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ATYPICAL ACUTE INJURIES IN POWERLIFTING – REVIEW

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Abstract

Powerlifting has been gaining increasing popularity among professionals and amateurs. This sport consists of three events - barbell squat, bench press, and deadlift - where maximum strength in a single repetition is assessed. Powerlifters experience both acute and overuse injuries. Among typical injuries, one can distinguish biceps femoris, quadriceps femoris, or pectoralis major rupture during the deadlift; pectoralis major or triceps brachii rupture and humerus dislocation during the bench press; and quadriceps or biceps femoris ruptures and spiral fractures of the tibia and fibula in the squat. Among atypical injuries, clavicle, scaphoid, talus, acetabular, and avulsion fractures, like Clay-Shoveler's, are notable. Most atypical injuries are treated conservatively through immobilization. Proper technique, accurate body posture, adequate warm-up, joint mobility enhancement, and appropriate weight selection with gradual increases can help prevent or reduce the frequency of injuries in powerlifting. Injuries are more common among novice powerlifters, with a predominance of males. Muscle strains are the most frequent traumas.
The main aim of the paper is to summarize atypical acute injuries in powerlifters, including clavicle, scaphoid, talus and acetabular fractures, and also avulsion fractures like Clay-Shoveler's type.

Key words: powerlifting, injury, orthopedics, sports

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Introduction

Weight training is an activity that has recently been gaining popularity worldwide [1]. It enhances strength, muscle hypertrophy and endurance, and is beneficial for both professional and recreational athletes [2], [3]. Some weight training disciplines are weightlifting, powerlifting, CrossFit, strong man, bodybuilding and Highland Games [2], [3]. Powerlifting is a strength sport comprising three events: barbell squat (SQ), bench press (BP) and deadlift (DL). The performance is assessed based on maximal muscular strength presented in single repetition in all three events [4]–[6]. The International Powerlifting Federation (IPF) is an organization established in 1972 to govern the sport of powerlifting and bring together federations from various countries. Since 2012, the IPF has been offering powerlifting competitions in two variations: classic (RAW) and equipped (EQ), the latter involving the use of supportive gear to enhance the performance [5]. Supportive equipment utilized in the equipped division includes squat and deadlift suits, a bench press shirt, and knee wraps for deadlifting [4], [5]. The raw category allows the use of knee sleeves, wrist wraps and belts [7]. A study conducted by Wilk et al. examined the performances of world record holders and champions of both sexes and revealed that the use of the compressive gear in EQ division indicated visibly better results in the squat and bench press events, comparing to RAW performances, for both men and women. The study did not reveal any significant changes in world records of deadlift between these categories [4]. The general impression is that compressive gear allows maximal weight lifted to be increased by competitors of both sexes [4].

Powerlifting athletes are categorized based on age and weight class. In each of the three disciplines (squat, deadlift, and bench press), competitors make three attempts using the maximum weight in a single repetition while adhering to the specific rules of the event, according to the technical rule book [7]. Each lift is assessed by three referees, and a positive mark from two of them is needed to accept the attempt [7]. Winners in each category are determined by totalling the maximum weight lifted across the three events [5]. There are special formulas to compensate for the relation between bodyweight to maximum strength. Previously the validated Wilks formula, implemented in 1995, was used. In 2019, the new IPF formula was introduced and replaced the previous method [5]. This formula enables the identification of the overall winner [7].

Among typical squat-related injuries one can distinguish quadriceps or biceps femoris ruptures and spiral fractures of tibia and fibula [8], [9]. The most common injuries occurring during bench pressing include pectoralis major or triceps brachii ruptures, humerus dislocation – both anterior and posterior [8]. There is a risk of bone fractures when performing the bench

press – such as rib, scaphoid, distal radius or clavicle fracture, but they are less common [8]. Deadlifting may cause injuries such as biceps femoris or pectoralis major ruptures [8].

Material and methods

For the purpose of this review, a manual search was done in March 2024. The paper is based on scientific publications available in PubMed, NCBI and Google Scholar databases. The keywords such as "powerlifting injury", "powerlifting trauma" were used. 63 articles were identified. Duplicates and irrelevant papers were removed. Papers in languages other than English were excluded. After the initial evaluation of articles, titles and abstracts, papers were selected and analysed by full text, considering their references. Five studies were included to the review. The main criteria for including publications to our work was if they raise the problem of atypical acute injuries in powerlifters. Papers describing typical, chronic or fatigue injuries were excluded. Articles about paralympic powerlifters were also removed from the review.

Acute Injuries in Powerlifting

In weightlifters, both acute and chronic injuries occur, and the factors that trigger them can be both internal and external [8]. Among acute injuries, soft tissue injuries are most common, but fractures can also be present. It is worth mentioning that weightlifters often continue training despite injuries [10]. The table below presents a brief overview of selected atypical acute injuries in weightlifters [9], [11]–[14]. Clay-Shovelers's fracture is an avulsion fracture of the spinous process of a lower cervical or upper thoracic vertebra, typical for deadlift or squat, especially if performed incorrectly [11].

Table 1. Brief summary of selected atypical acute injuries in powerlifters (M - male).

Study	Patient's data (age, sex)	Injury	Exercise and weight	Management	Comments
Herrick, 1981	34, M	Clay-Shoveler's fracture while putting the barbell back on the rack	SQ (200 kg in 4th set, 8th repetition)	Not stated	Re-racking barbell after squatting makes the perfect position for avulsion of the spinous processus by muscle contraction
Karnes, 2015	25, M	Acetabular fracture of the right hip – transverse and dislocated	DL (530 lb = approx. 240 kg)	Open reduction with internal fixation	Patient presented low serum calcium and vitamin D levels
Gill and Mbubaegbu, 2004	28, M	Clavicle fracture	BP (60 kg)	Conservative treatment in a cuff and collar sling	
Mason, 2015	21, M	Scaphoid fracture	BP (weight not stated)	Conservative treatment – 6 weeks immobilization in a cast, next 6 weeks immobilized in thumb spica splint	
Mannis, 1983	17, M	Talus fracture (transchondral fracture of the dome of the bone)	SQ (300 lb = approx. 136 kg)	Conservative with 6 weeks immobilization in a short leg cast	

In the literature, most of the case studies and case series describe typical injuries for powerlifters, such as common muscle or tendon ruptures or shoulder dislocation. Studies included in the table revealed that all of the described injuries affected young males 17-34. Two of the mentioned injuries occurred during the squat, one during the deadlift, and during the bench press; also two cases of acute injury were documented. Injuries affecting the upper limb, such as scaphoid and clavicle fractures were treated conservatively [12], [13]. Acetabular fracture, which happened to be transverse and displaced, was fixed surgically [14]. This severe trauma was also connected with the patient's low serum calcium and vitamin D levels which could have contributed to changes in the structure of his bone and a decrease in its integrity. This patient had previously experienced pain in the area of the right hip joint but did not seek medical attention [14].

Discussion

Both professional and amateur athletes experience pain and injuries during their powerlifting trainings or competitions. Such experiences are in most cases connected with multiple joints involvement, wide range of motions, heavy weights and extensive weekly training loads, inaccurate rest time or incorrect technique [8]. Traumas are more frequent in beginner lifters [15]. Female athletes seem to have lower injury rates than male ones – 1.3 per year, comparing to 2.1 per year in male participants [2]. In the literature one can find evidence that women are more likely to suffer from injuries located in the neck, hand and wrist area, and they generally tend to be injured earlier in life than men [2], [8], [16]. Men more frequently experience traumas of the chest and thighs [2], [8]. Elite athletes are reported to suffer from the upper extremity injuries most frequently – such as shoulder, elbow and hand-wrist area traumas [8]. A study of the literature revealed that in powerlifting the traumas affects the shoulder, back – especially the lower parts, elbow, chest and knee areas most commonly [2], [17]. On the other hand, knee injuries tend to be less frequent in powerlifters than in weightlifters [2]. Injuries of the shoulder are typically overuse traumas, caused by repeated strain, mostly when bench pressing [15]. The most common injuries among powerlifters are muscle strain – this kind of trauma is common among athletes lifting heavy loads, also in weightlifting and strongmen. The occurrence is estimated as 6-62% [2]. The safety of powerlifting performance may be enhanced by a gradual implementation of higher loads, proper recovery and maintaining correct technique while performing exercises [15].
Powerlifters can suffer from both acute and fatigue injuries [8]. Keogh et al. assessed 101 powerlifters of both sexes and reported that their traumas were rather acute (59%) than chronic [18]. Stromback and co-workers examined 90 powerlifters and 41.1% of them reported acute injury connected with the sport [16]. It is worth mentioning that powerlifters more frequently suffer from muscle and tendon injuries [17]. According to previous studies, approximately 22%–32% of injuries are associated with the squat, 18%–46% with the bench press, and 12%–31% with the deadlift [8]. In the research conducted by Stromback and colleagues, 43% of injuries originated during squat training, 27% during bench press exercises, and 31% during deadlift sessions. As for injuries sustained during competitions, the respective occurrences were 3% for the squat, 4% for the bench press, and 7% for the deadlift [16]. It is worth noticing that there is a limited evidence to establish a clear reference between the three powerlifting exercises and injuries specific for them [8]. A study conducted by Aasa and colleagues assessed injury incidence in powerlifting as 1.0-4.4/1000 hours of training [17]. Researchers also stated that the risk of injury in powerlifting is comparable to the risk in other non-contact sports [17]. The risk is estimated as lower compared to contact and team sports [2].

The main groups of muscles engaged in the squat are the back and hip extensors, hip adductors, hip abductors, knee extensors and ankle plantar flexors. When performing a bench press, the pectoralis major, triceps brachii and the anterior deltoid muscles are involved. When deadlifting, the muscles of the hip, knee and back extensors are working [8]. It is worth remembering that two techniques of the deadlift are allowed – classic, with the narrow feet position and hands placed on the barbell on the outside of the knees, and sumo, when feet are positioned in a wide stance and hands located in the inside of the knee joints [8].

A study conducted by Ferland and co-workers in 2023 assessed the influence of body composition on powerlifting performance. They measured Bone Mineral Content (BMC), Bone Mineral Density (BMD), Lean Body Weight (LBW) and Relative Lean Body Weight (RLBW) [10]. Researchers examined thirty-four powerlifters (21 men and 13 women) from different age groups (18-49) and various weight classes, who underwent at least one Dual-Energy X-Ray Absorptiometry (DXA) scan and a yearly follow-up [10]. The study revealed positive correlation between weight lifted and BMD, BMC, LBW and RLBW – the higher the given measures are, the bigger weight can be lifted [10].

One factor that may be associated with the correlation between the occurrence of acute injuries and training is the utilization of anabolic-androgenic steroids (AAS) [17], [19]–[22]. The misuse of AAS by athletes and bodybuilders is a serious issue in Western countries, owing to its ergogenic and myotrophic effects [19], [23]. This can lead to adverse effects, including an increased risk of tendon rupture (approximately 9-fold). According to the literature, the increase in the risk of lower extremity tendon rupture is significantly lower than that of upper extremity tendon rupture [19]. The cause of this phenomenon is not fully understood [19], [23]. The excessive utilization of AAS is associated with altered lipid metabolism and prothrombotic effects, which can result in an elevated likelihood of atherosclerosis and cardiovascular incidents [24]. AAS can cause biotransformation or bind to the androgen receptor. They may cause adverse effects such as acne vulgaris, hypertension, erectile dysfunction, gynecomastia, and cardiomyopathy [22]. Selective androgen receptor modulators (SARMs) are non-steroidal chemical compounds designed to circumvent the limitations of steroidal

androgen receptor agonists (testosterone and DHT) [25]. They are characterized by a favourable bioavailability after oral administration and reduced risk of side effects relative to steroids [26]. SARMs exhibit anabolic impacts selectively on both muscle and bone tissues, while the effect on non-target tissues is minimal [27], [28]. The increasing popularity of SARMs among athletes is attributed to the perception of this class of drugs as a "tool" for achieving peak performance with relative difficulties in their detection in contrast to other androgenic agents [28]. SARMs can have side effects such as drug-induced liver damage, rhabdomyolysis, and tendon rupture [29], [30]. A study by Albright et al. found an increased chance of Achilles tendon injury and Achilles tendon injury requiring surgery in patients who took testosterone replacement therapy (TRT) for at least 3 consecutive months [31]. It is important to note that not all powerlifting athletes are willing to admit to using steroid hormone preparations or SARMs. This may cause major limitations to studies on powerlifters and their injuries [1].

Summary

Acute injuries are an inherent part of every sport, including powerlifting. They can be caused by improper technique, excessive loading or insufficient rest between training sessions or competitions. Other factors may include low serum levels of calcium or vitamin D or the use of anabolic-androgenic steroids and selective androgen receptor modulators. Depending on the location and morphology of the injury, treatment may be conservative or surgical.

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