A Review of the Efficacy of Weight Training Aids

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ABSTRACT

This article will review the efficacy of several different weight training aids that are available for use by recreational weight trainers and also competitive athletes in the sports of weightlifting and powerlifting. Some of these aids have been investigated by researchers while information regarding the use of others has been left to practical experience. This review will discuss the use and effectiveness of many weight training aids, thereby offering practitioners the ability to make an informed decision on their use.

INTRODUCTION

Various aids are commonly used while weight training with the intent on improving performance and reducing injury. These aids may be considered ergogenic because of their purported performance improvements, especially in competitive lifting situations. Many of the aids that will be discussed such as lifting belts, chalk, and lifting straps are common and can be found in most free weight gyms. However, there are other types of equipment used in competitive powerlifting that can actually add to the total amount of weight lifted. This specialized gear includes bench press shirts, compression briefs, and squat and deadlift suits. Although the use of these aids is expected to improve acute performance, the repeated use may contribute to more effective chronic adaptation of muscle. According to the overload principle of training, these increased stresses on muscle will illicit further adaptation. The purpose of this review is to provide a summary of these weight training aids and their specific uses and to evaluate their efficacy based on peer-reviewed research when available.

GRIP ENHANCEMENT

Grip strength is an often neglected factor necessary for performance in fitness training and success in the sport of weightlifting. It might actually be the weakest point in the chain between the lifter and the load. Weight training chalk is often used as a drying agent that increases the friction between the lifter’s hands and device, specifically a barbell. Increased friction between the hands and the bar would likely result in improved performance. Traditional weight training chalk is magnesium carbonate, which is most often purchased in blocks but can be easily pulverized into a fine powder. Peer-reviewed research on the use of chalk in weightlifting seems to be nonexistent, although research exists on the use of chalk in rock climbing. Researchers examined the use of chalk on the fingertips in a laboratory-based investigation on friction between the fingertips and stone (sandstone, granite, and slate) (39). Interestingly, it was discovered that the application of chalk reduced the coefficient of friction. The authors conclude by recommending the use of chalk as a drying agent followed by removal of all chalk remnants to prevent the reduction of the coefficient of friction. Others also concluded that powder chalk effectively reduced the coefficient of friction against a dry surface in a study investigating 4 different grip enhancing agents (7).

Conversely, Amca et al. (1) found the opposite effect. In a different experimental setup, the authors found that the use of chalk increased the coefficient of friction of the fingers on sandstone and limestone. Although they provide some insight into the effects of chalk on the coefficient of friction in rock climbing, application of these investigations to weight training is limited. The researchers seemed to use more of a pinching grip against stone while weight training uses fingers fully wrapped around the device that is usually metal. However, the hand and finger musculature trained when using a pinching grip could potentially provide strength transfer into the grip position used when clenching a barbell, thus indirectly making the rock climbing research applicable to the weight training situation.

More recently, different types of chalk have been made commercially available. In a July 18, 2014, edition of Outside Online magazine, author Andrea Bolt highlights a few of these newer types of chalk that often have additives to the magnesium carbonate. Commercial gyms often ban the use of chalk because of the mess it creates.
on the weights/machines, floor, and air. In response to these bans, “liquid chalk” has been developed and can be purchased commercially. Liquid chalk is simply magnesium carbonate with an alcohol additive, which will evaporate off of the surface of the skin, dry the skin further, and leave a thin layer of chalk, as described by Neigl (45) in his research regarding the sport of bouldering, a form of rock climbing. Weinbruch et al. (55) investigated the effect of different forms of magnesium carbonate on dust particle concentrations in the air in an indoor climbing gym. The research concluded that liquid chalk reduced the concentration of dust in the air, whereas powder chalk from a block and chalk from a chalk ball (powder enclosed in a sack of mesh) did not.

In addition to reducing the coefficient of friction with magnesium carbonate, lifters also use talcum powder, or magnesium silicate, to achieve the opposite result. Powerlifters performing a maximal deadlift often apply talcum powder to the thighs to reduce the friction between the thighs and the barbell. The lifter must be very careful to avoid the application of talcum onto the hands and shoes, however, so that grip strength and balance are not compromised during the lift. Most powerlifting federations allow for the use of substances such as magnesium carbonate and magnesium silicate in competition settings.

Although there seems to be no published research on the use of wrist straps, lifters often use them to enhance grip strength especially during pulling exercises. Wrist straps are strips of material that wrap around the lifter’s wrist and also the bar, thus creating a strong link between the 2. They are wrapped in such a way that a rotating bar will easily unwrap the strap from the bar at the conclusion of the set or if a lift is missed and the bar must be dropped. It is generally believed that wrist straps significantly increase overall grip strength as a result of the combination of muscle force and strap friction. Strongman competitions allow the use of wrist straps in the deadlift event, but they are not legal for competitive use in most powerlifting federations.

A possible consequence of the continued use of wrist straps could be the reduction of grip strength. Without the use of the straps, the muscles of the forearm would carry the total burden of the load. The use of the straps may reduce the training adaptation of those muscles. It is recommended that use of lifting straps be limited to the heaviest loads to strengthen the gripping muscles.

**JOINT SLEEVES AND WRAPS**

Neoprene sleeves and elastic wraps are used for potential support and performance of, especially, the wrists, elbows, and knees. The degree of potential performance enhancement is dependent on a number of factors such as types of wrap, wrapping technique, angle of wrist or knee flexion during wrapping, and tightness of the wraps (47). Researchers investigated the use of knee wraps on squat performance (32). Results demonstrated a 10% increase in both vertical impulse and peak power during the vertical displacement phase of the squat while wearing knee wraps. The authors go on to conclude that despite the improved capacity, caution while using straps is recommended because of altered back squat technique which may result in injury. This is contrary to conventional practice, which suggests that the use of wraps may prevent knee injury. Alternatively, it was found that squat biomechanics was no different between wrap and nonwrapped conditions (14).

Wraps are also sometimes used for blood-flow occlusion training, mostly by lifters who cannot tolerate the constant high mechanical stress on the joints. The mechanism by which blood-flow occlusion training exerts its effects is through an accumulation of metabolites such as whole lactate, plasma lactate, and muscle cell lactate (38). The metabolic increase is significant because it creates an acidic environment, which, in turn, stimulates the release of growth hormone (54). Some lifters using knee wraps for maximal squat attempts do experience some degree of blood-flow occlusion in the lower leg. A study using powerlifters wearing compressive gear as participants concluded that the blood-flow velocity was decreased significantly in the popliteal artery with the subjects in a supine position wearing only a squat suit, and with the further addition of knee wraps, the blood-flow velocity was decreased to the point of full occlusion (19). Others have observed that knee wraps resulted in partial occlusion of blood flow, but participants were able to continue with the exercise protocol (38).

Little research exists on the use of neoprene sleeves on performance. Biomechanical variables in the squat were measured in experienced competitive powerlifters and novice powerlifters to determine the aspect of the lift that seemed to be the determining factor in successful completion of the lift (42). Their findings suggest that acceleration from the bottom of the lift seemed to separate skill levels of lifters and that the knee flexion angle was increased in novice lifters allowing for greater compressive forces that could result in injury. The knee sleeve could potentially decrease the knee flexion angle at the bottom of the lift and, at the very least, provide additional support to the joint. However, others concluded that elastic knee wraps might actually increase internal friction between the patella and the knee cartilage, increasing the risk for injury (56). Birmingham et al. (5) measured knee joint position sense with and without knee sleeves. Results showed that there was an improved ability to replicate knee joint angles with the sleeve, especially in open-kinetic chain tests. Similarly, wrist wraps are often worn during bench press and also during squat performance to maintain joint rigidity and prevent injury. Elbow sleeves also provide a level of support and warmth for the elbow joint, which could potentially decrease inflammatory risk.

**LIFTING BELTS**

Lifting belts are used to aid performance and for injury prevention.
particularly when performing exercises that load the spine. A survey of recreational weight trainers reported that 27% of those surveyed were lifting belt users. Of the lifting belt users, 22% reported wearing one to improve performance and 90% for reducing injury (16). Belts made of both leather and synthetic material are commercially available. Lifting in general increases the intra-abdominal pressure (IAP) (12,24,30,46). As the force needed to lift the weight increases, the IAP also increases (10,23,31,40) and is therefore a good indicator of forces on the spine (33,35). This natural increase in IAP during lifting improves lumbar spine stiffness (8) and stability (9). Belts work by increasing the IAP while lifting above the natural IAP created by lifting without a belt. A tightened belt increases the IAP by compressing the abdominal contents, thus reducing the compression by reducing the load directly on the spine (35). Miyamoto et al. (43) also concluded that the combination of the Val-salva maneuver and the weight belt increased the intramuscular pressure in the erector spinae muscle group, resulting in greater lumbar spine stabilization. It is recommended that one only use a belt when lifting greater than 80% of 1 repetition maximum (RM) when the spine and associated musculature are most susceptible to injury (3). The muscles of the midsection naturally contract and increase IAP without the use of a belt. Using a belt with low loads may inhibit the training of the core muscles, essentially detraining the supporting muscles during spine load-bearing exercises (25).

Despite the common usage of lifting belts, direct evidence for performance improvement is lacking. No research has reported that using a lifting belt results in more weight lifted in a weight training setting. This is not surprising because of the difficulty of reducing the placebo effect of the obvious use of the belt versus no use. Indirect evidence includes electromyography (EMG) data. Researchers reported increased electrical activity of the erector spinae muscles during back squat with a lifting belt while performing 6 repetitions at 60% of 1RM (4). It would be expected that EMG activity would decrease if a belt were facilitating the support of the spine. The authors suggest that the increase in EMG was possible because of preload of the erector spinae from the tightness of the belt. Escamilla et al. (15) reported increased EMG activity in the rectus abdominis when the belt was used in the deadlift and an increase in external oblique activity when no belt was used. Others (57) reported no significant difference in EMG activity when using a belt while participants performed the squat at 90% of 1RM. Lander et al. (35) reported increased muscle activity by 8.3–23.5% in the rectus abdominis, 11.6–22.9% in the erector spinae, and 13.4–44.2% in the external obliques without using a belt while performing the squat. In another study, increased activity was reported in the biceps femoris and vastus lateralis muscles while using a belt during performance of an 8RM squat (34). Researchers did report an increased speed of squat performance (35) especially during latter repetitions (34). Any conclusion drawn from EMG activity is troublesome because of the lack of continuity in methods such as load, exercise, and number of repetitions. In addition, only one study reported any verification of the degree of tightness of the belt while lifting, which is an obvious confounding variable (35). It is also important to note that there are various styles of belts available for lifters including hook and loop, single-prong, double-prong, and lever closures. Despite the common usage of lifting belts among recreational weight trainers (16), there seems to be no empirical evidence to support the use of lifting belts for prevention of injuries in a weight training setting. A number of studies on injury rates among lifting belt users in industrial settings have been conducted. A review of those studies found the results to be inconclusive (48) with no reduction in injury rates or small changes being reported.

MOUTHGUARDS

Mouthguards are regularly used to protect from dental injuries while engaging in contact sports. Kracht and Kalets. (26) reported that damage to the athlete’s teeth while not wearing a protective mouthguard is 60 times more likely to occur. The National Collegiate Athletic Association requires athletes wear mouthguards in field hockey, football, ice hockey, and lacrosse (44). A specific mandibular orthopedic repositioning appliance (MORA) has been recommended to improve strength in other areas of the body as a result of appropriate tempromandibular joint (TMJ) positioning and was supported by research (52,53) although there has been criticism of the validity of the research because of lack of control groups and an appropriate statistical analysis (18). More recently, there has been evidence to support the use of an MORA to improve strength. Lee et al. (37) reported an increased muscle activity and isometric force of the forearm muscles and masseter muscle while using an MORA. In another study, an increase in activity in the sternocleido-mastoid, erector spinae, trapezius, triceps, rectus abdominis, and internal and external oblique muscles was observed (36). The authors suggest that the increased TMJ stability facilitates increased forearm strength (36,37). Other researchers discovered a reduced cortisol level after resistance exercise in participants who wore a mouthguard (17) suggesting a reduced anabolic state, thus facilitating protein response and recovery from exercise. Finally, researchers found no significance in muscular power, strength, dynamic balance, and agility when comparing no mouthguard, a placebo mouthguard, a self-adapted jaw repositioning mouthguard, and a custom-fitted jaw repositioning mouthguard (20). The authors recommend the continued use of mouthguards for athletes susceptible to dental injury.

AMMONIA INHALANTS

Ammonia capsules, often waved under the nose of an individual who has
fainted to return them to a conscious state, have long been used in powerlifting to assist the lifter in the performance of maximal lifts. Lifters claim that breaking open an ammonia capsule and deeply inhaling the substance before a maximal lift allows them to achieve a deeper psychological focus and also to get a deeper breath, blocking out unnecessary distractions. The effectiveness of an ammonia inhalant versus a placebo was investigated in 28 trained lifters performing the squat and the bench press (49). The findings reported that there was no difference in physiological performance between the lifters who used the ammonia inhalant versus the placebo; however, subjects did report psychological impacts including level of arousal.

**SHOES**

Many lifters simply use normal athletic or running shoes when weight training. The barbell squat exercise presents a unique biomechanical challenge to the lifter who may warrant unique shoes. The load placed on the upper back in the back squat may place a large shear stress force on the lower back with the stress increasing with increasing forward body lean (22). Athletes in the sport of weightlifting use a special shoe with a hard sole and raised heel. The hard sole facilitates the transmission of the force into the floor unlike cushioned running shoes, whereas the raised heel seems to offer a significant advantage over a lower heel (50). Sato et al. (50) required participants to perform the back squat exercise on 2 occasions: one with normal athletic shoes and other with weightlifting shoes. Results revealed a significant difference in foot angle and trunk lean in the more favorable upright squatting position while using the weightlifting shoes. The authors also suggest that the use of weightlifting shoes improves knee extensor excitation. The main factor the lifter should consider when deciding the type of shoe to wear relates to the individual’s specific biomechanics. A lifter with a wider squatting stance will be more likely to use a flat-soled shoe. The forceful hip external rotation present during this movement will apply torque to the shoe they are wearing as well. These forces applied by the lifter externally rotating the lower limb have prompted the development of reinforced flat-soled shoes. The reinforced shoe structure is made from a synthetic material similar to the fabric used for the hypercompressive gear used by the equipped powerlifter (i.e., a powerlifter using additional supportive gear), allowing the lifter to apply force to the lateral aspect of the shoe without damaging the material, thus giving the lifter a more stable connection to the floor and creating a stronger connection through the leg joints. The use of weightlifting shoes is recommended for those lifters having difficulty keeping an upright posture, thus reducing shear stress and possible injury of the lower back.

Lifters also wear specialized shoes or slippers while performing the deadlift, which facilitates gripping the bar for taller athletes and reduces the distance the bar must travel during the lift. As described by McGuigan and Wilson (41), there are 2 deadlift techniques used by powerlifters: sumo style and conventional. The sumo-style lift requires that the lifter stands in a wide stance with feet apart, similar to the wide stance squatter, and grips the barbell with the arms between the legs. This wide foot position allows for forceful external rotation of the hip, suggesting that a flat-soled shoe may be beneficial for the sumo deadlift. The conventional deadlift technique consists of a very narrow stance with arms gripping the barbell on the outside of the legs. The conventional lifter will sometimes wear a flat-soled shoe or deadlift slippers to decrease the range of motion necessary to complete the lift. The closer the lifter is to the floor, the less vertical distance required for the barbell to reach the lockout position at the top of the lift. A shoe with a raised heel seems detrimental in the deadlift because of the shift in the center of gravity of the lifter associated with the heel lift. A shift forward in the lifter’s center of gravity could potentially prohibit the leverage required for proper activation of the posterior chain, preventing the completion of the lift before the onset of fatigue.

**COMPRESSION GARMENTS**

Many types of compression garments exist from sleeves worn to support joints to full-body suits. In addition, the research addresses both the use of compression garments in an acute performance enhancement setting and also the use during a 24-hour to 48-hour recovery period from exercise. Both uses will be reviewed here, but, unfortunately, many potential confounding variables exist in the extant literature necessitating careful examination of their effectiveness by practitioners.

**COMPRESSION FOR PERFORMANCE**

There is very little peer-reviewed research involving equipped powerlifting; however, there does seem to be some investigating the use of compression garments in various activities. It was discovered that although compression shorts had no effect on single vertical jump maximal force or power, there was a significant effect on repetitive vertical jumps in men and women collegiate volleyball players (27). In another investigation, maximal knee flexion/extension torque and squat strength were evaluated with and without compression shorts in 10 male and 10 female volunteers (28). Results indicated that there were no significant differences in either dependent variable. The authors’ conclusion from their investigation was that the use of compression shorts had no effect on performance in repetitive high-intensity lower-body exercise.

In an effort to make the force on the legs from the compression shorts more consistent, a study was conducted using custom-fit shorts (13). In this investigation, the participants’ girth measurements at the waist, hip, thigh, and knee were collected. The garment was termed “hypercompressive” and was sized to be 15% less than each participant’s actual measurements. Moreover, the garments were composed of 75% closed cell neoprene and 25% butyl rubber and were 4.76-mm thick, which is...
An equipped competitive powerlifter uses hypercompressive gear to aid in the performance of their lifts. As discussed by Austin and Mann (2), the powerlifter should perform equipped lifts in training to understand how to use the gear, but the equipped lifter performs unequipped training as well to improve overall strength. The authors also addressed the issue of the order of application of the gear during the training session or warm-up session if at a meet, but individuals often have their own system for gear application. It also can be dependent on the federation requirements if engaging in competition. Typically, the lifter would begin the warm-up unequipped and then gradually add compressive briefs, knee wraps, and squat suit bottoms as the load is increased. Then, only for the heaviest loads, would the lifter attach the squat suit straps over their shoulders. The authors comment that the gradual addition of the gear will reduce the perception of the load being lifted.

24 hours following resistance training exercise (21). The compression garment group showed faster recovery in the chest press and knee extension exercises, although the chest press showed recovery sooner (8 hours) than the knee extension (24 hours). It was concluded that wearing a full-body compression garment during recovery was beneficial to recovery from resistance training.

Finally, similar results were demonstrated when researchers measured several psychological, physiological, and performance measures 24 hours after heavy resistance training exercise while wearing full-body compression garments (29). Significant differences in resting muscle fatigue, muscle soreness, swelling, bench press throw, and creatine kinase were observed when the full-body compression garments were worn compared with controls when no garments were worn. Taken together, the limited research shows that wearing full-body compression garments during a recovery period may have some positive benefit on resistance training recovery while leg length compression garments did not significantly affect recovery after a soreness-inducing jumping exercise.

CONCLUSION
There are numerous benefits to using the weight training aids discussed here. These benefits range from increased loads lifted due to better grip strength and increased IAP to enhanced recovery from full-body compression garments. If used correctly, these devices may enhance force production and prevent injury. The competition setting allows for the use of most aids discussed in this article, with the most commonly used being the weight belt, chalk, and wrist and knee wraps. The use of hypercompressive gear in training and competition is not nearly as common and requires the lifter to devote a significant amount of time into learning technique, acquiring strength gains through raw lifting, and training spotters to assist the process effectively and in a safe manner. Although the use of weight.

POWERLIFTING COMPRESSION GEAR
In contrast to common compression shorts that are readily commercially available, powerlifting athletes often use highly specialized garments during competition. One type of compression garment used during powerlifting competitions is the bench press shirt. This is an extremely tight and stiff shirt that is worn to enhance concentric strength during competition. Despite its common use, there is little research on this specific compression garment. Investigators examined the effects of bench press shirt use on bar path during IRM bench press exercise (51). Participants showed greater bar path total distance and specifically in the horizontal direction when the participants did not use the bench press shirt compared with those that did use the bench press shirt. The researchers concluded that the less bar travel in the bench press suit condition meant less total work and thus improved load capacity (51). Finally, it has been recommended to wear a lifting belt with the bench shirt to keep the shirt in place (2).

Similar to the bench press shirt, a squat suit is often worn during powerlifting competitions for improved performance. Investigators examined peak concentric force and power with and without the squat suit. Results demonstrated improvements in both variables while using the squat suit (6). The authors suggest that the improvement in performance is simply due to the squat suit's ability to store elastic energy during the eccentric phase and subsequent release during the concentric phase.

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training aids may be beneficial, it is recommended that individuals become familiar with their purpose and safe use and choose which aids to use according to each individual’s personal preference.

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