimigraine preparations. In the author's experience, prophylactic NSAIDs are effective if given prior to exercise, although these drugs seem to have reduced efficacy in the headaches that occur in hot weather. Graduated exercise programmes have also been studied as a means of preventing such headaches, with limited success.^[39]

8.6 Acute Post-Traumatic Headache (IHS 5.1 to 5.2)

Trauma to the head and neck in sport may lead to the development of headache. The initiating traumatic event may not necessarily be severe, nor the degree of injury correlate with headache symptoms. The IHS diagnostic criteria is shown in table VI.

The IHS classification does allow a separate classification where the degree of head injury does not meet criterium (A). The 2-week onset is arbitrary

and represents a compromise to establish causality for medicolegal purposes.^[40]

Although a number of headache textbooks describe at least 6 distinct types of post-traumatic headache, in practice this distinction is seldom clearcut, with considerable overlap between these groups.^[18,41] Some of the specific subtypes of post-traumatic headache which pose management difficulties are as follows:

- **Post-traumatic (or trauma-triggered) migraine.** This may be seen in sports such as soccer, where repetitive heading of the ball gives rise to the term ‘footballer’s migraine’.^[12] Studies have shown that even mild head trauma can induce migraine.^[42-46] One particular syndrome that is recognised in the setting of minor head blows is migrainous cortical blindness. This disturbing condition often raises fears of serious cerebral injury, but tends to resolve over 1 to 2 hours.
- **Extracranial vascular headache.** This terminology dates from early studies on post-traumatic headache^[47] and reflects a tendency to develop periodic headaches at the site of head or scalp trauma. Such headaches may share a number of migrainous features, although at times can be described as ‘jabbing’ pains. Apart from surgical treatment to locally damaged structures, the management is usually that for migraine.
- **Dysautonomic cephalgia.** This headache is an unusual consequence of trauma to the neck region. This syndrome is due to blows on the anterior part of the neck triggering autonomic symptoms from local injury to the sympathetic trunk and adjacent ganglia,^[48,49] and may be successfully treated with propranolol. This syndrome is extremely rare, even in collision sport, and the author has only encountered 1 such patient.
- **An overlap syndrome which resembles both tension-type headache as well as cervicogenic headache.** Such patients typically have persistent, low grade, occipitally-based headache with little in the way of accompanying neurological symptomatology. Within this syndrome there may also be an element of analgesic rebound headache.^[50]

Table VI. International Headache Society criteria for the diagnosis of acute post-traumatic headache (IHS 5.1 to 5.2)^[10]

A. Significant head trauma as documented by: <ol style="list-style-type: none"> 1. Loss of consciousness 2. Post-traumatic amnesia >10 minutes 3. At least 2 abnormalities on the following investigations: clinical examination, skull x-ray, neuroimaging, evoked potentials, CSF exam, vestibular function test, neuropsychological testing
B. Headache onset <14 days post-trauma
C. Headache disappears within 8 weeks after trauma
CSF = cerebrospinal fluid

A variety of other post-traumatic headaches have been reported, including hemicrania continua,^[51] intracranial vascular headache,^[52] cluster headache,^[53,54] occipital neuralgia,^[55] carotid artery dissection^[56,57] and vertebral artery dissection.^[58-61]

In a number of sources, the so-called ‘second impact syndrome’ is often described as a cause of post-traumatic headache secondary to diffuse cerebral swelling.^[62] However, a recent review^[63] has cast doubt on the existence of this syndrome, often ascribed anecdotally to repeated concussive injury.

8.7 External Compression Headache (IHS 4.2)

This entity, formerly known as ‘swim-goggle headache’, presents with pain in the facial and temporal areas produced from wearing excessively tight face masks or swimming goggles.^[64] It is commonly seen in swimmers and divers. In divers, this may be referred to as ‘mask squeeze’, and is seen on descent to depth as the effects of pressure reduce the air space inside the mask. The aetiology is believed to be due to continuous stimulation of cutaneous nerves by the application of pressure, although neuralgia of the supraorbital nerve has been implicated in at least 1 case.^[65]

8.8 High Altitude Headache (IHS 10.1.1)

Altitude headache is a well recognised accompaniment of acute mountain sickness, which occurs within 24 hours of ascent to altitudes above 3000m. The headaches are vascular in nature and are seen in unacclimatised individuals. Typically,

these are associated with other physiological effects of altitude or may be an early manifestation of acute mountain sickness. The treatment is to descend to a lower altitude, although pharmacological interventions such as acetazolamide, ibuprofen and sumatriptan have been used for symptomatic treatment.^[66,67]

8.9 Hypercapnia Headache (IHS 10.2)

Divers headache is a vascular type of headache that is thought to be due to carbon dioxide accumulation during 'skip' breathing. The arterial pCO₂ level is usually increased above 50mm Hg in the absence of hypoxia. Divers are also prone to headaches from other causes such as cold exposure, muscular or temporo-mandibular joint pain from gripping the mouthpiece too tightly, cervicogenic headaches from incorrect buoyancy technique, middle ear and sinus barotrauma and cerebral decompression illness.^[68]

9. Conclusion

Although our understanding of the epidemiology and nature of exercise-related headaches is limited at present, it remains an area where clinical research has much to offer both from a neurological as well as a sports medicine perspective.

The treatment of exercise-related headaches in athletes can be potentially rewarding for the sports physician as well as the athlete.^[69] Whilst the common headache syndromes seen in the general population must be considered, recognition of the diversity of these sports-related headache syndromes provides the basis for good clinical care.

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