Strength and Conditioning for Throwing in Cricket

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ABSTRACT

IN CRICKET, THE ABILITY TO THROW A BALL AT HIGH VELOCITY WITH GREAT ACCURACY IS CRITICAL TO SUCCESSFUL PERFORMANCE AND OFTEN DETERMINES THE OUTCOME OF MATCHES. THE SKILL OF CRICKET FIELDING INCORPORATES A MOVEMENT PHASE AND A PICK-UP AND THROW PHASE AIMED AT DECREASING RUN RATE OR PRODUCING A RUN OUT OF THE OPPOSITION. A MAJOR ISSUE IN CRICKET IS THE RISK OF INJURY TO PLAYERS ATTRIBUTED TO AN ACUTE SPIKE IN THROWING INTENSITY AND VOLUME DURING PRACTICE AND MATCHES. THIS ARTICLE DISCUSSES STRENGTH AND CONDITIONING PRACTICES THAT MAY REDUCE THE PREVALENCE OF THROWING-RELATED INJURIES AND IMPROVE THROWING PERFORMANCE.

INTRODUCTION

The ability to throw a ball at high velocity and with great accuracy is critical for successful performance in sports such as cricket and baseball (9). It has been acknowledged that cricket is unique because of 3 differing match formats, namely Twenty20 (T20), limited-overs cricket (50 overs–1 day), and multiple-day (test and first-class) cricket. Each format varies in structure and volume, and therefore, the physical requirements of the players also varies greatly (29,30). T20 cricket matches are completed within 2–3 hours, and each team overhand bowls 120 balls (20 overs/6 balls per over) or until the opposing team is bowled out, caught, or has run out 10 of the 11 batsmen before the end of the innings (maximum of 120 balls). Limited-overs cricket matches are completed within 6–8 hours, where each team overhand bowls 300 balls (50 overs/6 balls per over) or until the opposing team is bowled out, caught, or has run out 10 of the 11 batsman before the end of the innings (maximum of 300 balls). Multiple-day cricket matches are completed over 3–5 days, where each team bats twice during 2 innings with an unlimited number of balls, as the opposing team attempts to bowl out, catch, or run out 10 of the 11 batsmen. Of note, overhand bowling and overhand throwing are 2 distinctly different movement patterns, the former used to bowl the ball toward the wickets and batsman; the latter, the primary focus of this article, is used during fielding.

There is research comparing the movement patterns and physiological differences between playing positions, match formats, and training sessions in cricketers (22,30–32,36,40,42). These studies revealed that cricketers competing in T20 and limited-overs (1 day) matches performed ~50–100% more sprints per hour in comparison with multiple-day matches; in contrast, a greater number of total sprints were performed per day during multiple-day matches because of longer daily match durations. These studies also demonstrated that conditioning intensity and throwing volume were greater during training (mean heart hate = 159 ± 8 beats·min^{-1}; total distance covered = 4,241 ± 1,503 m; number of throws = 42.5 ± 26.3) versus competition (mean heart hate = 126 ± 11 beats/min; total distance = 2,231 ± 1,824 m; number of throws = 10.5 ± 10.4). Curiously, there is little evidence investigating the differences in throwing intensity and volume between match formats and training; although the following 2 scenarios are hypothesized; (a) as the format of the game becomes longer in duration, the total number of throws increase; (b) as

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Figure 1. (A) Cable external rotation at 0° abduction, (B) Cable external rotation at 90° abduction, (C) Bent-over empty can (trap 3 raise).

the format and duration shortens, the game intensity increases (28,30) and the ratio of high-intensity throws compared with low-intensity throws increases. In summary, longer-distance, low-intensity throws are performed in multiple-day cricket and a mix of long- and short-distance high-intensity throws are performed in limited-overs and T20 cricket. Subsequent discussion will focus on strength and conditioning strategies for overhand throwing in cricket.

THROWING TECHNIQUE

The technical aspects of throwing in cricket have been likened to that of baseball (9), and to that end, a similar approach should be taken to preparation. The throwing motion can be divided into 5–6 individual phases. The preparation phase (wind up replaces this phase in baseball), stride, arm cocking, acceleration, deceleration, and follow through (16,27). The shoulder of the overhead throwing athlete, because of the nature of its performance demands, must provide enough mobility to allow maximal external rotation during the late cocking phase of throwing (14,24) and enough stability to allow forceful accelerations as high as 7,510°/s^2 (15). This fine balance of sufficient mobility and stability has been referred to as the "thrower's paradox" (24). Whether the required range of motion is an adaptive response to throwing or a congenital laxity is undetermined (24), but it seems to be critical to success (14).

The mobility-stability balance is frequently compromised, which can in some instances result in throwing-related pain (TRP) and a drop in performance (50). TRP in the shoulder and elbow are common within baseball throwers (35) as continuous excessive exposure to a pattern of throwing load causes microtrauma to involved tissues and can weaken them to the point of injury (11). Instances of spikes in throwing load (a sudden acute increase in load) occur frequently at the beginning of a competitive season or during a transition from a longer match format to short-form cricket. These spikes

Figure 2. (A) Dumbbell snatch, (B) Dumbbell split jerk, (C) Medicine ball catch and throw.

tend to coincide with increased reports of TRP and may be attributed to a lack of strength, mobility, or exposure to specific throwing-based conditioning (50).

TRP in cricket is common, although it can go unreported because of most of the athletes continuing to play in a reduced capacity or in another fielding role (33). However, the incidence of TRP in cricket is less than would be expected in a sport that incorporates moderate to high volumes of overhead throwing, which had previously been attributed to fielders throwing for distance (26). Given this information, this article details a range of exercises that may be used as part of a strength and conditioning program for preparing an athlete for overhead throwing, alongside a detailed throwing conditioning program designed specifically for cricket.

INJURY PREVENTION AND RETURN TO THROWING PERFORMANCE

There is a lack of literature specific to the preparation of cricketers for the acute spikes in throwing workload experienced during the transition from off-season to competitive season and/or transitioning between the differing match formats throughout the year. A systematic progression of load (intensity and volume) using a program specific to overhand throwing in cricket would suggest a decrease in TRP incidence and also maximize throwing performance (1,40). It is the authors' experience that most of a cricket athlete's throwing load will occur during training and match day preparation. The primary incidence of TRP occurs during acute spikes in throwing load and intensity, which may transpire when teams are required to switch between the longer and shorter match formats.

It is essential that the health of the entire scapulohumeral complex remains intact to provide some protection from the throwing motion. The musculature concerned with dynamic stability, force production, and dissipation surrounding the shoulder, scapula, elbow, and wrist should remain strong

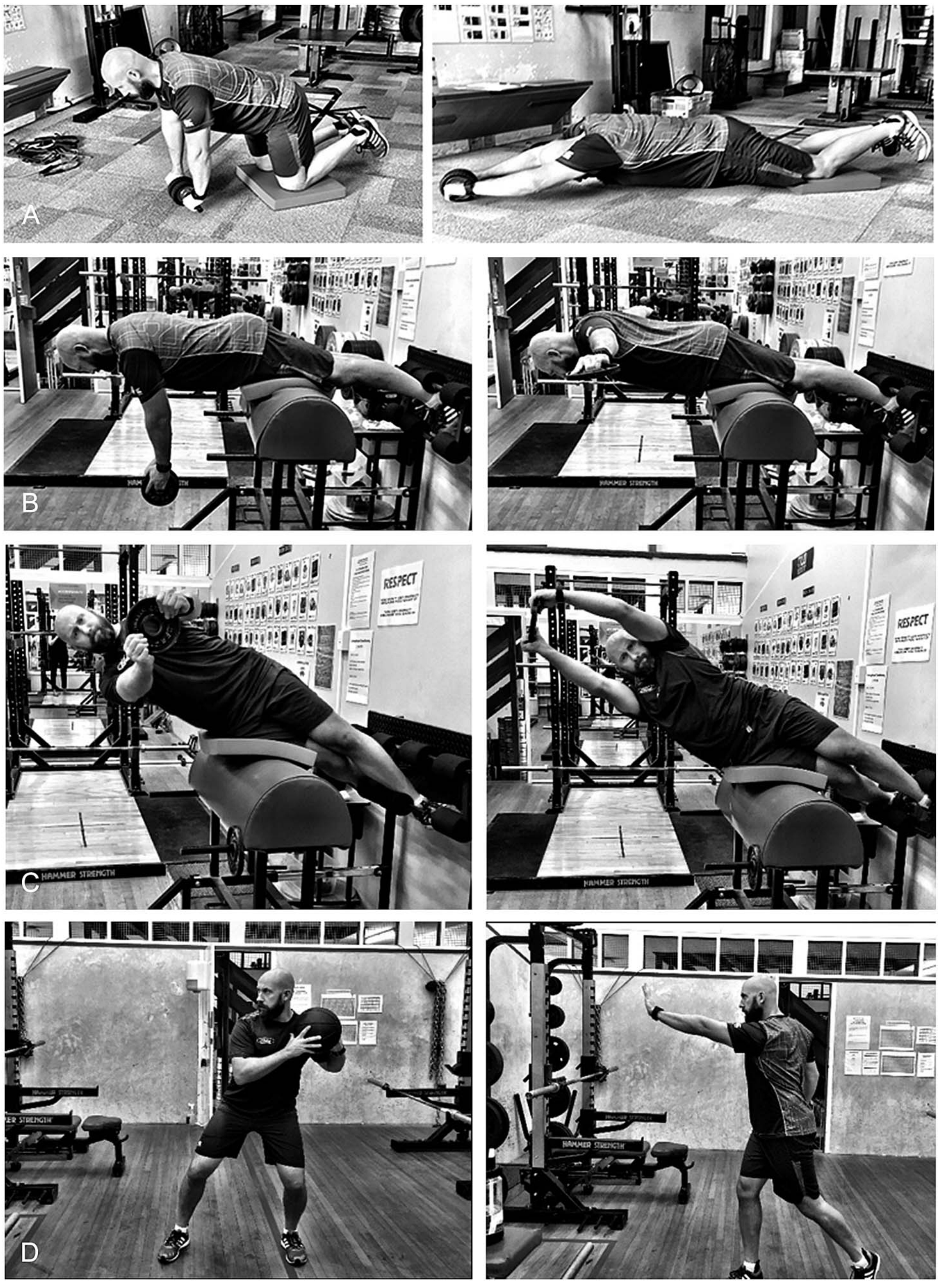

Figure 3. (A) Kneeling roll-out, (B) Isometric front-hold reverse fly, (C) Isometric side-hold plate press front and overhead, (D) Medicine ball rotary putt.

and with effective neuromuscular control (34). Specifically, the muscles of the rotator cuff, which work in a synchronized fashion and act as force couples about the scapula, provide both movement and stabilization (50). The balance of the strength capacity between the external and internal rotators of the throwing arm should be a minimum of 65%, but optimally 66–75% to provide dynamic stability throughout the throwing motion (50). This balance has shown to vary significantly throughout a training year dependent on training schedule and the volume of throwing in that particular training or competitive phase (49). An increased volume of throwing has shown to result in an increase in internal rotator strength and by demand a decrease in external rotator strength of the involved muscles (23,47). This adaptive response leads to the undesirable increase in muscle imbalance. The stimulus created by the throwing arm follow through is therefore not enough to maintain eccentric strength in the external rotators required for deceleration (23) and can in effect lead to a detraining of the posterior musculature (7,47).

Table 1
Throwing workload training frequency

Week	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1		Session 1		Session 1	
Week 2		Session 2		Session 2	
Week 3	Session 2		Session 3		Session 3
Week 4	Session 3		Session 4		Session 4
Week 5	Session 4		Session 5		Session 5
Week 6	Session 5		Session 6		Session 6
Week 7	Session 6		Session 7		Session 7
Week 8	Session 7		Session 7		Session 7

A strength and throwing conditioning program should include but not be limited to traditional resistance training, sport-specific warm-ups (8) and sport-specific throwing exercises with resistance (12), as strength and plyometric programs specific to throwing movements have been shown to increase the throwing velocity (48,51). The strength and conditioning practitioner alongside the coaching staff should therefore implement a best practice approach for the prevention of injury, by planning and preparing the athlete for known changes around increased requirements of volume and intensity.

A typical exercise program similar to that of the "Thrower's Ten" (48,51) aimed at maximizing throwing performance and injury prevention for cricket athletes is shown in Figure 1. The exercises differ in complexity, and early progressions are aimed at differentiating rotator cuff strength from scapular strength and mobility during an early phase of the return to throwing program.

1. Return to Throwing Exercise Program. During early-phase preseason or return to throwing, it is recommended that the athlete performs mobility and stability as a focus to gain or maintain control of the glenohumeral joint through full range. Depending on the athlete's training phase, they may perform all phases of the "Return to Throwing Exercise Program." The program should include up to 5 exercises that focus specifically on the rotator cuff and exercises that incorporate both rotator cuff and scapula strength and stability, such as external shoulder rotation at 0°, 30°, and 90° abduction (Figure 1A and 1B); internal shoulder rotation; and shoulder abduction variations (Figure 1C). Typical strength endurance loading parameters (1–3 sets of 10–25 repetitions per exercise) should be implemented in a periodized manner through the off-season and preseason training phases (2,5,51).
2. Performance program. This program has a specific focus on improving throwing performance through pressing (vertical and horizontal), pulling (vertical and horizontal), throwing, and whole-body movement patterns (Figure 2). The performance program should be performed within a strength session or as supplementary training 2–5 times a week depending on the training phase (5). High-velocity (17,19,25), hypertrophy (41), and maximum strength (4,46) loading parameters (Table 3) should be prescribed dependent on the physical needs of the athlete and training phase (4). An athlete may perform elements of each of the program before a strength session as part of a warm-up, during the rest periods between lower-body exercises, as a superset, poststrength session, or as preparation for throwing to ensure that the athletes are performing the necessary number of sessions.

THE TRUNK AND LOWER EXTREMITIES

Overhead throwing involves the transfer of ground-reaction and lower-extremity forces through the muscles of the trunk to the upper extremities (21,43). Studies have shown that vertical and horizontal ground force production is directly related to throwing and bowling velocity in cricket (18,52). The role of trunk flexibility and strength is somewhat uninvestigated in cricket, although it has been hypothesized that greater trunk stiffness and transfer of momentum from the lower limb to distal segments is an important contribution to throwing performance (45). An inability to transfer the forces generated by the lower extremities through the trunk to the upper extremities and an inability to dissipate forces in deceleration could result in a reduction in performance and an increased likelihood of injury. A well-constructed lower-body, trunk strengthening, and mobility program should result in a significant improvement in throwing accuracy (21,37).

To attain the maximum benefit from a throwing strength and conditioning program, the exercises must replicate the demand that throwing movement patterns place on cricket athletes. These movement patterns require sufficient trunk mobility, stability, and a level of rotational strength (20,37,38). The effectiveness of rotational movements in trunk training may be attributed to the consistency between the movement and the body's functional design (38). A look at the body's trunk musculature resembles a crisscross design known as the serape design (20,38,39). The serape's crisscross design provides an excellent structure for force production between the shoulder and the contralateral hip. By rotating the shoulders and pelvis in opposing directions, the trunk's musculature is stretched in a diagonal pattern referred to as the "serape effect." The forward momentum provided by the posterior hip (posterior serape) during the stride is transferred through a "stiffened trunk,"

Table 2
Progressive throwing workload training program

	Session 1 (# × D)	Session 2 (# × D)	Session 3 (# × D)	Session 4 (# × D)	Session 5 (# × D)	Session 6 (# × D)	Session 7 (# × D)
Throwing intensity							
Static throws	10 × 10 m	10 × 10 m	10 × 10 m	10 × 10 m	10 × 10 m	10 × 10 m	10 × 10 m
50% MTI	5 × 20 m	7 × 20 m	10 × 20 m	12 × 20 m	10 × 20 m	10 × 20 m; 10 × 30 m	10 × 20 m; 10 × 30 m
75% MTI	5 × 20 m	7 × 20 m	10 × 20 m	12 × 20 m	10 × 20 m; 5 × 30 m[a]	5 × 40 m[a]; 5 × 50 m[a]	5 × 50 m[a]; 5 × 60 m[a]
85% MTI	5 × 20 m	7 × 20 m	5 × 20 m	6 × 20 m	10 × 20 m	10 × 30 m	10 × 30 m
100% MTI	5 × 20 m	5 × 20 m	5 × 20 m	6 × 20 m	10 × 20 m	10 × 30 m	8 × 30 m; 7 × 40 m
Total number of throws	30/60	36/60	40/60	46/60	55/60	60/60	60/60
Total throw distance (m)	500	620	700	820	1,050	1,650	1,750
Session volume (% MTI × # × D)	340	424	465	552	763	1,173	1,248

× D = number of throws × distance (m); 100% MTI = maximum throwing intensity (velocity) with a step and a follow through; 50% MTI = a normal throw with a step and follow through at 50% maximum throwing intensity (velocity); 75% MTI = a normal throw with a step and follow through at 75% maximum throwing intensity (velocity); 90% MTI = a normal throw with a step and follow through at 90% of maximum throwing intensity (velocity); MTI = maximum throwing intensity (velocity); session volume = the product of maximum throwing intensity percentage, the total number of throws, and the total throwing distance per session; static throws = throwing the ball from a half-kneeling position at a low (~30% MTI) intensity; Total number of throws = the total number of throws with a maximum threshold of 60 throws per session.

[a]Throws were performed following the 100% MTI throws during a given session.

Table 3
Recommended resistance training loading parameters (2,5) listed

Training goal	Sets	Repetitions	Intensity	Interset rest (min)
Strength endurance (51)	1–3	10–20	30–70% 1RM	<1
Hypertrophy (41)	2–5	6–12	65–85% 1RM	1–2
Maximum strength (4,46)	2–6	1–6	80–120% 1RM	2–5
High velocity (19,25)	2–5	3–8	0–60% 1RM	2–8

Loading parameters are per exercise per training session and should be prescribed based on the training phase and needs of the athlete.

which is essential for efficient transfer of force between the lower- and upper-limb distal segments (39). The anterior serape maximizes this force transfer as the lead leg decelerates the momentum created from the posterior hip, allowing the throwing arm to "load up" during the cocking phase and then accelerate the throwing arm and subsequent ball before release (39).

Exercises aimed at maximizing the effect of the serape in force transfer can be found in Figure 3. These exercises look to resist ineffective trunk extension (Figure 3A), flexion (Figure 3B), and lateral flexion (Figure 3C) under high load and velocity when required. Traditional strength lifts such as variations of the squat pattern (e.g., back squats, front squats and split squats), variations of the clean and snatch (e.g., full, hang, and high pull), and upper-body vertical and horizontal pressing (e.g., shoulder press and bench press) and pulling (e.g., bench pulls and pull-ups) are crucial for maximizing force production (i.e., magnitude, impulse, and rate of force) in the throwing athlete (20). In addition, rotational exercises performed from a standing position (38), such as medicine ball rotational slams and throws (Figure 3D) and wood choppers (e.g., high to low and low to high), can assist in optimizing the force transfer during rotation and in turn increase release velocity in the throwing athlete (13,44,45).

THROWING WORKLOAD PROGRAM

A progressive workload bowling program is common practice with fast bowlers within cricket to prepare them physically for an anticipated match load (6). Whereas, progressive workload overhand throwing programs are far less common, but just as important for preconditioning the musculature for throwing. An acute increase in throwing workload has been shown to increase the likelihood of TRP (40). A progressive loading program for cricket ball throwing should increase the load on the shoulder by systematically increasing first the intensity (distance and/or speed) and then volume (number of throws × throwing distance × intensity of each throw) of throws. This allows the demand placed on connective and contractile tissue to adapt and strengthen over time, reducing fatigue and tissue microtrauma and minimizing injury risk (3).

Table 1 outlines the training frequency (3–4 times per week) of a typical 8-week "return to throwing" program based on the specific demands of a national cricket team. The authors observed that the highest physiological and throwing workloads cricketers experienced were from training sessions involved in preparing for matches and not workloads experienced within matches (31,40). The throwing loads required for training were in excess of 3 times the number of throws recorded in games (40). This was because of the warm-up phase of practices and sessions of technical training to "groove" specific motor patterns in maximizing throwing performance. A similar trend was observed with intensity, as higher throwing intensities were observed during training in comparison with games. Similarly, this can be attributed to not only "grooving" specific motor patterns at high intensities to improve performance but also the incorporation of aerobic and speed training during fielding to provide a "sport-specific" conditioning effect. Table 2 provides a systematic increase in first throwing intensity, represented as a percentage of maximum throwing velocity and then volume using 7 different sessions of increasing workload, over 22 occasions, during a period of 8 weeks in preparation for a competitive season. An increase in throwing load from session to session of less than 30% is thought to be the greatest increase in load that adaptive tissue can handle (10). The current throwing program is designed for overhead technical throwing and not the sidearm throw or overhand bowling. It should also be stated that the authors recommend that throwing technique analysis is an extremely important part of this process, and this may be the optimal period to address it. Upon successful completion of the program, weekly throwing volumes should be monitored to prevent any unwanted acute spikes in volume.

SUMMARY

TRP in cricketers because of an acute spike in throwing load from matches and training occurs when the athlete is not physically prepared for the imposed demand. This article has highlighted a range of strength and conditioning exercises that may aide in the physical preparation of the cricketer for improved throwing performance. Recommended resistance training loading parameters to develop strength endurance, hypertrophy, maximum strength, and high velocity for a given exercise are outlined in Table 3. As previously described, it is also pertinent that athletes perform a progressive workload-throwing program up to 4 times weekly that consists of a systematic increase in throwing intensity and volume to better prepare the body for throwing workloads experienced during competition and training (Table 2). However, further research is required to accurately quantify the throwing demands of cricket based on player position and match format (T20, limited-overs, and multiple-day) to better prepare the cricketer for competition.

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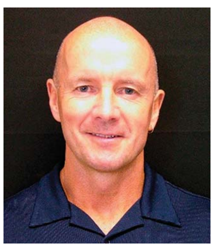

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