Does football cause brain damage?

Available evidence suggests anecdotal media reports need to be assessed carefully

The critical issues in the clinical management of sports concussion include confirming the diagnosis, excluding structural abnormality and determining when players can be safely returned to competition. Despite the apparent simplicity of this process, the management of this one injury seems to provoke more debate than all other sports injuries combined. Unfortunately, this debate has largely been played out in the news media rather than through scientific journals. Complex issues have been oversimplified and distorted, causing significant alarm over putative long-term risks and concern over how an acute injury should be managed.

One source of anxiety is the phenomenon of chronic traumatic encephalopathy (CTE). The concept of "subconcussive" head injury has also evolved, with the concern that the cumulative effect of these ill defined "injuries" can lead to permanent structural brain injury.[1,2] In this issue of the Journal, Gilbert and Partridge argue for preventive measures that in many cases have already been instituted.[3]

Tragic stories of athletes who have not been managed appropriately or who have failed to fully disclose their injury to team medical staff, with catastrophic outcomes, are regularly aired in the media and have driven legislators in the United States to propose regulatory measures that restrict medical management of concussion in ways to which no other medical condition is subject. In addition to proposed congressional legislation, more than 40 US states have considered or passed bills relating to the management of sports concussion. In some states, mandatory preseason cognitive testing and other paradigms are included. Ironically, this focus on media anecdote and government regulation has occurred at a time when we know more than ever about the science of concussion in sport.

Although CTE in American footballers and wrestlers has been highlighted as a novel risk, scientific study into chronic brain injury in athletes extends back almost a century. What remains unclear is whether all athletes who suffer recurrent concussive (or subconcussive) brain impact are at risk of such sequelae, or whether a subset of athletes, presumably with a genetic predisposition, are at higher risk of CTE. A further, more likely, possibility is that retired athletes may simply suffer from an incipient neurological illness (such as frontotemporal dementia) unrelated to their sporting career.[1,2]

Mental health issues (such as depression) have also been reported as a consequence of sports concussion, occurring in 11% of retired footballers, with an association with recurrent concussion.[1,2,4] However, depression and anxiety symptoms occur in 15%–60% of subjects after traumatic brain injury from any cause and are also highly prevalent in this age group in the absence of trauma.[5]

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In the minds of most readers, professional boxing would represent the sine qua non of chronic brain injury.[6] Interestingly, amateur boxing has no strong association with CTE.[7] Studies of professional boxers suggest that a small proportion will develop the features of CTE, with the principal risk factors being extremes of boxing exposure and the presence of the apolipoprotein E ε4 gene allele.[2] In the mildest cases, clinical symptoms include a slurring dysarthria that may be accompanied by subtle pyramidal disease or disequilibrium. In the latter stages, cognitive impairment becomes the major feature. Throughout the course of the condition, various neuropsychiatric and behavioural symptoms may occur but are usually not prominent.[8] The neuropathological findings of CTE share many features of Alzheimer disease.[9]

The recent media interest in CTE in American footballers and ice hockey players is based on only a handful of case reports.[10,11] Moreover, CTE has been redefined as a different entity from that previously described in boxers. Patients now tend to be younger (presenting in their 40s and 50s) and have prominent neurobehavioural and/or neuropsychiatric symptoms rather than the pyramidal and extrapyramidal features seen in boxers. Some of the striking associations in this small group are a positive family history of dementia and the use of steroids, illicit drugs and other pharmacological agents. While the first of these suggests a genetic association, their presence may be more important in screening athletes before participation in contact sport, and considering counselling, to limit exposure in high-risk athletes. In addition, enhanced medical surveillance would be a key part of a comprehensive management approach.

The neuropathological findings in these few reported cases are variable, ranging from features indistinguishable from frontotemporal dementia through to more widespread atrophy and tau protein deposition and, in one reported case, only a single perivascular deposition of tau protein of unknown significance. Healthy older subjects may have similar neuropathological findings in the absence of cognitive impairment.[12] Critically, the detection of pathological change in the brains of former athletes does not necessarily support a causal relationship with their sporting careers or history of head impacts.

Radiological, neuropsychological and neurophysiological studies show focal abnormalities in the brain (such as the dorsolateral prefrontal cortex) in some patients with postconcussive symptoms.[1] It remains to be seen whether such focal lesions correlate with the anatomical sites of tau protein deposition and other abnormalities. Such outcomes will only become evident with increasing numbers of pathologically verified (and published) cases.

Given the high number of sporting concussions, estimated at up to 3.8 million per year in the US,[13] the potential exists for significant numbers of CTE cases even if it is relatively rare. Prospective studies will be necessary to determine if current management of concussion is effective in reducing putative late-life brain effects, as well as to determine at what age the nervous system is most susceptible to the deleterious effects of trauma. The complexities of the association and the implications will be compounded exponentially if subconcussive injuries are also considered.

As the ability to reduce the effects of concussive injury after the event is minimal, education is vital. Everyone involved in athlete care, including referees, administrators, parents and coaches, as well as the athletes themselves, must be educated about the importance and principles of safe return to play after injury. Methods to improve education, including social media, are important in delivering the message and providing peer support.[14] The support of enlightened international sports bodies, such as the Fédération Internationale de Football Association (FIFA), the International Olympic Committee (IOC), the International Rugby Board, and the International Ice Hockey Federation, is valuable, as they reach a global audience. In Australia, the Australian Football League (AFL) and National Rugby League have developed their own guidelines in line with international best practice (eg, the Zurich concussion guidelines[15]) and have been proactive in this regard. Rule changes to reduce head contact and increased penalties for infringement have already been instituted. The AFL has also devoted extensive resources to rolling out concussion education programs and management pathways to community-level sport. These sporting codes should be commended for their efforts.

There is no good clinical evidence that currently available protective equipment (especially soft-shell helmets) will prevent football-related concussion. Two randomised controlled trials have demonstrated the lack of efficacy of helmets in preventing concussion in rugby union and Australian football, and extensive laboratory studies have shown that current helmets have little or no protective capability in this regard.[16] The use of any protective equipment in contact sport is problematic, as players may adjust their play and take more risks. It has been recognised that hard helmets can be used as "weapons" by American footballers and may increase a tendency to engage in a more aggressive manner of play.[1,2,17]

At this stage, the available evidence suggests that current conservative management guidelines for acute concussion, if followed, are safe and appropriate.[15] Sideline assessment tools for concussion have been developed for both lay and medical use and are freely available online or as apps for smartphones or tablet computers. The engagement of mainstream neuroscience in this area is important but, rather than driving the debate through the media, the issues raised need to be tested in the cold light of scientific peer review. We must remember that the plural of anecdote is not data.

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