Professional Contact Sport Athletes with Persistent Cervical Cord MRI T2 Hyperintensity Following Trauma May Safely Return to Play

by Zachary J. Tempel, MD, Jeffrey W. Bost, PA-C, and Joseph C. Maroon, MD

In professional sports, the management of cervical spine injury presents a unique challenge due to the potentially devastating medical and economic consequences facing the athletes and their sports organizations. Return-to-play (RTP) decisions after injury are always complex, but much more so if significant radiographic abnormalities remain. The significance of persistent T2 MRI hyperintensity within the cervical spine following sports-related trauma is even more obscure.

Traditionally, the presence of T2 hyperintensity on MRI in the acute post-traumatic period is believed indicative of edema following a transient insult to the spinal cord. Previous reviews have reported relative contraindication to RTP that includes residual presence of T2 hyperintensity on MRI, with or without persistent injury-related symptoms or signs. In our recent review article published in Neurosurgery in March 2015, we reported on five cases of professional athletes who presented with sports-related traumatic transient cervical neurapraxia along with persistent T2 MRI cord hyperintensity. Four of these athletes were eventually released to return to contact sport.

In this review, we discuss operative and non-operative management of the cervical spine, recommended radiographic follow-up, and the physiologic significance of persistent cord T2 MRI signal changes. We also present the decision criteria used for clearance for return to play for this group of contact sports athletes.

The athletes presented with various degrees of congenitally small cervical canal, spondylosis, stenosis, and disc herniation, along with focal cord T2 hyperintensity. Four of the five athletes required stabilization of the affected level via single level anterior cervical discectomy and fusion (ACDF). Clearance for return to play preceded complete resolution of MRI T2 hyperintensity in three of four athletes. Of the athletes that returned to contact sport, none (as of the date of publication) had suffered any further cervical spine injuries. The return to play for this unique group of professional athletes with persistent T2

Figure 1. Preoperative sagittal T2-weighted MRI demonstrated T2 hyperintensity within the spinal cord in (A) a professional wrestler after a hyperflexion injury; (B) an NFL defensive end after an axial loading and hyperflexion injury; and (C) an NFL defensive tackle after an axial loading and hyperflexion injury.
Chairman’s Message

Telemedicine Opening New Frontiers

The ability to consult with your colleagues in the care of a patient is often a key factor in ensuring a positive outcome in a case. We freely collaborate to ensure that all treatment options are explored, to guarantee that all medical avenues of attack are considered.

In today’s burgeoning high-tech medical environment, consults and collaboration among colleagues is no longer limited to a phone call, x-ray, or disc shared through the mail.

New advances and approaches in teleconferencing now allow us to thoroughly and quickly diagnosis, plan, and consult on the most difficult cases, not only across town, but also around the globe.

This past April, I was proud to host a fundraising dinner for Crown Prince Alexander II and Princess Katherine of Serbia to help raise money to further develop a telemedicine program linking UPMC’s experts with doctors in Belgrade. The event — attended by top UPMC executives and other local business leaders — raised more than $25,000 for telemedicine development to help Serbia reclaim and rebuild its own medical system.

It may be prohibitively expensive for many individuals to come to the United States for medical treatment, but we can connect the doctors seamlessly from Belgrade — and other locations around the world — to Pittsburgh, helping them evaluate and plan courses of action. This arrangement has already paid dividends. This past February, for example, a two-year-old boy in Belgrade with a serious but difficult-to-diagnose heart condition successfully underwent surgery after a telemedicine consultation with a team of experts at Children’s Hospital of Pittsburgh of UPMC.

Medical teleconferencing is not simple, despite the advances in today’s “super highway” of connectivity. Language, technical issues, and infrastructure costs all need to be addressed. Doctors here need to carefully walk through the process with doctors elsewhere, making sure all the studies, tests, and other medical steps are addressed properly.

We hope to take the telemedicine process a step further in the future by sending our doctors to Belgrade to teach for short periods of time, and by bringing Serbian doctors here for a month or two to observe.

It’s a long process, but a worthwhile one in advancing new medical frontiers around the globe.

Robert M. Friedlander, MD, MA
Chairman and Walter E. Dandy Professor of Neurological Surgery
Co-Director, UPMC Neurological Institute

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Study Shows Very Low Risk of Adjacent Level Fractures After Balloon-Assisted Kyphoplasty

By Erin E. Paschel PA-C, Chris P. Deibert, MD, and Peter C. Gerszten, MD, MPH

Balloon-assisted kyphoplasty (BAK) is a safe and effective surgical procedure used to treat vertebral body compression fractures that are unresponsive to conservative measures of treatment. Approximately 1.4 million new cases of osteoporotic vertebral compression fractures (VCFs) are diagnosed annually throughout the world and are a source of debilitating pain and loss of function, especially in the elderly population.

The BAK technique involves the insertion of a balloon within the collapsed vertebral body in an attempt at height restoration and to reduce kyphotic deformity prior to stabilization with polymethylmethacrylate. The inflatable balloon (Medtronic, Minneapolis, MN) is inserted through a cannula into the vertebral body and inflated with a balloon-plasty technique to not only create a focal cavity to fill with cement, but also to attempt re-expansion of the vertebral body to regain height.

Osteoporosis is a disease where skeletal bone becomes demineralized, increasing the risk of fractures, and is most commonly found in elderly women. There has been speculation surrounding the BAK procedure due to the theoretical risk of developing subsequent osteoporotic compression fractures, either remotely or in adjacent levels. However, a recent study performed by researchers at the University of Pittsburgh Department of Neurological Surgery, which is the largest such study to date, demonstrates the risk of new VCF following BAK to be less than 10 percent.

It has been postulated that vertebral augmentation with BAK leads to biomechanical alteration of the osteoporotic spine, predisposing a patient to developing subsequent fractures. Other studies have reported the incidence of subsequent fracture to be at 11 percent, and as high as 21 percent. This can occur in a level immediately adjacent to the treated level or in a remote vertebra.

This current study examined 726 patients who underwent BAK at the UPMC Department of Neurological Surgery over a 13-year period. A total of 922 fractures were treated during that time. The indication for surgery for all patients was debilitating pain unresponsive to medical management due to osteoporotic VCF. Pathologic and traumatic compression fractures were excluded from the cohort.

Of those 726 patients, 77 subsequently developed a symptomatic compression fracture, requiring a second BAK, with a mean age of 71 at onset. The timing between the index and subsequent surgery averaged 350 days. Subsequent fractures were found in an adjacent level 58 percent of the time, with the mean onset time being 256 days following initial treatment. Fractures in a remote level of the spine were found to occur 489 days following initial treatment. Eleven of the 77 patients required a third BAK at 206 days. There was no difference in age, sex, smoking status, steroid use, or location of the index fracture when comparing patients with a remote or adjacent level fracture. No significant risk factors for development of new VCFs were identified.

While there are rare complications associated with BAK, the greatest degree of concern lies in the development of subsequent VCF after the procedure. This study clearly demonstrates a future fracture risk of only 10 percent and is the largest cohort to date. New adjacent fractures following BAK may represent an alteration in biomechanics following VCF, while new remote fractures are likely due to progression of underlying osteoporosis. In either case, the likelihood of developing a subsequent VCF following balloon-assisted kyphoplasty is very low and further endorses use of this procedure in the treatment of symptomatic vertebral compression fractures.

For more information on kyphoplasty, please call 412-647-1700.

![Figure 1. Intraoperative fluoroscopic images of BAK procedure.](image-url)
Weighing the Childhood Risks of Contact Sports

(Reprinted with permission of The Washington Times)

by Joseph C. Maroon, MD, and Julian Bailes, MD

The incidence and severity of brain injury is one of the hottest topics in sports media today, and it is creating a storm of near-panic in youth sports — especially football. We worry that the public’s misunderstanding of the available medical research is the gravest threat facing organized contact sport at the youth and high school levels.

As neurosurgeons and early researchers of concussions and Chronic Traumatic Encephalopathy (CTE), we are often asked if parents should permit their kids to play football, ice hockey, lacrosse and other contact sports. Our answer is an unqualified yes. The benefits of organized contact sports on childhood and adolescent development far outweigh the risks, given the available medical data.

We are surgeons and researchers who have dedicated much of our lives to pursuing the safer play of contact sports. We are also fathers and former collegiate athletes with a passion for the traditions and lessons learned from participating in organized contact sports. These sports make invaluable contributions to character development and future success of children by teaching them teamwork, discipline, self-control and triumph over adversity. These years also provide some of the most precious and long-lasting memories parents make with their children.

Organized sports are a bulwark against the very real health risks associated with childhood obesity, such as diabetes, hypertension, and cardiac disease. These benefits are critical to the health and development of our youth and they serve to show the need for a more balanced approach to how we address the safety of our kids playing contact sports. Unfortunately, participation in youth football nationally and high school football in many regions of the country has substantially fallen in recent years.

Why the near-hysteria about concussions? Perhaps it’s the heartbreak effects of Chronic Traumatic Encephalopathy on beloved athletes, such as our friend and NFL Hall of Famer, the late Mike Webster. People wonder how kids are safe if the professionals are not. It is a fair point, at first glance, but the data tell us otherwise.

Each year, more than three million kids play youth football; a million more play in high school; about 70,000 play at the college level; and about 2,500 are professional football players. The medical literature on Chronic Traumatic Encephalopathy reveals that in the past 10 years, a total of 63 football players were diagnosed with CTE, almost all professional athletes, out of approximately 44 million players. Research has not quantified the almost-certain risk factors, aside from concussions, such as genetics, pharmacological and toxicological factors. So, is there a CTE epidemic and is withdrawing participation in organized contact sports the remedy? Our answers are no and no.

Fear has created a market for concussion information and products, and the media is overreacting to sensational but unsubstantiated pronouncements and factoids. The anti-football hype is so prevalent that even Pulitzer Prize-winning columnist, George Will, asserted, “For all players who play five or more years, life expectancy is less than 60; for linemen it is much less,” without as much as a footnote. It’s a shocking statistic but it’s not an accurate one. Research

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UPMC Clinical Researchers Tackle Cervical Spondylitic Myelopathy

by Alexandra Wappler and Adam S. Kanter, MD, FAANS

Cervical Spondylitic Myelopathy (CSM) is a degenerative condition caused by repeated compression of the spinal cord from arthritic changes in the neck (see Figure 1). It is the most common dysfunction affecting the spinal cord in adults older than age 50, and accounts for nearly 20 percent of cervical spine surgeries performed in the United States.

Patients suffering from CSM typically experience clumsy hands with numbness, tingling, loss of fine motor control, and difficulty with gait and balance function. When surgery is required, the primary goal is to remove pressure from the vertebral canal to prevent damage to the spinal cord. If injury has already occurred to the spinal cord, it cannot be reversed, which is why accurate diagnosis and prompt treatment are critical in managing this potentially devastating condition.

Despite the relatively high incidence of CSM, there is no consensus regarding the best surgical approach to decompress the spinal canal in these patients. UPMC Presbyterian is now one of 10 premier sites throughout the country working to answer the age-old question: What is the best operation to treat CSM?

The Cervical Spondylotic Myelopathy Surgical Trial (CSM-ST) is sponsored by the Patient-Centered Outcomes Research Institute (PCORI). The study aims to enroll 250 patients with CSM due to spinal cord compression. A panel of 15 spine experts from various institutions throughout the country are presented with each patient’s individual history and examination findings, in addition to their radiographic imaging (MRI, CT, x-rays). A poll is conducted to determine what approach each surgeon would choose to perform if the patient were in their personal clinic.

Once the polling is complete, each surgeon will provide their patients with the 15 “second opinions.” If no consensus was reached among the experts, the patients can be enrolled in the randomized arm of the study and receive either an anterior (front) surgical approach or a posterior (back) surgical approach to alleviate the pressure on their spinal cord. If more than 80 percent of the experts opted for a specific surgical procedure, the patient can be enrolled into the non-randomized arm of the study and receive the procedure deemed appropriate by the majority vote.

Patients are followed both clinically and radiographically for a minimum of two years after their surgery. Outcomes questionnaires are completed at each follow-up visit until the study’s conclusion, so that health-related quality of life (HRQOL) following anterior versus posterior surgery can be compared to better elucidate the most efficient and effective way to treat patients with CSM.

To learn more about this study, please visit www.clinicaltrials.gov and search for NCT02076113, or contact our research office at 412-864-3418.

Risks of Contact Sports (Continued from Page 4)

shows that retired NFL players are living as least as long as their peers and have lower rates of cancer and heart disease.

On the other hand, parental concern has instigated refinements in practice styles, rule changes, training, and protective equipment, such as limits on checking in hockey and improved tackling technique in football. Equipment innovations in energy-dispersing pads, telemedicine, and technology to reduce brain cavitation inside the skull — known as “brain slosh” — will enhance the safety for young athletes. Schools and youth leagues are adopting baseline neurocognitive tests, such as Immediate Post Athletic Concussion Testing, to help physicians evaluate possible concussions for athletes. Telemedicine solutions will soon be able to link any sideline in America with concussion-certified medical professionals using helmet sensors and a tablet computer.

We believe in medical technology advancements, thoughtful rule changes, and safety protocols to protect players of all ages. Increased levels of public and private investment in concussion prevention and management research should be a national priority. Finally, the media and the public have an opportunity to refocus their attention away from fear and toward a more balanced approach, preserving the physical and character development benefits of sports.
Disturbances in memory function are a concern for many neurosurgical disciplines. Loss of memory function may indicate underlying brain pathology. While the past few centuries have seen substantial improvements in our understanding of memory, many gaps remain, especially with respect to how to preserve memory.

Memory continues to be an important area of scientific exploration relevant to improving outcomes in a number of health conditions, including, but not limited to, dementia, traumatic brain injury (TBI), concussion, and cancer. Thus, many people are currently suffering from, or at risk for, memory loss. Clinical and basic science researchers at the University of Pittsburgh Department of Neurological Surgery are working to better understand the neurological basis of memory, as well as therapies that may help minimize or treat memory deficits in a number of conditions.

Memory is the most severely affected and the most frequently reported symptom by both patients and relatives after all severities of TBI. Memory performance is an important outcome variable by which to monitor recovery and determine treatment options.

Our laboratory is studying the mechanisms of memory deficits in preclinical models. Researchers have found that a well-documented response to TBI is the persistent impairment of synaptic release of multiple neurotransmitters. Impaired synaptic neurotransmission may contribute to post-traumatic memory deficits. Because neurotransmitter release requires fusion of synaptic vesicles with the presynaptic plasma membrane, researchers hypothesize that a reduction in this vital molecular process may contribute to post-traumatic memory deficits.

Regulated fusion of a synaptic vesicle with the plasma membrane and the subsequent release of neurotransmitters into the synaptic cleft are critical for neuronal communication. Vesicular fusion in the presynaptic terminal is dependent upon the availability of vesicles and the formation of the molecular machinery that catalyzes membrane fusion. Reductions in the number of vesicles in the readily releasable pool, or vesicles immediately available upon stimulation, are associated with impaired neurotransmission. In the presynaptic terminal, formation of the soluble N-ethylmaleimide-sensitive factor attachment protein receptor (SNARE) complex is a crucial step to initiate vesicle docking and fusion with the plasma membrane. In a newly published article (Carlson, et al., Journal of Neurotrauma, 2015), researchers demonstrated, for the first time, that experimental TBI can significantly alter the abundance of SNARE proteins and reduce the formation of the SNARE complex, the machinery critical for synaptic vesicle docking. Using transmission electron microscopy to image synapses within the hippocampus, a significant reduction in vesicle number within 150 nm of the active zone was reported.

The findings of altered synaptic vesicle distribution and impaired SNARE complex formation suggest that alterations in synaptic vesicle docking may be a common underlying mechanism that contributes to deficits in neurotransmission in multiple brain regions and in different neurotransmitter systems of the injured brain. This federally supported research provides novel evidence that altered vesicle distribution and impaired vesicle docking may be important contributors to deficits in neurotransmission after TBI.

This and other research being conducted at the University of Pittsburgh Department of Neurological Surgery enhances the understanding of memory, which will help clinicians reduce memory deficits that accompany disease, injury, or therapy. Additional pre-clinical and clinical research is necessary for continued improvement in patient outcomes.
Chinese Vice Premier Visits Department

Department chairman Robert Friedlander, MD, MA, (right) makes a presentation to university chancellor Patrick Gallagher, Chinese vice premier Liu Yandong and her delegation, and school of medicine dean Arthur S. Levine, MD.

The University of Pittsburgh and the Department of Neurological Surgery hosted Chinese vice premier Liu Yandong and her delegation, and school of medicine dean Arthur S. Levine, MD.

During the vice premier’s visit, department chairman Robert M. Friedlander, MD, MA, showed her delegation a 3D presentation on the use of high-definition fiber tracking to plan surgical procedures. They also heard from one of his patients who fully recovered from brain cancer thanks to the assistance of high-definition fiber tracking.

The vice premier’s visit is a sign of the close ties the university has developed with several Chinese institutions including Sichuan University and Tsinghua University. The Sichuan University-Pittsburgh Institute, located in Chengdu, China, will welcome its first group of 100 students this summer.

Department Doctors Named Best in Field

Several department neurosurgeons were named among this area’s best doctors in their field in a national physician survey published locally in Pittsburgh Magazine.

The list includes: Adnan Abla, MD; Daniel M. Bursick, MD; Hikmat (Matt) El-Kadi, MD, PhD; Johnathan Engh, MD; Juan C. Fernandez-Miranda, MD; Robert M. Friedlander, MD, MA; Paul A. Gardner, MD; Adam S. Kanter, MD; L. Dade Lunsford, MD; Joseph C. Maroon, MD; John J. Moosy, MD; David O. Onkonwo, MD, PhD; Ian F. Pollack, MD; Raymond Sekula, MD; and Elizabeth Tyler-Kabara, MD, PhD.

The list was compiled by Best Doctors®, founded in 1989 by Harvard Medical School physicians with the purpose of helping people get the right medical diagnosis and right medical treatment.

Department Honors Graduating Chief Residents

A special black-tie graduation reception and dinner was held Saturday, June 20, at the Pittsburgh Golf Club honoring 2015 graduating chief residents Kimberly Foster, MD, Phillip Parry, MD, and Paul Richard, MD. Dr. Foster will join St. Jude’s Children’s Research Hospital in Memphis, Tenn. Dr. Parry joins the David Grant USAF Medical Center at Travis Air Force Base in Calif., and Dr. Richard joins Neuroscience and Spine Associates in Naples, Fla.

Annual teaching awards were also announced at the dinner with Dr. Parry selected as best resident teacher by the staff and Raymond F. Sekula Jr., MD, MBA, receiving the best faculty teaching award as selected by the residents.

Congratulations

Resident Benjamin M. Zussman, MD, was selected as a Council of State Neurosurgical Societies socioeconomic fellow for 2015-16. D. Kojo Hamilton, MD, was named to the advisory board of the European Spine Journal. Nduka Amankulor, MD, was awarded the 2015 Leo H. Crip, MD, Excellence in Patient Care Award from the University of Pittsburgh Cancer Institute.

Special Lectures & Appearances

L. Dade Lunsford, MD, was the honored guest at the Georgia Neurosurgery Society Annual Spring Meeting at Sea Island, Ga., and was a visiting professor at the University of Michigan.

David O. Onkonwo, MD, PhD, served as course director for two AONEuro neurotrauma courses in Guangzhou, China, May 19-22.

Paul A. Gardner, MD, was an invited guest speaker at the 16th World Congress of Rhinology, held in Sao Paulo, Brazil.

Paul A. Gardner, MD, and Carl Snyderman, MD, MBA, taught a two-day course with hands-on cadaveric dissection and live surgery of minimally invasive techniques for endoscopic endonasal surgery of the pituitary fossa and cranial base in Kazan, Russia. Drs. Gardner and Snyderman were also invited to visit The Burdenko Neurosurgical Institute in Moscow where they participated in a mini-seminar on “Challenges in Advanced Endoscopic Skull Base Surgery.”

Joseph C. Maroon, MD, was a guest of the Navy SEALs in Virginia Beach, Va., where he gave a talk on concussions and post-traumatic stress as part of the group’s Special Warfare Command Resiliency Program.

Peter C. Gerszten, MD, MPH, was the keynote speaker at the inaugural meeting of the Latin American-Iberian Radiosurgery Society in Panama City, Panama. Dr. Gerszten is one of the founding members of this new society.

Major Grant Awards

The National Institutes of Health awarded a $1.8 million grant to Juan C. Fernandez-Miranda, MD, in support of his project, Language Connectivity Pathways and Neuroplasticity in Aphasic Stroke Patients.

In the News

Daniel A. Wecht, MD, was featured in a Pittsburgh Post-Gazette article, which discussed how brain surgery and rehabilitation helped a college student recover from a dangerous cerebral vascular malformation.

Joseph C. Maroon, MD, was featured in a Q & A article on SportingKid Live — National Alliance for Youth Sports website — explaining why youth football has never been safer. He was also quoted in a Pittsburgh Post-Gazette article, that reported on a study pointing out the potential health benefits of turmeric.

R. Mark Richardson, MD, PhD, was a guest on the KDKA Radio Morning News Show with Larry Richert and John Shumway, talking about epilepsy.
Professional Contact Sport Athletes (Continued from Page 1)

MRI hyperintensity included being completely symptom-free, having a normal examination, and no evidence of radiographic spinal instability. Additional observations are needed to confirm this approach due to the small series size reported in the literature thus far.

Much of the literature on cervical cord T2 hyperintensity relates to degenerative spine conditions. For example, several studies have examined the evolution of intramedullary T2 hyperintensity following ventral decompressive surgery for CSM.

Some studies have found that resolution of T2 hyperintensity in subjects with CSM who undergo ventral decompressive surgery correlates with improved functional outcomes. Other studies have found little correlation with post-operative outcome.

In the setting of severe spinal cord injuries, such as central cord syndrome, T2 hyperintensity correlates with acute intramedullary hemorrhage. However, in these patients, the signal abnormality is often diffuse, spans several levels, and correlates with severe deficits. This is in contrast to athletes with transient neurapraxia and a focal T2 signal abnormality.

In contact sports, the cervical spine is most susceptible to injury when the mechanism involves substantial axial loading forces applied to the head while the neck is in flexion or extension. If the force is great enough to compromise the integrity of the discovertebral complex or ligamentous elements, direct injury to the spinal cord may occur due to disc herniation or buckling of the ligamentum flavum posteriorly. Acute neural element compression may be transient; however, studies with athletes involved in contact sports have shown a greater prevalence of pre-existing chronic compressive pathology, such as congenital spinal stenosis, that may predispose them to this type of event. Spondylosis with canal stenosis increases the risk of spinal cord injury due to limited functional reserve within the canal.

Free Online CME
We provide numerous free courses for CME credit on our website: UPMCPhysicianResources.com/Neurosurgery.

A world-renowned health care provider and insurer, Pittsburgh-based UPMC is inventing new models of accountable, cost-effective, patient-centered care. It provides more than $888 million a year in benefits to its communities, including more care to the region’s most vulnerable citizens than any other health care institution. The largest nongovernmental employer in Pennsylvania, UPMC integrates more than 60,000 employees, more than 20 hospitals, more than 500 doctors’ offices and outpatient sites, a more than 2.6-million-member health insurance division, and international and commercial operations. Affiliated with the University of Pittsburgh Schools of the Health Sciences, UPMC is consistently ranked among the nation’s best hospitals by U.S. News & World Report. For more information, go to UPMC.com.

UPMC is proud to be the only hospital in western Pennsylvania to be named to U.S. News & World Report’s prestigious national Honor Roll for excellence in 15 specialty areas, including neurology and neurosurgery. For more information about our programs, continuing medical education, Video Rounds, news, and events, please visit UPMCPhysicianResources.com/Neurosurgery.