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From the Editor's Desk

Dear Colleagues,

Boxing is a dangerous sport with high risk for both acute and chronic traumatic brain injury (TBI). The risk of non-life threatening but disabling orthopedic and ophthalmological injuries is also high. The sport is still characterized by macho culture and hyper-masculinity. To never quit no matter what the odds is ingrained into boxers from their early days in the gym. One may argue that this combat sport mentality to never quit, to never say *No Más* is what separates a champion from just another fighter. The initial symptoms of traumatic brain injury are subjective and include headache, feeling of dizziness, and cognitive dysfunction. Machoism and warrior mentality make the boxer and his corner ignore these early warnings signs of TBI. Boxers deny these symptoms when asked. Medical stoppage by the referee or ringside physician is vehemently opposed. In the editorial titled, **"Can Boxing Be Made Safer?"**, the author makes a call for this boxing culture to change. Machoism and warrior mentality needs to evolve to one where *No Más* is accepted and live to fight another day mentality prevails. Quitting a fight should not be equated as a sign of weakness or emasculation.

Cerebral microbleeds, also at times referred to as cerebral microhemorrhages, are sometimes encountered in MR imaging of combatants. In the article titled, **"Cerebral Microhemorrhages in Boxers' MRIs–To Fight or Not to Fight?"** the clinical significance of these incidentally detected lesions is discussed.

I trust you shall find Volume 4 issue 2 of the *ARP Journal of Combat Sports Medicine* interesting and educational. Our two Senior Editorial Managers Lisa Nelson and Susan Rees continue to work tirelessly to improve the journal and make it a valuable resource for the combat sports physician community. The *ARP Journal of Combat Sports Medicine* is actively soliciting case reports, case series, review articles, and original studies related to the field of combat sports medicine. Please consider the journal for publication of your valuable work.

I wish you and your families good health and happiness.

Sincerely,

Nitin K Sethi, MD, MBBS, FAAN

CAN BOXING BE MADE SAFER? YES, BUT THE CULTURE NEEDS TO CHANGE

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KEYWORDS: boxing, combat sports, fighter safety, ringside physician

STUDY FUNDING: No targeted funding reported.

DISCLOSURES: The author serves NKS serves as Associate Editor, *The Eastern Journal of Medicine*, and Chief Medical Officer (CMO) of the New York State Athletic Commission (NYSAC). The views expressed by the author are his own and do not necessarily reflect the views of the institutions and organizations which the author serves.

Professional boxing is a popular combat sport worldwide. It is also a sport where risk of life-threating acute and chronic traumatic brain injuries (TBI) as well as non-life threatening but disabling orthopedic and ophthalmological injuries is high. In popular contact sports such as American football, rugby, and soccer, concussive injuries to the brain occur accidentally, usually when there is contact of the player's head with the opposing player(s) head, torso, turf, or as occurs in soccer, with the ball while heading. Boxing on the other hand is unique in that it is the only sport where in the sole objective of winning is usually accomplished by throwing punches at the opponent's head to cause a knock-out (KO) which is nothing but a concussive injury to the brain.

Concussion is defined as a clinical syndrome characterized by immediate and transient alteration in brain function, including alteration of mental status and level of consciousness, resulting from mechanical force or trauma.[1] It is important to remember that loss of consciousness is not required for a concussion. Concussions at times are graded into mild, moderate, and severe based on the duration of loss of consciousness and post traumatic amnesic period. Concussive properties of a boxer's punch are related to the way the punch is delivered (force and velocity of punch), how the mechanical forces are transferred and absorbed through the intracranial cavity of the opponent. Punches thrown from the shoulder, such as the roundhouse or hook, tend to deliver more force than a straight jab or right and cause concussions by delivering both linear and rotational (angular) acceleration forces. It does not need the presence of a neurologist ringside to correctly identify a KO as a concussive injury of moderate to severe grade. It is, though, important to emphasize that mild concussive injuries occur frequently during a boxing bout. Every time a boxer buckles, is off-balance, looks glassy eyed, or "has his bell rung", he has likely sustained a concussive injury.

The nature of the sport, however, is such that these mild grades of concussive injuries are ignored, and the boxer is allowed to proceed. One may argue that if boxing bouts are stopped for these minor concussive injuries, boxing as a sport would cease to exist in its current form. While this argument

has its merits, it is impossible to defend it medically if we are genuinely concerned about the brain health of these athletes. Abundant medical literature highlights the long-term health significance of multiple head impact exposures.[2] Minor concussions contribute to the development of chronic traumatic encephalopathy, a neurodegenerative disorder usually presenting after the boxer has retired with a constellation of cognitive changes, mood, and behavioral changes along with motor system dysfunction (Parkinsonism).[3]

The combat sport mentality is also to never quit no matter how big the odds. Phrases like, "I'd rather be carried out on my shield" are frequently voiced by boxers. Quitting midway through a bout is regarded as a sign of failure and a shameful act.[4] Injured boxers continue to fight egged on by their coaches. "Dig deep" is frequently yelled ringside and medical stoppage by the referee or ringside physician is vehemently opposed. Fans too express their displeasure, booing the ringside physician and at times slandering their professional reputation online with derogatory comments.[5] When a tragedy occurs in the ring, ringside physicians and referees are blamed for not stopping a fight in time. Costly lawsuits follow and physicians risk damage to their hard-earned professional reputations and higher medical malpractice insurance premiums.

Boxing, an inherently dangerous sport, can never be made completely safe. Boxers have died in the ring or in the immediate aftermath of a bout. The usual cause of death in these cases is traumatic subdural hematoma causing midline shift and herniation.[6] If the boxer is evacuated to a Level I trauma center in a timely fashion, an emergency decompressive hemicraniectomy, while lifesaving, frequently leaves devastating neurological deficits. Such a boxer requires lifelong multidisciplinary care and is a pale shadow of his former self with poor quality of life, dependent on caregivers. In no sport should an athlete die or suffer such a fate. Boxing thus needs to be made safer. Various proposals such as restricting the number of rounds and head shots, wearing protective headgear in professional bouts, use of better-designed mouthguards, while worthy of further discussion, are unlikely to be adopted since they will change the very nature of the sport. Practical proposals which should be adopted include better medical supervision of the sport, educating all concerned parties on concussion recognition and management, standardizing medical stoppage criteria, and implementation of NO-GO criteria.[7]

Boxing culture needs to evolve simultaneously. The considerable health risks of the Sweet Science need to be openly acknowledged by all concerned parties including athletes, coaches, promoters, boxing governing bodies, and fans. Machismo and warrior mentality need to evolve to one where *No Más* is accepted and "live to fight another day" prevails. Quitting a fight should not be equated as a sign of weakness or emasculation. Consideration should be given to stopping a boxing bout on medical grounds when a boxer sustains multiple head impact exposures even though the boxer appears neurologically intact and able to continue. When a fight is stopped on medical grounds by either the referee or the ringside physician, the decision should be respected by all parties, including fans. The trained professional (referee or ringside physician) entrusted to protect the fighter said *"No Más"* because the threshold had been reached beyond which they were unable to guarantee the health and safety of the combatant going forward.

Boxing remains a niche sport and a major reason for this is that many people find the brutality of the sport against their moral and ethical norms. Human cockfighting and blood sport are terms used to support a call to ban boxing. If boxing wants to thrive as a sport, its culture needs to change. In no sport should an athlete die. This change in boxing culture needs to come from within and the time for that is now!

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CEREBRAL MICROHEMORRHAGES IN BOXERS' MRIs: TO FIGHT OR NOT TO FIGHT?

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KEYWORDS: boxing; cerebral microhemorrhages; MRI brain, CT scan head

STUDY FUNDING: No targeted funding reported.

DISCLOSURES: The author serves NKS serves as Associate Editor, *The Eastern Journal of Medicine*, and Chief Medical Officer (CMO) of the New York State Athletic Commission (NYSAC). The views expressed by the author are his own and do not necessarily reflect the views of the institutions and organizations which the author serves.

Background. Professional boxing carries high risk for both acute and chronic traumatic brain injuries (TBIs). Neuroimaging is a requisite for initial licensure and periodically thereafter for maintenance of licensure under most Commission jurisdictions. While some Commissions require magnetic resonance imaging (MRI) of brain, in others computed tomography (CT) scan of head suffices to determine brain fitness to fight. Occasionally cerebral microhemorrhages, also known as cerebral microbleeds (CMBs) are detected as incidental findings in MRI brain scans carried out in young healthy asymptomatic boxers. The clinical significance of these lesions and whether these boxers should be allowed to compete is unknown.

Discussion. Cerebral microhemorrhages are identified incidentally in MRI brain scans done at the time of initial licensure and maintenance of licensure. In combat sport like professional boxing where every punch thrown at the head is thrown with the idea of winning by causing a concussive brain injury, the clinical significance of these incidental lesions and association with long term neurological sequelae such as chronic traumatic encephalopathy is currently unclear.

Conclusion. The clinical significance of incidentally detected CMBs in brain fitness screening MRIs done in professional boxers is unclear. Fighters with multiple CMBs should be counseled about the clinical significance of these lesions and risk of chronic neurological injuries associated with boxing. Fighters with minimal CMBs can be cleared to compete under close medical supervision and more frequent serial MRI follow up.

A-28-year-old male professional boxer with history of one knockout in his career underwent MRI brain scan for clearance to fight. He was found to have a cavum septum pellucidum along with multiple regions of susceptibility artifact in the cerebral hemispheres, pons, left cerebellum consistent with multiple cerebral microbleeds (CMBs). No lesions demonstrated T2 prolongation, associated diffusion restriction or mass effect. The scan was read as consistent with multiple CMBs without mass effect.

In professional boxing, most boxers undergo a neuroimaging study, either a CT scan head or MRI brain, to determine brain fitness to fight at the time of the initial licensure and periodically for maintenance of licensure. The presence of CMBs is usually an incidental finding in some scans of healthy asymptomatic boxers. Should boxers with CMBs be medically cleared to compete is currently not known. Only a handful of studies have looked at the presence of CMBs in boxers. Data regarding CMBs and long-term neurological sequelae of boxing such as chronic traumatic encephalopathy (CTE) are lacking. Developing and standardizing medical decision making with respect to presence of CMBs on neuroimaging would help protect boxers' health.

The following medical decision-making process with respect to presence of CMBs in combatants' neuroimaging is proposed based on personal ringside experience and review of existing medical literature.

1. **Boxers with multiple CMBs on MR imaging along with other findings such as large cavum septum pellucidum, regional or whole brain atrophy and deficits on neurocognitive tests should be denied licensure to fight as there is likely an increased risk for adverse long-term neurological outcome.**

2. **Boxers with isolated and infrequent CMBs on MR imaging can be allowed to fight if they pass a neurocognitive test. These combatants though should be closely followed with serial MRI and neurocognitive evaluations.**

Discussion

In professional boxing, most boxers undergo a neuroimaging study either a CT scan head or MRI brain to determine brain fitness to fight at the time of the initial licensure. Lesions consistent with CMBs are increasingly detected in MRI brain scans of these young, asymptomatic athletes. Cerebral microbleeds, also referred to as cerebral microhemorrhages, appear on MR images as hypointense foci notably at T2-weighted or susceptibility-weighted (SW) imaging. There is no associated diffusion restriction or mass effect with these lesions. The MR imaging characteristics of CMBs are thought to be on account of pathologic iron accumulation/hemosiderin deposition leading to changes in local magnetic susceptibility.[1] CMBs are increasingly recognized in some patients with normal aging and in diseases such as Alzheimer's dementia, cerebral amyloid angiopathy (CAA), and other vascular diseases. The presence of CMBs in CAA predicts the risk of recurrent lobar intracerebral hemorrhage. False positive mimics of CMBs include microdissections, microaneurysms, and microcalcifications. The absence of T2 prolongation makes the differential diagnosis of microcalcifications, microangiopathy and multiple cavernous angiomas though less likely in these otherwise healthy elite athletes.

The clinical significance of incidentally detected CMBs in MR scans of young asymptomatic boxers is unclear. Hahnel et al. performed 3T transverse dual spin-echo MR imaging sequence, 3D sagittal magnetization-prepared rapid acquisition of gradient echo sequence, coronal T2*-weighted sequence, and axial time-of-flight MR angiography sequence on 42 male amateur boxers and compared the scans with 37 healthy nonboxing male volunteers. Risk factors which were assessed included total number of fights and knockouts, weight division and duration of boxing. After making the imaging data anonymous, the MR images

were independently evaluated by two neuroradiologists. The group proportions of microhemorrhages were compared with Fisher test of exact probability. A statistically higher prevalence of cerebral microhemorrhages was found in the group of boxers (3 of 42; 7.1%) than in nonboxing male volunteers (0 of 37; 0%). The difference was, however, not statistically significant (P = .2479; Fisher exact test).[2] Hasiloglu et al. used SW imaging to determine the prevalence of cerebral microhemorrhages in 21 amateur boxers as compared to 21 nonboxers. More microhemorrhages were detected in amateur boxers (2 [9.52%] of 21) as compared to controls but the difference was not statistically significant. In their study, the authors also compared the sensitivity of susceptibility weighted imaging (SWI) with T2 FSE and T2*GE sequences. The identified microhemorrhages were not visible on T2 FSE or T2*GE images.[3]

It is important to note that one of the reasons these lesions are detected now with increasing frequency in professional combatants is because some commissions require MRI scans to be done on a 1.5 T or 3 T magnet (high magnetic field strength) with SWI and gradient echo (GRE) imaging sequences. CMB detection rate increases with magnet field strength and use of advanced three-dimensional sequences. These lesions are currently missed by commissions who require CT scan head for licensure. Boxing is unique in that every punch thrown at the head is thrown with the intention of winning by knockout which is nothing but a concussive brain injury. The risk for both acute and chronic neurological injuries in boxing is exceedingly high. While subdural hematoma is the most common cause of boxing-related mortality, the burden of chronic neurological injuries such as post-traumatic Parkinsonism and chronic traumatic encephalopathy (dementia pugilistica) is likely very high but largely hidden coming to medical attention only after the boxer has retired. Jordan et al. analyzed CT scans of 338 active professional boxers and found abnormality in 25 boxers (7%). The most common abnormality was cerebral atrophy (22 cases) noted more frequently in boxers with large cavum septum pellucidum (CSP).[4] As of now there are no validated neuroimaging biomarkers for concussion and chronic neurological injuries in these combatants. It is unclear whether CMBs are a possible marker for mild TBI in these athletes. It is important to remember that while current data show that CMBs themselves do not cause change in neurocognitive performance acutely, it is unknown whether they lead to an increased risk of adverse long-term neurological outcome.

Conclusion

The presence of CMBs and risk of boxing-related chronic brain injury should be debated vigorously by the ringside physician community and be further refined by conducting well designed longitudinal studies on boxers with CMBs. Evidence-based medical recommendations should then follow.

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Submissions must:

- Be submitted in Microsoft Word format (.doc or .docx);
- Be double-spaced with 1" margins;
- Be typed in a commonly-used font (Times Roman, Helvetica, Arial, or similar), no smaller than 11 points.
- Include page numbers

Abbreviations and Acronyms

The use of abbreviations and acronyms, except for those that are quite common in combat sports medicine is strongly discouraged. Authors should be careful to ensure that idiosyncratic acronyms are not included in the submitted version, as this will improve readability for the editors and the reviewers. In addition, authors will be asked to remove idiosyncratic acronyms in any accepted materials.

Photos, Figures and Tables

ARP encourages the submission of photos, slides, graphs, charts, etc. that serve to complement or reinforce the information provided. At initial submission, all tables and figures may be embedded in the main document file. Materials accepted for publication must have the associated figures submitted individually and appended to the main document at final submission (see below for formatting instructions). Manuscript preparation should follow the guidelines provided in the AMA Manual of Style (10th edition or later). If a figure has been published previously, authors must cite the original source and submit written permission from the copyright holder to use it. This permission must be submitted at the time of manuscript submission.

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- Title
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Electronic Journal Article

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With DOI:

Gage BF, Fihn SD, White RH. Management and dosing of warfarin therapy. *The American Journal of Medicine.* 2000;109(6):481-488. doi:10.1016/S0002-9343(00)00545-3.

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Centers for Disease Control and Prevention (CDC). Licensure of a meningococcal conjugate vaccine (Menveo) and guidance for use--Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR Morb Mortal Wkly Rep.* 2010;59(9):273.

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Basic science and research articles should include the following subcategories, clearly labeled in the manuscript:

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