Impact of CrossFit-Related Spinal Injuries

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Abstract

Introduction: Exercise-related injuries (ERIs) are a common cause of nonfatal emergency department and hospital visits. CrossFit is a high-intensity workout regimen whose popularity has grown rapidly. However, ERIs due to CrossFit remained under investigated. **Methods:** All patients who presented to the main hospital at a major academic center complaining of an injury sustained performing CrossFit between June 2010 and June 2016 were identified. Injuries were classified by anatomical location (eg, knee, spine). For patients with spinal injuries, data were collected including age, sex, body mass index (BMI), CrossFit experience level, symptom duration, type of symptoms, type of clinic presentation, cause of injury, objective neurological examination findings, imaging type, number of clinic visits, and treatments prescribed. **Results:** Four hundred ninety-eight patients with 523 CrossFit-related injuries were identified. Spine injuries were the most common injuries identified, accounting for 20.9%. Among spine injuries, the most common location of injury was the lumbar spine (83.1%). Average symptom duration was 6.4 months ± 15.1, and radicular complaints were the most common symptom (53%). A total of 30 (32%) patients had positive findings on neurologic examination. Six patients (6.7%) required surgical intervention for treatment after failing an average of 9.66 months of conservative treatment. There was no difference in age, sex, BMI, or duration of symptoms of patients requiring surgery with those who did not. **Conclusions:** CrossFit is a popular, high-intensity style workout with the potential to injure its participants. Spine injuries were the most common type of injury observed and frequently required surgical intervention.

Key Words: CrossFit, sports medicine, spine injury, spine surgery, exercise-related injury

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INTRODUCTION

Exercise-related injuries (ERIs) are a common cause of nonfatal emergency department and hospital visits.[1] In the United States alone, up to 7 million ERIs are treated annually, with over 4.3 million of these representing visits to the emergency department.[2,3] Similarly, the number of new and creative exercise modalities continues to grow faster than ever before, with an industry-wide revenue of roughly $24.2 billion yearly.[4,5] As such, an appropriate understanding of ERI is complicated by the constant introduction of new, potentially high-impact, exercise modalities.[1,6–12] There remains a need for physicians to understand the associated risks with "cult-like" exercise programs that may predispose injuries to patients.

Among the most popular and rapidly growing high-intensity style workout routines is CrossFit, with an estimated 2 to 4 million participants worldwide.[13] This program involves heavy and rapid weight-lifting, gymnastics, pull-ups, and rope climbing combined into short, repetitive, high-intensity workouts.[14,15] Since its commercial release in 2000, CrossFit has grown rapidly and has been adopted by many military and civilian sport gyms worldwide with an estimated 13 000 affiliate gyms.[13] CrossFit's appeals, such as fitness gains, decreased blood pressure, lower resting heart rates, increased aerobic capacity and associated weight loss, and have led to widespread adoption of its program.[15–21]

Although numerous health benefits have been documented, injury risks have also become a relevant concern.[15,22–27] The intensity and high-impact nature of CrossFit has led to an injury rate reported as high as 20% to 73%[15,23] ranging from muscle tears to exercise-induced rhabdomyolysis.[15,22–27] Retrospective studies have even suggested that as many as 7% of documented CrossFit injuries go on to require surgical intervention.[15,23]

Of particular relevance, due to longevity of symptoms and high costs associated with medical treatments are exercise-related spinal injuries. These injuries occur frequently in exercise settings, particularly in those involving high-intensity weights, with reported injury rates as high as 23.1%.[28] Participants must be aware of the potential risks associated with involvement in new exercise modalities, as such risks are rarely publicized or known to the inexperienced participant. The purpose of this study is to examine the type of injuries that occur with high-intensity CrossFit workouts that may perhaps lead to preventative measures for future injury.

MATERIALS AND METHODS

All patients who presented to a major academic center complaining of an injury sustained performing CrossFit between June 2010 and June 2016 were identified using the Electronic Data Warehouse, which is a clinical data

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repository. Institutional review board approval was given for retrospective review, and a comprehensive query of all archived medical records containing the key phrases "CrossFit," "crossfit," "Crossfit," or "cross fit" was run. The key phrase search contained all provider notes, including a variety of specialties all associated with the medical institution. Patient initial presentation location was also classified as either the hospital's emergency department or outpatient clinics. Specialties evaluating injuries included Neurosurgery, Orthopedic Surgery, Physical Medicine and Rehabilitation, and Sports Medicine. Those presenting with spine-related complaints were further evaluated by 1 of the 5 neurosurgeons, or 1 of the 3 orthopedic surgeons at our institution who specialize in treating spinal disorders. Initially, 955 unique patients were identified having 1926 associated medical records all containing one of the mentioned key phrases. Records were reviewed, and all patients were selected who had sustained injuries associated with the mention of concurrent CrossFit participation. Reports of patients were excluded if they either had no chief complaint or had complaints unrelated to participation in CrossFit exercise. Patients with injuries known to have been sustained outside CrossFit were further excluded. A total of 498 patients with 523 injuries sustained from CrossFit met the inclusion criteria of this study (Table 1). Eighty-nine patients were further identified, having 89 distinct spinal injuries. Patients with self-reported spinal injuries, demographic data such as age, sex, body mass index (BMI), CrossFit experience level, symptom duration, type of symptoms, type of clinic presentation, cause of injury, objective neurological exam findings, imaging type, number of clinic visits, and treatments prescribed were collected. Radiculopathy was defined as the subjective mention of pain radiation down either an upper or lower extremity.

TABLE 1. Distribution of CrossFit-Related Injuries

	Count (%)
Overall injury type (n = 523)	
Musculoskeletal	426 (81.5)
Cardiopulmonary complaints	36 (6.9)
Other neurologic complaints*	32 (6.1)
Other injuries/conditions†	29 (5.5)
Musculoskeletal injury type (n = 426)	
Spine	89 (20.9)
Shoulder	78 (18.3)
Knee	66 (15.5)
Gluteal region	27 (6.3)
Elbow	24 (5.6)
Leg	24 (5.6)
Wrist	18 (4.2)
Ankle	16 (3.8)
Foot	15 (3.5)
Hand	12 (2.8)
Other musculoskeletal‡	38 (8.9)

** Headaches, migraines, weakness, paresthesia.*
† Rhabdomyolysis, ocular dysfunction, abdominal pain, pulmonary symptoms, scrotal inflammation, proteinuria, dehydration.
‡ Groin, fingers, arm, musculoskeletal chest pain.

Microsoft Excel 2011 (Microsoft, Redmond, Washington) was used to conduct all statistical analyses. Parametric data were given as mean ± SD. T tests were run to compare patients requiring surgical intervention with those not needing intervention. Variables run include age, sex, duration of symptoms, and number of clinic visits. A value of $P < 0.05$ was considered statistically significant.

RESULTS

In our cohort, most patients were evaluated for musculoskeletal injuries (81.5%) with spine and shoulder injuries being the most common (20.9% and 18.3%, respectively). Patient demographics and clinical characteristics for patients sustaining spinal injuries are shown in Table 2. The mean age and BMI were 37.1 ± 8.9 years and 26.8 ± 4.8, respectively. The most common location of injury was the lumbar spine (83.1%) with radicular complaints in 53%, and an average symptom duration was 6.4 months ± 15.1. A total of 30 (32%) patients had positive findings on neurologic examination including, but not limited to positive straight leg tests, positive seated slump tests, decreased sensation, or motor function. Most patients received no imaging (49.5%), with the most commonly chosen imaging modality being magnetic resonance imaging (28.4%). There was no significant difference in subjective duration of symptoms for those patients presenting initially to the emergency department as compared to those presenting initially to an outpatient clinic.

The most commonly prescribed treatment for spine injuries was physical therapy, which was prescribed to 36 (40.4%)

TABLE 2. Patient Demographics and Clinical Characteristics (n = 89)

Patient Characteristics	
Age, yr	37.2 ± 8.9
Sex (male)	51 (57.3)
BMI	26.8 ± 4.8
CrossFit experience	
Beginner	8 (9.0)
Experienced	9 (10.1)
Unknown	72 (80.9)
No. of clinic visits	2.7 ± 3.5
Type of presentation	
Emergency department	12 (13.5)
Outpatient	77 (86.5)
Location of injury	
Cervical	15 (16.9)
Lumbar	74 (83.1)
Duration of symptoms	6.4 ± 15.1
Radiculopathy present?	47 (52.8)
Objective neurologic findings?	30 (32)
Imaging performed?	
Magnetic resonance imaging	25 (28.1)
Radiograph	16 (18.0)
Both	5 (5.6)
None	45 (50.6)

All values reported as mean ± SD or value (%).

patients (Table 3). Surgery consultation was recommended for 9 (10.1%) of the patients presenting. A total of 6 patients (6.7%) of the initial 89 underwent surgical intervention for treatment after failing to respond to nonsurgical intervention. Surgical characteristics and demographics for these 6 patients are further shown in Table 4. The most commonly performed procedure was a lumbar diskectomy. For those undergoing surgery, the average length of conservative treatment was 9.57 months. There was no difference in age, sex, BMI, or duration of symptoms of patients requiring surgery with those who did not, with *P* values of 0.52, 0.50, 0.57, and 0.51, respectively. The group requiring surgical intervention had significantly more clinic visits associated with their injury than the group not requiring surgery ($P < 4.4$ E -09). Each surgical patient showed degrees of symptomatic improvement postoperatively. Spine surgery did not disqualify patients from CrossFit, with a recommended return to play of 3 months for patients undergoing decompression surgery (microdiskectomy and laminectomy) and 1 year for patients undergoing fusion surgery.

DISCUSSION

CrossFit is a form of exercise that is growing exponentially in popularity. CrossFit's high-intensity workout style, while providing many benefits to participants,[16,18–21] may lead to various injuries. In the current study, we performed a comprehensive retrospective chart review of all patients with CrossFit-related chief complaints over the past 6 years at a single institution. Such injuries provide potential needs for risky and costly treatments ranging from hospitalization to invasive surgical management. To our knowledge, this is the first study to date in which a large cohort of patients all experiencing CrossFit-related injuries or complaints was assessed and analyzed.

Our study shows the most common injury to be spinal injuries consisting of 20.9% of all reported injuries. Of these spinal injuries, the lumbar region was the most commonly injured reporting 83.1% of all spine injuries. The average duration of symptoms was 6.4 ± 15.1 months, and the average number of associated clinic visits was 2.7 ± 3.5. Although the most commonly prescribed treatment modality was physical therapy (40.4%), surgery was required in 6 patients (6.7%). The surgical group required more clinic visits than the nonsurgical group ($P < 4.4$ E-09) as would be expected due likely to the severity and complexity of injuries sustained.

Multiple studies[26] have reported the lower back and the shoulder regions as the most prevalent locations of ERI. It has been further shown that athletes are at an increased risk of lumbar spine injuries as compared to the general population.[29] For instance volleyball, basketball, or golf report rates of 0.9%, 4.7%, and 11%, respectively.[30–32] Other contact sport injury rates vary, with rates as low as 9% in adolescent ice hockey, to higher, more variable ranges of 11.4% to 32% in competitive rugby.[33,34] Moreover, sports noted to have an increased risk of disk herniation include wrestling, rowing, ballet, diving, swimming, running, and baseball.[29] Furthermore, the injury patterns for the spine, particularly those of the lower back, seem to reflect those of other high-intensity competitive weight lifters as described in previous studies.[26,28] Raske and Norlin[26] documents the proportion of lumbar spine injuries in elite power lifters as ranging from 17% to 27%. CrossFit's unique focus on high repetition and speed, in contrast to other forms of powerlifting, allows for seemingly simple maneuvers to become very risky. The location of the injuries affecting the lower lumbar spine is most probably due to the axial loading that CrossFit exercises entail namely in squats and dead lifts. Both dead lifts and squats require the thoracic and lumbar spine to remain inline and neutral throughout each repetition. Throughout an entire workout, fatigue can make keeping technique especially difficult. Because of the heavy axial load, and high repetition, even minor lapses in form such as a slight forward flexion are susceptible to increased intradiscal pressure and disk herniation.[23]

Lumbar disk herniation has been further shown to have worse associated clinical outcomes in elite athletes than in the general public.[35] As such, treatment choice and outcomes are of utmost importance to maximize return to play and overall quality of life. Although most of our reported injuries were treated successfully conservatively, some ultimately required surgical intervention at a rate of 6.7% with a decompression being the most common operation. However, some patients required fusion surgeries to relieve their symptoms. This rate is very similar to the rate reported by Hak et al[23] in a survey study of CrossFit injuries, documenting a surgical intervention rate of 7%. Risk factors for development of such injuries continue to remain unknown and unpredictable, further adding to the need for awareness.

Our reported rate of surgery reflects only those patients needing medical attention. As a result, the true incidence of CrossFit injuries requiring surgical intervention among the entire population of participants is likely lower and potentially less concerning. Further surveys or prospective studies are needed to better elucidate the true incidence and subsequent significance of such injuries to current and new participants alike.

TABLE 3. Treatment Characteristics (n = 89)

Treatments Recommended/Prescribed	Value (%)
Nonsteroidal anti-inflammatory drugs*	25 (28.1)
Steroids	9 (10.1)
Physical therapy	36 (40.4)
Rest	17 (19.1)
Injections	11 (12.4)
Surgery	9 (10.1)
Other pain medication*	6 (6.7)
Patients undergoing surgical intervention	6 (6.7)
No surgical intervention	83 (93.2)

** Prescription medications only.*

TABLE 4. Surgical Characteristics (n = 6)

Age	Sex	Period of Conservative Treatment, d	Procedure
50	F	52	C6-C7 anterior cervical diskectomy and fusion
28	M	105	L5-S1 diskectomy
38	M	191	L5-S1 diskectomy
20	F	Unknown*	L3-4 and L5-S1 diskectomy
30	F	268	L4-L5 diskectomy
46	M	819	L5-S1 diskectomy

** Procedure performed at an outside institution.*

Having identified such risk, preventative measures need be implemented to hopefully reduce the incidence of associated spinal injuries. CrossFit culture emphasizes extremely physically demanding workouts from the very first experience. As such, new participants are often not in the appropriate physical condition required to keep up with the demands of even the most basic classes. This makes allowing for proper focus devoted to maintaining appropriate technique while keeping up with class structure difficult. As such, participants must begin CrossFit participation gradually, with more emphasis being placed on proper technique and slow adjustment. Workout regimens tailored to an individual's own fitness and skill level should be recommended over those designed for a group effort. Furthermore, CrossFit's attention to aerobic fitness, while beneficial in many aspects, often allows for neglect of the required strengthening required to prevent injury.[23] Research has further suggested that developing a strong abdominal core can help prevent fatigue and allow for more stability to the spine during potentially high-risk exercises.[36] Core stability can help maintain neutral spinal alignment and optimal position during the transfer of heavy spinal loads.[36] It can further be recommended that, before beginning CrossFit participation, core strengthening exercises be done to further reduce risks and hopefully prevent the need for surgical intervention.

Our study has several limitations. Because of its retrospective nature, this study is subject to bias. As there is no control group in our study, our study was descriptive and cannot identify predictors of injury. Furthermore, the specific mechanism of injury is a relevant but absent variable that would enhance our understanding of the problem. Loss to follow-up was also high, with specific relevant variables often absent in follow-up medical records. This made it difficult to determine return to participation time, whether patients were compliant with recommended treatment or even whether participants continued to participate in CrossFit after injury. The next step may include case–control series that can identify risk factors, including specific workout routines and behaviors that are specifically associated with the development of injuries.

CONCLUSIONS

CrossFit is a popular, high-intensity style workout with the potential to injure its participants. Spine injuries were the most common type of injury observed, with some requiring surgical intervention.

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