# Headache In Sport

**Introduction**

Headache is a common problem with a three-month prevalence in the UK of 70%. (1) Migraine alone affects 7.6% of males and 18.3% of females (2), and this is likely an underestimate. Despite a substantial impact, the needs of many people with headache are unmet. (3)(4) On a worldwide basis, headache problems rank at the very top of neurological causes of disability (5).

Headache can have an impact on sport or physical activity either coincidentally or as a direct result of participation. For the professional sportsman there are important implications for performance and management with a number of headache medications being restricted. At a population level, 2% of people have given up sports based exercise due to headache. (6) Against a background of initiatives to encourage activity in the population, it is important to identify and understand any factors that may inhibit this pursuit. Physical activity is associated with reduced risk of a wide range of illnesses that include coronary heart disease, obesity, and type two diabetes. (7) Regular resistance training can also lower blood pressure, improve glucose metabolism and reduce cardiovascular disease risk. (8) It is estimated that in the UK, ill-health attributable to physical inactivity costs the National Health Service more than £1.06 billion per year and is directly responsible for more than 35,000 deaths each year. (9)

The mechanisms causing headache during activity are poorly understood but can include direct activation of dural pain fibres, central activation of trigeminal pain pathways, radiation from facial or neck structures, or from dysfunction of brain centres normally concerned with sensory modulation. Microscopic damage incurred

as a result of shearing or acceleratory forces are also likely to be important in the sports setting.

The beneficial impact of sport and aerobic exercise on headache remains contested. However, against a background of policy initiatives to increase activity and the fact that headache sufferers may be less active (10), an understanding of the relationship between sport and headache and options for management is important for health care practitioners at all levels.

**Epidemiology of sport and exercise induced headaches**

Estimates of the prevalence of exertional headache range between 12% and 30%. (6) (11) It is particularly prevalent among adolescents who are often the focus of exercise initiatives. Sports related headaches are likely to be more common in headache prone individuals who experience other types of primary headache, particularly migraine.

The prevalence of headache specifically related to sport is not well described. A study of university students found that 35% experienced sports or exercise related headaches. (12) A study of Australian footballers, where contact and propensity for mild head trauma must be high, found that 49% of respondents reported headache during competitive play and 60% during training. (13) In a study of American football players, 85% had suffered headache during play, 21% during their most recent match. However, the majority of these headaches were related to trauma. (14) A small study of Italian soccer players found a prevalence of 3.6% of reported headache during a season, all of which fulfilled ICHD-II criteria for tension-type headache. No attacks occurred during competition. (15) An estimation of the prevalence of primary exertional headache using International Headache Society criteria in a large group of sports cyclists resulted in a rate of 26%.(16)

**Headache classification in sport**

A previous study characterised sports headache as "effort migraine" 9%, "trauma triggered migraine" 6%, "exertional headache" 60%, "post traumatic headache" 22% and miscellaneous 3%. (17) The IHS classifies three types of primary headaches that are relevant in this context – primary cough headache, primary exertional headache and primary headache related to sexual activity (see figure 1), and in contact sports head trauma itself may be an important consideration. These forms share similar clinical characteristics and may share similar pathophysiological mechanisms.

*Primary cough headache*: Headache precipitated by coughing or straining in the absence of any intracranial disorder.

Diagnostic criteria:

A. Headache fulfilling criteria B and C

B. Sudden onset, lasting from one second to 30 minutes

C. Brought on by and occurring only in association with coughing, straining and/or Valsalva manoeuvre

D. Not attributed to another disorder.

*Primary exertional headache*: Headache precipitated by any form of exercise.

Diagnostic criteria:

A. Pulsating headache fulfilling criteria B and C

B. Lasting from 5 minutes to 48 hours

C. Brought on by and occurring only during or after physical exertion

D. Not attributed to another disorder

*Primary headache associated with sexual activity*: Headache precipitated by sexual activity, usually starting as a dull bilateral ache as sexual excitement increases and suddenly becoming intense at orgasm, in the absence of any intracranial disorder. Pre orgasmic and orgasmic forms are recognised.

Figure 1. IHS primary headaches relevant to headache in sport

From a practical perspective, these classifications can be somewhat cumbersome in specific settings such as sports. Four categories of sport-related headache are defined that provide a pragmatic organisation for practitioners.(18)

1. *A recognised primary headache syndrome (migraine, tension-type headache, cluster headache) coincidental to sporting activity.*
2. *A recognised primary headache syndrome (migraine, tension-type headache) induced by sporting activity.*
3. *Headache arising from mechanisms that occur during exertion.*

3a. Headache likely to be related to changes in cardiovascular parameters, (Increase in cardiac output and raised venous pressure).

3b. Headache related to trauma.

3c. Headache arising from structures in the neck.

4. *Headache arising from mechanisms that are specific to an individual sport.*

**1. A recognised primary headache syndrome (migraine, tension-type headache, cluster headache) coincidental to sporting activity.**

*Tension-type headache*

Tension type headache is the most common headache in the population. (19) The headache is dull, occipital and bilateral. However, it is usually improved by exercise, alleviated by simple analgesia and unlikely to be a problem in sport.

*Migraine*

The overall lifetime incidence of migraine is 16%, while it is 43% in females (20). Although regular exercise can help reduce the frequency, intensity and duration of migraine attacks, (21) it is likely to be the most common co-incidental primary headache during sport.

For the acute attack triptans, serotonin 5-$HT_{1B/1D}$ receptor agonists, are the mainstay of treatment of disabling migraine. The experience of administration during sport is limited to one small study of 38 attacks in Australian professional footballers using intranasal sumatriptan. (22) There was a good response with no major side effects and minor side effects being reported in over 70% of cases.

Apart from the potential impact of triptans on performance particularly from a cognitive perspective, there are theoretical concerns regarding the potential for coronary vasoconstriction. (23) For the amateur sportsman, a non-steroidal anti-inflammatory with or without a prokinetic or anti-emetic, would be a simple, generally safe, first choice. If triptans are necessary during sport in amateurs or in elite sportsmen, underlying cardiac pathology, in particular ischaemic heart disease and cardiomyopathy, should be excluded with an exercise ECG and echocardiogram. Any of the first line triptans, such as sumatriptan, almotriptan, eletriptan, rizatriptan or zolmitriptan represent reasonable initial choices. Triptan nasal sprays have the theoretical advantage of faster action and to some extent are able to bypass gasotrointestinal absorption limitations. Triptan formulations that are rapidly

dissolved are not faster acting but may be more convenient in the sporting context. Lack of or poor response to a triptan is not a class effect, and in this case an alternative from the class should be tried.

Beta-blockers are a first choice in the preventive treatment of migraine in routine practice. Propranolol 20mg twice daily increasing to 40-80mg twice daily is commonly used, while atenolol is convenient, cheap and may work just as well, starting with 25mg a day and increasing at weekly intervals by 25mg until effective, side effects or a maximum dose of 100mg a day is obtained. The use of beta-blockers in many sports has obvious implications for limitation of performance and are banned in many professional sports. Topiramate, sodium valproate, candesartan or pizotifen are reasonable alternative choices with appropriate monitoring for potential side effects.

*Cluster headache*

Cluster headache has a very high impact but is rare, affecting 0.1% of the general population. The cluster attack is predominantly unilateral, peri-oribital, excruciatingly painful and occurs in short bursts over a "cluster period", associated with peri-oribital or nasal autonomic features. Ninety per cent of attacks occur daily for 6-8 weeks, typically once or twice a year with spontaneous resolution. Sporting activity will be unlikely during the cluster period.

Short-term oral corticosteroids and oxygen will be contraindicated for the elite athlete. Triptans, either intranasal sumatriptan or zolmitriptan, or subcutaneous sumatriptan are effective. Cardiovascular concerns are the same as those outlined for the treatment of migraine. For prolonged bouts of episodic or for chronic cluster headache, verapamil is the preventive agent of choice but may cause cardiac

conduction delays and six monthly ECGs should be undertaken. It is best avoided in elite athletes where lithium 600–1200 mg daily or topiramate 50 mg twice daily can be used. Greater occipital nerve injection may be a useful intervention in episodic cluster headache (24) but again, corticosteroids will be contraindicated for the elite athlete.

## 2. A recognised primary headache syndrome (migraine, tension-type headache) induced by sporting activity.

Over 20% of migraineurs experience migraine precipitated by physical activity. (25) It has been suggested that exercise induced migraine can be prevented by aerobic warm up prior to activity (26) but the evidence base is poor. Cross sectional studies have suggested that tension-type headache does not restrict activities significantly. (27)

As with all treatments in this area, there are no randomised trials and studies are invariably too small to be definitive. A reasonable approach would be to use indomethacin 25-50mg or naproxen 500-1000mg one hour before onset of exertion. If this is not successful, then indomethacin 25-50 mg three times daily or naproxen 500mg twice daily over the 24 hour period prior to exertion, can be useful. If the elite athlete has consistent problems, then a Triptan administered 30-60 minutes before activity with the provisos mentioned above could be tried although the experience with Triptans used in this way is variable, and evidence from menstrual migraine suggests frovatriptan 2.5mg may be the best choice (28). If an elite athlete has consistent problems with sports induced migraine it may be best to start a preventive as outlined above. There is no evidence that cluster headache is induced by activity.

## 3. Headache arising from mechanisms that occur during exertion.

The physiological processes that occur during sport can induce headache. If no underlying structural cause can be identified these headaches are termed primary even though pain-inducing mechanisms may be inferred. If there is a structural abnormality, then the headache is termed secondary.

### *3a Headache related to changes in cardiovascular parameters*

i) Headache associated with increased cardiac output

The formal IHS criteria classifies a "primary exertional headache" as a pulsating headache lasting from 5 minutes to 48 hours for which no underlying cause can be identified and brought on by and occurring only during or after physical exertion. The headache is often described as migrainous in character, exacerbates in hot weather and at altitude and typically occurs during the period of maximum exertion although it can also be experienced during warm up. It can be difficult in practice to dissect primary exertional headache from exertion triggered migraine; migrainous features to the headache suggest using the approaches outlined above for exertionally triggered migraine.

Although mechanisms are unknown, arterial or venous distension may be implicated. Retrograde venous flow due to internal jugular vein incompetence has been suggested as one possibility. (29)

Although studies are small, estimates of a secondary cause range between 10 to 23%. (30)(31) Risk factors for secondary headaches are age, late onset of headache during activity and lack of responsiveness to indomethacin. All exercise induced headaches should be investigated with an MRI brain, blood pressure and ECG, blood screening for renal and liver function, haematology, thyroid disease and diabetes. Urinary catecholamines should be considered. Arnold-Chiari malformations, a

structural abnormality in which the lower part of the cerebellum protrudes through the foramen magnum into the spinal subarachnoid space, and neoplasms are the most common secondary pathology. Subarachnoid haemorrhage and arterial dissection are the most common cause of acute presentations. Rarely, headache can be a direct and isolated symptom of cardiac ischaemia ('cardiac cephalalgia') but the mechanism is unknown. (32)(33)

Having excluded a secondary cause, the treatment of primary exercise induced headache is anecdotal. Gradual warm-up exercise programmes have been advocated (26) but for short-term prevention, indomethacin is the treatment of choice. (34) (See above). For more frequent occurrence, a beta-blocker is the drug most often recommended providing there is no contra-indication for the elite athlete. There is little experience with other agents but the preventive migraine agents described above can be tried.

ii). Headaches due to raised venous pressure

This headache is more common in sports such as weight lifting and presumably caused by distension of the cerebral venous system. Intracranial hypotension is a rarer possibility but has been described. (34) [2x ref 34 in reference list]

As the small number of studies conflate this type of headache with exertional headache, and indeed in some types of exertion this may be the mechanism, the prevalence is unknown. An important secondary cause is an Arnold-Chiari malformation which must be excluded with neuroimaging with MRI. However, the indication for surgical treatment within the sporting context is contested, and it should be remembered in adolescents that minor malformations may resolve with time.

When no underlying cause can be identified this is classified by the International Headache Society as "primary cough headache," although the previously used term Valsalva manoeuvre headache is probably more appropriate. See figure1. Indomethacin is claimed to be effective although a positive response has been reported in some cases where there is an underlying cause.

*3b Headache related to trauma*

Headache is the most common symptom of a concussive injury and post traumatic headache accounts for 4% of all symptomatic headaches. Post traumatic headache both acute and chronic is the most common sports related headache with an estimate incidence in the US of up to 3.8 million a year. (35)

Head injury involves shearing due to linear acceleration/deceleration or rotational forces. The degree of injury does not always correlate with headache symptoms and the mechanisms that generate pain are poorly understood. Headache may be due to direct stress acting on dural structures or secondary mechanisms due to bleeding or axonal damage.

The headache can occur immediately or within the first week following an injury. In many cases athletes may not be aware of the initial head injury. Later onset headaches have been described but their causality is contested. There is an inverse relationship between the development of post traumatic headache and the severity of the injury (36), but most cases resolve in the first 3 months following an injury.

As published studies are not case controlled, the exact relationship between headache and trauma is not clear. (37) A variety of pain patterns may develop, some of which resemble primary headache disorders. Tension-type headache is the most common. In some cases migraine, known as "footballers' migraine" can be triggered

by mild head trauma. (38) More rarely a cluster headache like syndrome has been described. (39) Alternatively, a pre-existing primary headache can be made worse in close temporal relationship to trauma making them more refractory to treatment. (40)

Chronic post-traumatic headache is a headache that persists for three months after head trauma in the absence of a demonstrable traumatic brain lesion. It may be due to maladaptive central sensitisation, and is invariably associated with a number of other symptoms such as dizziness, difficulties in concentration and insomnia. The relationship between the severity of the injury and severity of the post-traumatic syndrome is not always direct. The phenotype of the headache is very often that of chronic migraine, as documented in the systematic description of these issues in a study of U.S. military (41).

There is no evidence base for the treatment of post-traumatic headache. The first line of treatment is symptomatic and medication overuse headache is always a cause for concern if analgesics are taken on more that three days in each week over the longer term. Amitriptyline ~~can~~ is reported to be effective.~~—~~(42). From a practical perspective, start with 10mg and increase by 10mg each night every four to ten days until side effects are problematic or a maximum dose of 1 to 1.5mg per kg body weight is reached.

Propranolol and valproate have also been suggested as treatment.(40) Other options are trigger point injections, occipital nerve blocks and botulinum toxin type A. However, a number of patients will remain disabled for some years following the insult and provide a clinical challenge. Developing secondary causes such as intracerebral or subdural haemorrhage and more rarely vertebral artery dissection should not be overlooked.

*3c. Headache arising from structures in the neck.*

Trauma to the neck can induce or exacerbate a cervical lesion with subsequent referred pain to the head via the upper cervical nerves. For a cervicogenic headache to be diagnosed, the IHS criteria require:

- Evidence of a disorder within the cervical spine or soft tissues of the neck as a valid cause of headache.
- Clinical signs that implicate a source of pain in the neck or the abolition of headache following a diagnostic blockade.
- Pain resolving within 3 months after successful treatment of the causes of lesion or disorder.

From a practical perspective, if the patient is able to demonstrate full movement of the neck with no local tenderness, cervicogenic headache can be excluded.

## 4. Headache arising from mechanisms that are individual to a specific sport

A number of headaches unique to a sport have been described which have a specific aetiology. For example, headache in spinning figure skaters is thought to be due to a centrifugal effect causing intracranial ischaemia (43), which is a claim without very considerable support given the fact that headache is certainly not an invariable rule in stroke. External compression headache is seen in swimmers due to mask pressure. (44) High altitude headache is recognised as an accompaniment of acute mountain sickness and is thought to be due to a vascular phenomena.(45) Diving headache occurs as a result of $CO_2$ intoxication. (46)

## Headache medication in elite sportsman

There is the possibility that performance-enhancing drugs can induce headaches and this should always be considered.

The Global Drug Reference Online (www.globaldro.com) provides athletes and support personnel with information about the prohibited status of specific substances based on the current World Anti-Doping Agency (WADA) Prohibited List and is relevant for those wishing to use prescribed and non-prescribed medication for their headache. If the medication an athlete is required to take to treat an illness or condition happens to fall under the Prohibited List, a Therapeutic Use Exemption (TUE) may give that athlete the authorization to take the needed medicine. This will depend on the sport and country where it takes place. Further details are available from WADA (www.wada-ama.org).

**Conclusion**

There are a number of problems with the study of headache in sport: the evidence base is very limited and studies are retrospective leading to recall bias; formal diagnostic criteria are rarely used; the pathogenesis of the majority of headaches is poorly understood and different types of activity may lead to different pathophysiological mechanisms. The impact of headache on sport is also likely to reflect the perspective of headaches sufferers in the community, i.e. stigmatised, largely unrecognised and inadequately managed with the needs of many sufferers unmet. For the research community, a useful first step would be to quantify formally the prevalence of this problem.

Further research is also needed to define more accurately the extent of the problem and options for management. An important first step is an awareness of the problem by the general practitioner, sports physician and those involved in sport and the encouragement of activity in the population at all levels.

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