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O.R. ergonomics:
Avoid the chronic physical
effects of long operations

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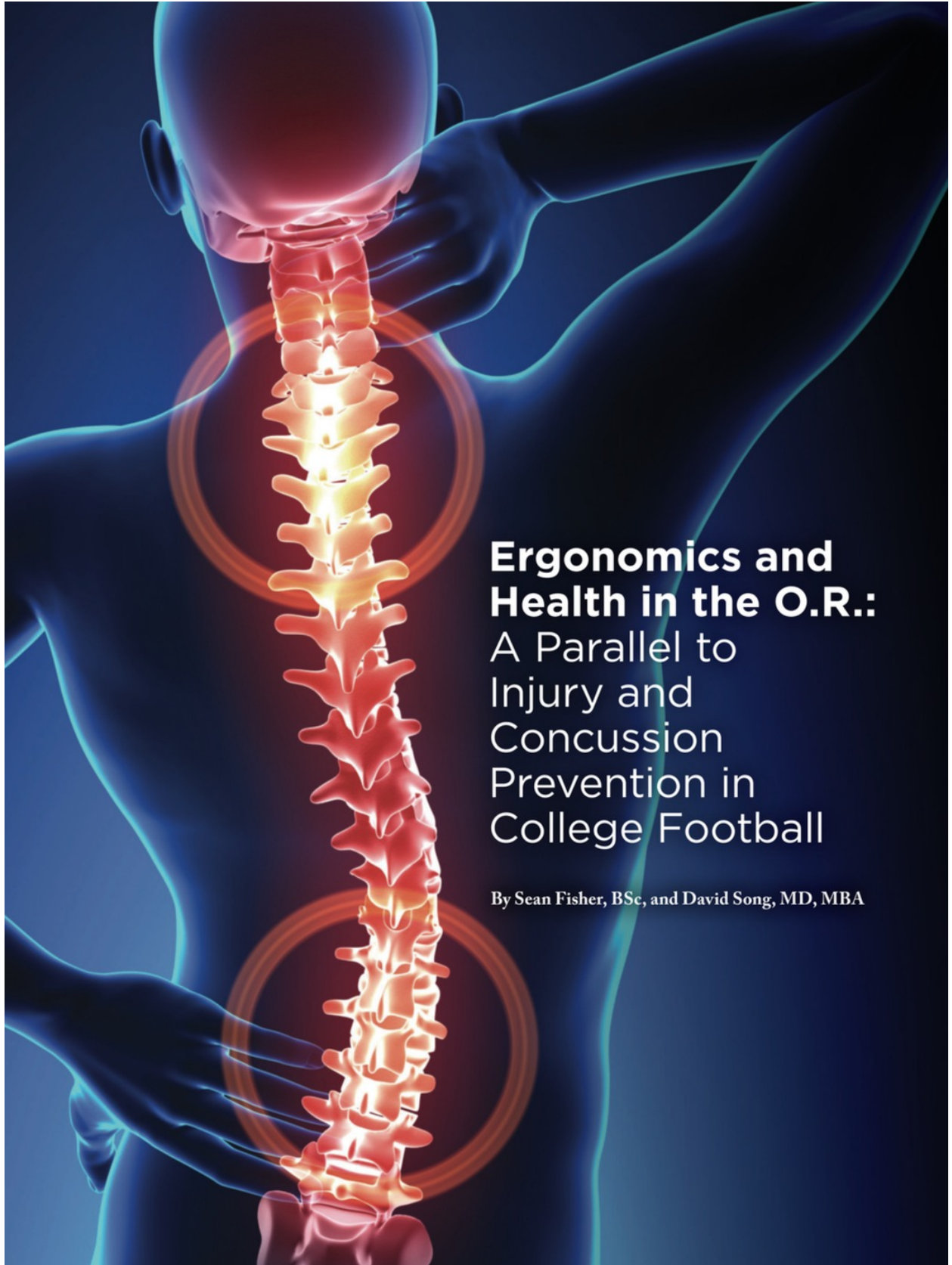
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**Ergonomics and
Health in the O.R.:**
A Parallel to
Injury and
Concussion
Prevention in
College Football

By Sean Fisher, BSc, and David Song, MD, MBA

Football is integrally woven into the fabric of our modern culture. Turn on the television on any given fall Saturday, and you're sure to be met with a barrage of clashing helmets, cheering fans and NCAA emblems. Rinse and repeat on Sunday, with substitution of the NFL for the NCAA. While rivalries, salaries and Hail Mary passes dominate the conversation surrounding the topic of football, a darker side looms in the future for many of the game's ex-participants.

At the age of 27, I should be in the physical prime of my adulthood. However, my experience thus far has been a departure from the golden 20s promised to most. Instead, there's a body that feels aged beyond its reported model year; a fractured leg, ruptured deltoid ligament and dislocated ankle ensure that each day begins with stiffness that feels more consistent with that of a 50-year-old; scars litter my body, as evidence of years of physical battery, and lower back pain serves as a constant reminder of the heavy weight frequently forced upon my back.

However, the most alarming memento from my college football career – which now is an aspiring plastic surgery career – is the frequent, cervical neck pain that has resulted from the constant utilization of my head as a weapon. When coupled with a 6-foot 5-inch frame, and assessing the spinal health of many career surgeons, the writing on the wall is clear. For myself, the conversation of ergonomics and health awareness for the surgical trainee is not simply a topic of interest. Rather, its emphasis is imperative for avoiding the degenerative spinal injuries that are too frequently acquired over many years in this physically demanding field.

Much more to do

While studies in the field of O.R. ergonomics and preventative health for surgeons have reported on the frequency of chronic pain and have illustrated the poor biomechanics that are too often present in the O.R.¹⁻⁵, little has been done to promote the meaningful change that must occur to ensure longevity for those entering this profession. In assessing the severity of this problem – and in considering solutions – one must only look to the football stadiums throughout this country, which can provide reliable parallels upon which to draw.

Since the first report of chronic traumatic encephalopathy (CTE)

by Bennet Omalu, MD, MBA, MPH, et al., in 2005, an increasing burden of evidence has suggested a seemingly obvious principle in the game of football⁶. That is, long-term exposure to repeated traumatic events results in lasting physical harm. While this premise is not revolutionary, the tangible effects of CTE are. (*Coincidentally, on the day this article came across the PSR editor's desk, the AMA announced that it would honor Dr. Omalu on Nov. 12 with its Distinguished Service Award "for his work discovering CTE in former American football players."*)

In recent years, a palpable shift has occurred in the public's willingness to accept the risks associated with the game of football, as a growing number of ex-participants has begun to exhibit signs of this disease. In its wake, society has begun asking the question of how to more accurately monitor and protect football players from the dangers of traumatic injuries. Through the application of prophylactic measures in every aspect of the game, an injury-prevention paradigm shift has begun to take hold. Using early education, technology and common sense physical-training strategies, the next generation of football player is being taught to take the threat of chronic injuries more seriously while being provided the tools necessary to help minimize the risk of such outcomes.

No collisions, but damaging still

Despite the fact that there have been no such revolutionary conclusions reached regarding physical harm in the field of surgery, it's abundantly clear that there are many long-term physical stressors imposed on aesthetic and reconstructive surgeons during the course of a long career. The National Institute of Occupational Safety and Health noted that static loads, extreme working postures and high levels of static contraction increase the occurrence of musculoskeletal defects



of the neck⁷, with other reports also noting the effect played by mental strain on these same symptoms⁸.

While the all-too-common 15-hour surgery does not elicit the same degree of shock as a violent collision on the football field, it nonetheless wears upon the parties involved. And just as a football collision, taken in isolation it has a seemingly benign consequence – the isolated, long O.R. case is not threatening to the surgical trainee's health. However, this isn't to say that these events don't pose long-term threats.

During my time playing football, the rush of the game and the pressure to succeed made it easy to brush-off the likely concussion, sprained ankle or ailing muscle. However, years later the physical manifestations of these decisions have begun to crystalize. In keeping with this same logic, the pressures and demands of the academic environment for surgical trainees and young surgeons often push them to ignore any consideration of the surgery lifestyle outcome (if left unopposed).

While the profession of plastic surgery is, to a degree, unavoidably demanding,

as evidenced by reports of chronic neck and back pain in up to 75 percent of surgeons¹, it's my belief that some of the same principles and technologies being applied to injury prevention in football warrant discussion in the context of tomorrow's plastic surgeon. In doing so, we may begin to facilitate the ushering-in of a new paradigm similar to that observed in the game of football, with the ultimate hope of protecting future generations of surgeons.

Physical preparedness

For anyone who has trained for a marathon, played a sport or set a weight-loss goal, it's known that the "main event" is but a fraction of the work and energy put into the overall process. In order to safely complete a marathon, one does not simply decide to run 26.2 miles. Rather, such a task requires dedication to physical health in a holistic sense. This concept was interwoven throughout collegiate athletics with frequent weightlifting and cardiovascular exercise, diet implementation, mandatory injury rehab and frequent stretching and recovery sessions.

In much the same way, the demanding nature of the surgical O.R. warrants the application of these same principals, as it has been established that both the static and dynamic postural stresses experienced in the O.R. can result in fatigue and disability². With periods of prolonged standing and retracting, and the constant maintenance of contoured body positions, trainees are subjected to atypical forms of physical exertion that are taxing beyond their apparent face value. This is evidenced by both reports of increased cardiovascular demand during surgery², as well as abundant long-term musculoskeletal complaints from career surgeons^{3,5,9}.

Although surgical training necessitates that a large amount of time and energy must be focused on the care of patients, it's nonetheless important to maintain a degree of personal fitness throughout this long process. In addition to

achieving the CDC's recommended weekly amount of exercise, for obvious health benefits¹⁰, other forms of activity and training should be incorporated that reflect the unique physical stresses placed on surgeons.

This premise was frequently utilized in football training, as a heavy emphasis was placed upon exercises that targeted vulnerable areas. Frequent attention was paid to muscles charged with stabilizing the neck, as head-to-head collisions frequently resulted in neck ailments. In much the same way, trainees should consider prophylactic neck-strengthening exercises in an attempt to bolster their cervical column, given the frequent strain placed on this aspect of the body. This targeted strength training has the potential to increase the compensatory threshold against the forces that promote cervical hyperflexion – ultimately minimizing the negative effects of headgear, eyewear and poor posture that are staples of the operating environment.

While residents' schedules often do not permit frequent trips to the gym, alternative at-home options such as yoga or Pilates may be considered to further tailor individual fitness-training. By focusing on core strength, these practices may help in injury prevention during times of prolonged contoured posturing. Further, daily stretching should be considered, as it can easily be incorporated into any morning routine.

While it's easy to neglect one's personal fitness, considering the extended hours frequently worked during surgical training, it's also important to recognize that such actions have long-term ramifications on one's ability to practice effectively. With previous studies demonstrating a reduced negative impact on practicing habits in surgeons who were noted to incorporate frequent exercise and stretching into their schedule⁶, it follows that surgeons at every level should strive to make exercise an integral part of their day.

Equipment

In addition to aspects of injury prevention that can only be improved through the actions of the trainee, we must also look to the surgical environment for additional areas to improve upon. Given the fact that loupes and headlamps make up such an integral part of the plastic surgeon's armamentarium, the effects they have upon posture and long-term spinal health warrant discussion.

While it's easy to consider these to be trivial components of the O.R. environment, it has previously been noted that the utilization of both loupes and headlamps may contribute to microsurgions spending as much as 85 percent of operating time with asymmetric head-neck posturing⁴. And while it's difficult to determine a causal relationship between this abnormal posturing and long-term degenerative spinal changes, studies have noted that up to 70 percent of surgeons and dentists who frequently use loupe technology report some degree of neck pain^{3,9}.

Additionally, Sahni, et al., demonstrated that spinal surgeons who reported the frequent use of both loupes and headgear had an increase in both frequency and severity of neck-related symptoms during their years in practice³. While there are currently no studies that evaluate the correlation between headgear or loupe usage and neck pain in plastic surgeons, it's reasonable to suspect outcomes similar to those of previous studies based on comparable rates of equipment utilization. As such, careful consideration is needed in the selection of appropriate eyewear, as well as the frequency of headlamp use.

When selecting loupes for training and beyond, residents should consider overall design, comfort, depth of field and the required field of view for their anticipated usage³. Additionally, special consideration must be given to both the declination angle as well as the working distance of lenses. Both of these factors play a critical

role in maintaining a healthy operating posture, as they contribute to the line of sight of the surgeon³.

If angulation in excess of 25 degrees is frequently sustained, a flexed position is established that can result in a large amount of torsional stress being placed on the cervical spine³. Similarly, this posturing can result with lenses that have an inadequate working distance, as surgeons are forced to manually adjust to ensure proper sight.

The summation of these small differences among currently available products can equate to a very tangible difference in overall outcome, as it has been noted that increasing the flexion angle of the spine from 15-30 degrees results in an additional 13-pound load being placed on the cervical spine¹¹. This strain is further exaggerated by the weight of both loupes and headlamps, as burdensome products may increase this torsional stress to a degree that exceeds the compensatory limits of neck musculature³.

While the all-too-common 15-hour surgery does not elicit the same degree of shock as a violent collision on the football field, it nonetheless wears upon the parties involved.

While some degree of neck flexion is necessary for improving surgeons' sight and reducing eyestrain, these benefits must be weighed against the cost of sustained hyperflexion of long duration. By selecting appropriately suited loupes, trainees can reduce the amount of time spent in these extreme positions – thus minimizing some of the long-term stress placed on the surgeon's cervical spine. Additionally, judicious use of headlamps should be considered depending on the procedure being performed, in an attempt to further minimize this stress.

Technologic advances: wearable devices

As technology continues to rapidly develop, we have seen its adoption across various aspects of medicine. While patient care is the most intuitive application of many newly developed

technologies, it's not unreasonable to consider their potential effects on ergonomics and health safety in the O.R. While constant feedback and development often occur between surgeons and equipment suppliers to improve instrumentation, there are few examples of revolutionary developments with respect to the concept of O.R. ergonomics.

The da Vinci robot system (Intuitive Surgical, Sunnyvale, Calif.) is one such example, as it has resulted in improved ergonomics by allowing surgeons to operate in a fundamentally different manner. This system allows surgeons to remove themselves from the patient's side and operate in a more comfortable sitting position. While this allows for improvement in physical positioning, its use falls into a niche (i.e., laparoscopic surgery) that's rarely occupied by plastic surgeons. As such, an emphasis should be placed not only on therapy-specific technologies, such as the da Vinci robot system, but also

on broadly applicable concepts that benefit surgeons across all fields.

While there's a paucity of evidence substantiating its use, wearable technology has the potential for this type of broad application in the O.R. This rapidly expanding field is currently being adopted across various aspects of our technologically minded culture. Fitness bands are now a common site on the wrists of many individuals – and within the realm of football, players are being fitted with impact-sensing chinstraps that indicate when a player has been subjected to a dangerous amount of force. In much the same way, wearable technology in the O.R. has the potential to provide continuous monitoring as well as real-time feedback regarding the presence of abnormal body posturing.

Products such as ALEX (Nomu, Seoul,

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South Korea) and LUMOback (Lumo Bodytech, Mountain View, Calif.) are two such examples that may find utility in this theoretical domain of real-time injury monitoring and prevention. These products advertise themselves as cervical neck- and lumbar-position monitoring systems, respectively, and while they haven't been validated in human studies, products such as these may offer an affordable and discrete means of protection against the long-term effects of poor body posture.

Changing perception

Proper equipment selection, health awareness and technologic advancements all have the potential to result in a degree of change in the prevention of chronic, degenerative conditions for future surgeons. However, a truly meaningful paradigm shift is only possible if the mindset of those in training and beyond begins to adapt, as well. Historically, the culture of surgical training discouraged reports of stress and fatigue, ultimately facilitating an environment that promoted chronic musculoskeletal problems. While there have been a variety of policy changes enacted to help combat this dogma, the "strong man" mentality still prevails to a degree in the O.R.

Certainly, the history of reported toughness in the surgical arena results in some degree of social conditioning for those currently in training. However, we must also recognize that the apprentice model frequently utilized by training programs promotes a degree of apprehension and compliance in residents. While this isn't to say that the onus of change is focused solely on those at the attending level, we must recognize that a top-down approach to the topic of injury prevention is necessary to truly facilitate lasting change.

During my time playing college football, I witnessed a similar culture that glorified misplaced resilience and ignored the ramifications of such

actions. It was only when the tone of the conversation changed that players began to think differently about concussions and injury prevention. Simply stated, trainees must feel comfortable in asking for an opportunity to adjust positions, take the occasional break or ask for a sitting stool during times of exceptional strain.

In spending time operating with the co-author of this article, I can attest that these seemingly difficult requests become a natural component of the O.R. dynamic when posed by the senior surgeon. By maintaining a vested interest in not only their own health but also the health of trainees, those who oversee the curriculum for plastic surgery residents have the ability to set the path from an early point in their future careers.

Final thoughts

The careers of plastic surgeons and college football players are categorically different. There's almost no risk of sustaining a fracture or concussion while spending time in the O.R. However, the physical risks associated with the environment of a surgeon are nonetheless important to consider for anyone entering the specialty of plastic surgery. Given the duration of training associated with becoming a board-certified plastic surgeon, individuals must seriously consider the controllable risks that may substantially shorten one's career.

While cervical degeneration and peripheral neuropathies may seem inconsequential to the general public, such impairment is detrimental to a surgeon. As such, residents should begin to consider – at an early point in training – the physical manifestations of years of poor operating posture and health negligence.

To facilitate such a change requires a drastic shift in the thinking of those in training and beyond. While there are seemingly few things connecting the game of football and surgical training, we should take pause to evaluate how

concussion prevention is becoming a central focus of the NFL, NCAA and even Pee-Wee Football. In doing so, our hope is that adequate steps will be initiated to re-shape both people's thinking and their actions regarding long-term health maintenance among current and future surgeons.

For just as people are beginning to seriously consider the ramifications of repeatedly running into someone with their head, we should also critically evaluate why such an alarming proportion of surgeons report some degree of musculoskeletal problems of the neck and spine. Change is only facilitated by the effort and actions of many, and it's our hope that we begin to give this issue the attention it deserves both for the protection of today – and for tomorrow's plastic surgeon. **IR**

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