Common injuries in the skilled wrestler

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The most common serious orthopedic injuries suffered by wrestlers involve injury to the cervical spine. There are also significant potential health consequences and time lost from competition due to nonorthopedic problems, especially those related to weight loss issues and skin infections. This review of the literature from the past 2 years is consistent with those topics. Curr Opin Orthop 2003, 14:109–113

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Introduction

Of all sports, amateur wrestling is one of the most physically challenging. The relatively high incidence of injuries reported among wrestlers should come as no surprise [1–4]. Fortunately, the incidence of catastrophic injuries among wrestlers is extremely low. But, the great majority of severe injuries involve head and neck trauma, and it is troubling to note the unusually high number of cervical spine injuries resulting from participation in wrestling [1–4]. The vast majority of these are minor in nature, but data collection in the sport of wrestling has been sporadic at best, so the true scope of the problem is difficult to ascertain.

Wrestling is unique in that nonorthopedic problems also play a significant role in time lost from competition. Wrestling is one of the few sports that require competition by weight class. This adds an additional physiologic stress as wrestlers seek to optimize competitiveness by cutting weight through rapid dehydration, restriction of nutritional intake, and occasionally ergonomic aids or nutritional supplements. Because of the increased amount of skin-to-skin contact between athletes, a significant amount of time also is lost from competition due to various types of skin infections.

The literature from the past 2 years has focused on spine injuries, physiologic effects of wrestling competition and weight loss, creatine supplementation, and skin infections common to wrestlers. This review will discuss those studies.

Spinal injuries

These injuries range from trivial to catastrophic. Recent review articles discussed recommendations for evaluation and treatment of cervical injuries. Luckstead and Patel published a review of pediatric sports injuries [5] that focused on cervical spine injuries. They reinforced the protocol that unconscious athletes should be presumed to have a cervical spine injury until proven otherwise. Appropriate initial treatment includes head and neck immobilization, a physical exam including neurologic evaluation, and cervical radiographs. If the plain radiographs are abnormal, or the patient has neurologic deficits, a CT scan, MRI, or both should be obtained to further define the injury [5]. Further treatment would be dependent on the exact site of injury.

Stingers or burners are common injuries that are characterized by a shocking or painful sensation in the neck with unilateral radicular numbness and burning that most commonly occurs in the C5 and C6 dermatomes. These symptoms are usually transient, lasting only minutes, however, full return to normal may take up to 1 hour [5]. Feinberg [6] emphasized that recurrences of these injuries are common. Diagnosis and treatment are usually based on physical examination. However, in cases with prolonged symptoms or multiple recurrences, radiographs, MRI, and electrodiagnostic testing may aid in localizing and quantifying the neurologic injury. In rare cases, permanent deficits can occur [6]. The authors emphasized that in athletes with bilateral neurologic symptoms, or symptoms associated with transient quadriplegia, spinal cord injury may have occurred. These injuries are potentially more severe and may be associated with cervical spinal stenosis

Cervical spinal stenosis can be associated with cervical cord neuropraxia (CCN). Cervical cord neuropraxia is characterized by transient bilateral motor paresis of the arms, legs, or all four extremities, with radiographic studies that show no evidence of fracture or ligamentous injury. Sensory changes range from burning pain, numbness, and tingling to complete sensory loss. The injury can result from cervical hyperextension, hyperflexion, or axial loading. Causative factors of CCN are congenital or degenerative narrowing of the sagittal diameter of the cervical canal. Three measurable predictors of increased risk for recurrence of CCN are smaller spinal canal to vertebral body ratio (Torg ratio), smaller disc level canal diameter, and less space available for the cord [7]. Boockvar *et al.* [8•] examined 13 pediatric athletes that had CCN injuries, two of whom were wrestlers that sustained hyperflexion injuries. They demonstrated that, unlike skeletally mature athletes, pediatric athletes with CCN injuries do not typically have congenital cervical cord stenosis when measured by the Torg ratio or sagittal canal diameter. They concluded that CCN in children could be attributed to increased mobility of the pediatric spine. The increased flexibility of the pediatric spine was felt to be due to ligamentous laxity, underdeveloped musculature, and immature joints. Therefore, the situation could be improved as the wrestler matures, as body and neck musculature develop and joints and ligaments become more rigid.

In experienced adult wrestlers, developmental and spondylitic narrowing is more common than congenital stenosis, and is more likely responsible for the cervical spinal stenosis. These acquired changes increase narrowing of the space available for the spinal cord and increase the risk for neurologic injury seen during sudden hyperextension or hyperflexion of the cervical spine [8•]. A sagittal canal diameter of less than 14 mm or a Torg ratio less than 0.8 are two measures of significant cervical spinal stenosis [8•].

Cervical spine fractures also occur in wrestling, as illustrated by the case reports by Wu and Lewis [9] that focused on three high school wrestlers who sustained fracture-dislocation traumas to the cervical spine as a result of certain head-holds.

Schnebel [10] recommended criteria for return to play in contact sports following cervical spine injury. Their criteria restricting return to play included: intersegmental instability on flexion-extension radiographs; anterior/posterior glide in the upper cervical spine; cord impingement with myelopathy; significant neurologic impairment or risk of impairment with a herniated disk or obstructing lesion; severe pain; previous spinal fusion; and cervical stenosis associated with transient quadriplegia. Some controversy has arisen from return to play restrictions following transient quadriplegia caused by cervical stenosis. Torg *et al.* [7] found a 56% incidence of recurrent episodes of transient quadriplegia in this setting, but found no cases of permanent neurologic injury. In uncomplicated cases, Torg would allow an athlete to return to contact sports, but this is not universally accepted.

Strengthening of the cervical musculature may help prevent cervical injuries. Tsuyama *et al.* [11] studied cervical extension strength in college wrestlers and judo athletes. Their results indicated that isometric cervical extension strength and cross-sectional area of neck extensor muscles in wrestlers were significantly higher and larger, respectively, than the comparison group of judo athletes. They specifically analyzed the posterior muscle groups shown by previous reports to be most protective during cervical extension: the multifidus, rotator, semispinalis, splenius, longissimus, and trapezius muscles. Tsuyama's paper demonstrates the developed neck musculature in the adult competitive wrestler that likely offers dynamic protection to the cervical spine. The authors do not suggest whether this is adaptive or a result of cervical strength training [11].

Lundin *et al.* [12•] investigated back pain and radiologic changes in the thoracolumbar spine of athletes. This was a long-term follow-up study of an earlier report that demonstrated increased radiographic abnormalities of the thoracolumbar spine among former top athletes. In their recent study of 134 athletes, they found no corresponding increased frequency of back pain compared with nonathletes [12•]. Over the 13-year follow-up period, the only radiographic abnormality that corresponded to increased back pain was a decreased disc height in one or more intervertebral discs. Additionally, there was a significant correlation between the number of deteriorated discs and the incidence and severity of back pain. Back pain was labeled as severe if the athlete was unable to work at any time in the previous 3 years or if it affected daily living. Severe back pain was more common in wrestlers than in both the nonathletes and the other athlete groups. Fifty-four percent of wrestlers reported severe back pain. The authors did not specifically report on the incidence of disc height reduction in the wrestlers. Of interest was that more than 50% (range 50% to 68%) of all groups, both athletes and nonathletes, reported moderate or severe back pain. Moderate back pain was defined as back pain that did not affect work or daily living.

Spondylolysis and spondylolisthesis are known common causes of back pain in athletes. The Italian Olympic Committee's Department of Sport's Medicine reported an incidence of these disorders in up to 30% of wrestlers [13]. These disorders are associated with athletes who experience repeated hyperextension of the spinal column [14]. However, there are many athletes that have asymptomatic spondylolysis or spondylolisthesis, and in the recent study by Lundin *et al.* [12•], they found no correlation between back pain and spondylolysis or spondylolisthesis. In addition, there were only two athletes who had a measurable progression of their slip.

Wrestling physiology/weight loss

The physiologic responses and profiles of elite wrestlers have received much attention in recent years. Yoon [15] reported that upper body strength and anaerobic power were significantly different between successful and unsuccessful wrestlers. Kraemer *et al.* [16•] reported on the physiologic effects of tournament style wrestling in experienced wrestlers competing for the Olympic freestyle team (members of the Pennsylvania State University varsity wrestling team). This was a novel study that assessed the affects of weight loss of 6% body mass during the week preceding a simulated freestyle wrestling tournament that consisted of five matches over 2 days. They found that lower body power and isometric strength both significantly decreased as the tournament progressed. They also found that testosterone, cortisol, norepinephrine, plasma osmolarity, and lactate levels all increased significantly after each match versus prematch baselines. Of specific interest was the finding that resting baseline levels of plasma osmolarity, which were taken 3 to 4 weeks after the regular season, were higher than the normal 280 to 285 mOsm/kg, indicating that elite college wrestlers may be in a chronic state of dehydration [16•]. The immediate postmatch average of 320 mOsm/kg illustrated that these wrestlers perform at extreme hyperosmotic levels [16•]. The testosterone levels also provided interesting data. Despite the match induced increase in testosterone blood levels, there was a significant decrease in prematch resting serum testosterone concentrations throughout the tournament. In fact, levels fell to below the age matched control normal range of 20 to 25 nmol/l. By the final match on day two, the mean value was just higher than 12 nmol/l, for which the authors point out is in the range of prepubescent boys; an affect which may compromise the anabolic recovery functions of testosterone [16•].

Both aerobic and anaerobic energy is expended during a typical wrestling match. While aerobic energy contributes to the sustained endurance, anaerobic energy provides the short, quick, and explosive bursts of power [17]. The elite wrestler generates great anaerobic power with high muscular endurance. The large amount of anaerobic energy expenditure during a match generates high levels of lactic acid within the muscle tissue [15,16•]. Measurements of blood lactate concentrations have been used to follow anaerobic power and capacity in successful wrestlers [15,17]. High muscle endurance may be related to both efficient anaerobic glycolysis and high lactate tolerance. Lactate tolerance may be improved by an increased blood buffering capacity or increased pain thresholds in these elite wrestlers [15]. When performance is required with the added stress of weight reduction, by fluid and nutritional restriction, there is likely a decrease in the glycogen stores of muscle and liver. This could explain Kraemer's findings of decreased physical performance as measured by decreased vertical jump, grip strength, and force produced in a 'bear hug' test [16•]. A recent study has shown that elite wrestlers can improve their anaerobic work capacity and can reduce their serum lactate levels through intense training [17]. The rate at which the athlete fatigued was diminished in this study. However, this study did not address the stress of pre-event weight loss, or the psychological or emotional stresses of tournament-style competition. These variables likely decrease endurance and increase the athlete's subjective fatigue rating [16•]. Over-training and prolonged weight reduction may impair the wrestler's ability to quickly recover and prepare for tournament competition at the end of the season [15].

Yoon [15] outlines the optimal body composition of successful wrestlers. The mesomorphic physique is typical, with highly muscular, lower height, and low-fat body types. He points out that world champions usually have less than 10% body fat. This is not necessarily a result of weight reduction, but more a result of strengthening and 'bulking-up' [15]. Differences in wrestler's muscle mass, neuromuscular recruitment and composition, and muscle fiber type also likely play a role in the ability to generate anaerobic power and may affect success rates [15]. Ideally, proper nutrition and training should be employed to maximize lean muscle and maintain 7% to 10% body fat [15].

In an effort to make weight, some wrestlers at all levels practice potentially dangerous methods of rapid and extreme weight loss. Kiningham and Gorenflo [18•] demonstrate the large percentage of high school wrestlers who engage in potentially harmful weight loss measures. Wrestlers commonly seek to gain a competitive advantage by dramatic weight reductions. This is done over a short period of time and largely by dehydration [18•]. In this large series of 2,532 Michigan high school wrestlers, 72% reported that they engaged in at least one potentially harmful weight loss method per week of the season, with a mean of two per week per wrestler [18•]. Fasting and dehydration techniques were the most common methods reported, with diet pills, laxatives, and diuretics in 2%, and vomiting in 2%. Sixty-two percent of the wrestlers reported losing over five pounds in the five days before a match. The potentially harmful weight loss techniques were found to be common at all grades and success levels [18•]. These dangerous weight loss methods are not limited to the high school levels. It was reported that a rapid dehydration method was used to lose 5.8% total body weight by a wrestler in the week before competing in the Olympic trials [17]. In 1997, three collegiate level wrestlers died as a result of similar weight loss methods as those noted above [18•].

The NCAA recently implemented a wrestling weight certification program (WWCP) as a result of these three collegiate wrestler's deaths. The program mandates that an initial weight class be certified for each wrestler based upon body mass, body composition, and specific gravity of urine (SG). This program outlines five rules to promote a safe competitive environment [19]:

1. Establish a weight class system that better reflects the wrestling population.
2. Establish a permanent healthy weight class early in the season.
3. Hold weigh-ins as close to the match as possible.
4. Hold weigh-ins on each day for multi-day events.
5. Eliminate tools that cause rapid dehydration.

One NCAA Division I wrestling program participated in a study following the outline of the WWCP. Hydrated body weight, urine specific gravity (SG), and body density were measured during the preseason. Calculations were then made to determine percent of body fat, fat weight, and fat free weight (FFW). The lowest allowable weight (LAW1) was determined by FFW plus 5% for body fat. The final certified body weight was calculated by allowing a maximum weight loss of 1.5% of original body weight per week until the first competition of the season (LAW2). The final certified weight class (CWC) was the greater of LAW1 and LAW2. The first year under these guidelines, the wrestlers underwent the typical rapid weight loss over the first week of the season, and then experienced a rebound weight gain the following week. They cycled their weight this way throughout year. The wrestlers lost a similar total weight when comparing the first and second years studied. However, by the second year they had begun to maintain or lose weight more steadily within the limits of the established CWC. Urine SG was used to verify euhydration. One interesting finding was that about 20% of wrestlers in both years continued to attempt to 'make weight' for the WWCP with the addition of dehydration. These wrestlers failed to meet the required SG of 1.020 or below even when they were aware this would be monitored to verify euhydration. This group all made the minimum SG standard within 48 hours when retested and were then allowed to complete the WWCP [19].

Utter [20] looked at the affects of the WWCP and changes in body compositions in wrestlers. In particular the fluctuations in body mass, percent body fat, fat free mass (FFM) and hydration status were evaluated at four times throughout the season (preseason, beginning of season, peak season just before the NCAA championships, and postseason). They found less seasonal decrease in body weight and less FFM loss as compared with previous seasons before the WWCP. Comparisons were also made between the starters and nonstarters on the team. Starting wrestlers lost most of their fat mass in the beginning of the season and were able to maintain their body fat through the season. Starters maintained their FFM while nonstarters gained FFM. The author's speculated that wrestlers were able to maintain FFM due to the improved weight management as a result of the new WWCP regulations.

Many wrestlers begin training and competing at a young age. Cutting weight during or before puberty has the possibility of affecting growth. Growth hormone (GH), insulin growth factor (IGF-1), and the hypothalamic-pituitary-gonadal (HPG) axis are important regulators of growth and pubertal maturation [21•]. Under-nutrition disrupts the HPG axis and induces a relative GH resistance (through GH-IGF-1 axis disruption) [21•]. Roemmich *et al.* examined testosterone levels and FFM in skeletally immature wrestlers and found that both decreased by late season but then quickly increased to reach control levels at the end of the season [21•]. However, skeletal maturation and height of wrestlers was similar to controls both during and after the season [21•]. So it would appear that despite the temporary in-season hormonal alterations, linear bone growth and pubertal maturation are not affected [21•]. The authors suggest that the season is followed by a long period of up to 9 months of resumed adequate nutrition. The season of undernutrition may not be long enough to slow growth or decrease the final height of wrestlers [21•]. This may be different for those highly competitive young wrestlers that chronically compete at a controlled weight during the offseason.

Immune responses/skin infections

Weight loss and intensive exercise can have detrimental effects on the immune system. This was demonstrated in a study by Imai *et al.* [22]. They compared the immune functions between amateur wrestlers experiencing weight loss and those without weight loss after similar intensive exercise training. Rapid weight loss (average

7% in 1 month) was found to decrease interferon-gamma production and to compromise T-cell response to anti-CD3 antibody. Weight loss did not appear to affect T-cell response to bacterial superantigen (staphylococcal enterotoxin B and streptococcal pyrogenic exotoxin A). The hyporesponsiveness returned to normal 2 months after the tournament when the wrestlers weight also returned to normal. This implies that these wrestlers may be susceptible to viral infections [22]. This may explain why wrestlers are frequently infected with herpes viral infections, common colds, and keratoconjunctivitis [22].

Skin infections in wrestlers are common. Impetigo and herpes simplex epidemics are well recognized. Due to the skin-to-skin contact of wrestlers these infections are transmitted readily once present in the wrestling training room. Tinea corporis gladiatorum is a dermatophyte that has received more attention recently. The prevalence has been reported in 10 studies to range from 20% to 77% [23]. Often, teams are not aware of the epidemic. The most common organisms isolated from lesions are *Trichophyton tonsurans* (40%), *T. rubrum* (40%), and *Microsporum canis* (14%) [23]. The lesions are well defined and erythematous with papules and plaques. The most common locations in wrestlers are the head, neck, and arms. Early lesions may be difficult to distinguish from early herpes gladiatorum, atopic dermatitis, acneiform papules, and early impetigo [23]. It is believed that skin-to-skin contact is the route of transmission. Wrestling mats may not play a direct role as lesions are rarely found on the lower extremities [23]. Skin inspection plus a positive potassium hydroxide test or fungal cultures confirm the diagnosis. No uniform protocol has been established for treatment of Tinea corporis gladiatorum or the length of time restricting participation in competition. Adams [23] recommends the following: 1) solitary lesions should be treated with a topical fungicidal agent, clotrimazole twice daily for 1 to 2 weeks and potentially a new antifungal, terbinafine may prove to hasten treatment using topical agents; 2) the wrestler may be allowed to practice if the lesion can be easily bandaged; 3) interscholastic or intercollegiate competition may be resumed safely after 1 week of topical treatment; and 4) wrestlers with multiple lesions may benefit from adding an oral antifungal agents such as fluconazole 200 mg for up to 4 weeks.

Conclusions

The physician caring for wrestlers must be alert to potential cervical spine injuries and be prepared to handle them appropriately. In addition, one must be aware of the potential for serious health problems associated with weight loss, especially severe and rapid dehydration. Preliminary studies appear to show that recent rule changes on limited rapid weight loss are having a positive effect. And finally, the physician must be vigilant in diagnosing and treating skin infections that can rapidly spread to other wrestlers.

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