

THE BENEFITS OF LOW-FRICTION RESISTANCE TRAINING IN AN ADOLESCENT BASEBALL PLAYER

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Abstract

Introduction/Aim of the Study: Our case report details the effects of workouts done on a novel low-friction inertial exercise trainer (IET; Impulse Training Systems, Newnan GA) over a 140-day period by a young baseball player to improve his pitch velocity.

Methods: Workouts entailed 32 exercises each performed by the right, and then followed by the left, sides of the body against 3.4 kg of added mass to the IET three times per week. Approximately every two weeks the subject's performance was measured with two tests. One test assessed pitch velocity with a standard 142 g baseball and calibrated radar gun, while the second measured internal rotation force on the IET with no added mass to the device.

Results: After 140 days, test results showed large maximum internal rotation force (+338%) and pitch velocity (+28%) improvements.

Conclusions: The success of IET workouts likely resulted from high rates of acceleration per repetition and a greater overspeed adaptation than that seen from other training modalities. The IET also imposes a low frictional resistance that limit stresses placed on the maturing skeleton and connective tissues, which may be especially efficacious for a young baseball pitcher's throwing shoulder. Based upon our results, new research on the effects of the IET to improve baseball pitch velocity is warranted.

Key words: inertial exercise trainer, acceleration, high-speed exercise

Introduction

Theories abound as to the optimal exercise strategy to increase baseball pitch velocity. Three strategies entail general [1], special and specific [2, 3, 4] exercise protocols [5]. Intended to offer adaptations similar to actual baseball pitches, specific resistive exercise protocols were combined with other paradigms [6]. Adaptations from such workouts include improvements in force or speed, sometimes referred to as overload and overvelocity, respectively. Typical results from resistive exercise protocols that emphasize overload entail substantial force, but only modest ball velocity, gains [1, 5, 6]. A four-day per week resistive exercise protocol, given for eight weeks to collegiate baseball players, elicited a mean 31.4% force increase for athletes who received the treatment, while control subjects incurred an 8.1% gain [1]. Pitch velocity changes after eight weeks showed modest gains (+2.5%) and losses (-1.1%) to the exercise and control groups, respectively [1]. Other study results, such as special resistive exercise protocols geared towards overhead throws, also show large force gains coupled to small pitch velocity changes [5]. With workouts that emphasize throws with light- and heavy-weighted baseballs, spe-

cific resistive exercise protocols may act as an optimal strategy to achieve overvelocity and faster pitch speeds [2-4, 6]. Ideally specific resistive exercise protocols should evoke a higher degree of overvelocity, with a better transfer of workout adaptations to the pitching mound.

Numerous exercise devices have also been examined in order to improve pitch velocity. Both general and special resistive exercise protocols used barbells and machines with a selectorized weight stack [1]. Devices to test rotator cuff strength, a muscle group associated with pitching, include isokinetic dynamometry [7]. Yet specific resistive exercise protocols emphasize workouts with baseballs of various masses; they include light- (113 g) standard- (142 g) and heavy-weighted (170 g) balls to assess which may induce overvelocity and higher pitch speeds [2-4]. To date, results from specific resistive exercise studies are mixed [2-4]. Two studies used high school and college male pitchers [2, 3], while the third used adolescent players [4]. The latter study showed lighter balls improved pitch velocity and biomechanics more than other examined treatments, as well as limit the risk of overuse injuries in young athletes [4].

The rationale for workouts with lighter balls is that they may improve pitch velocity and limit overuse injuries since they require less force to overcome inertia and initiate movement [4]. A device with similar properties is an inertial exercise trainer (IET; Impulse Training Systems, Newnan GA). The IET includes a track with a very low (.017) coefficient of friction that enables users to achieve high sled accelerations as repetitions are performed. Due to the track, its inertia is less than other equipment used to improve pitch velocity [1, 5, 6]. The IET appears in Figure 1. Any part of the pitch motion can be mimicked on the IET; training adaptations may include overvelocity and neuromuscular changes that evoke greater gains in ball speed than other devices [1, 5, 6, 8]. In addition the low-friction track allows movement with less strain placed on the throwing shoulder and elbow as they mature, thus IET workouts may be ideal for a young pitcher as their musculoskeleton develops over time [8]. This case report details pitching improvements from IET workouts, which has been exclusively used by professional athletes to limit injuries and enhance performance. Our subject was

an adolescent baseball player who trained exclusively on the IET for a short time. It is of interest to note the degree of pitch velocity improvement he attained during that time.

Methods

Since our subject was a minor, consent for the use of his records was given by his parents with the knowledge data were to be used solely for publication and that their child's identity would be protected. An assent form for minors was also given to our subject. These methods of consent were affirmed by a university-based IRB where the primary author is located. Performance tests and workouts occurred over a 140-day period. Aside from IET workouts, our subject used a 1.2 m beam on a daily basis to improve his balance. With the beam's narrow side in contact with the floor, he balanced atop it with his left foot. He then attempted to touch the top of the beam with his right hand without falling or the apparatus tipping over. He engaged in no other training over the 140-day period. Our subject began as a 13-year old with a maximum pitch velocity of $27.3 \text{ m}\cdot\text{s}^{-1}$ assessed with

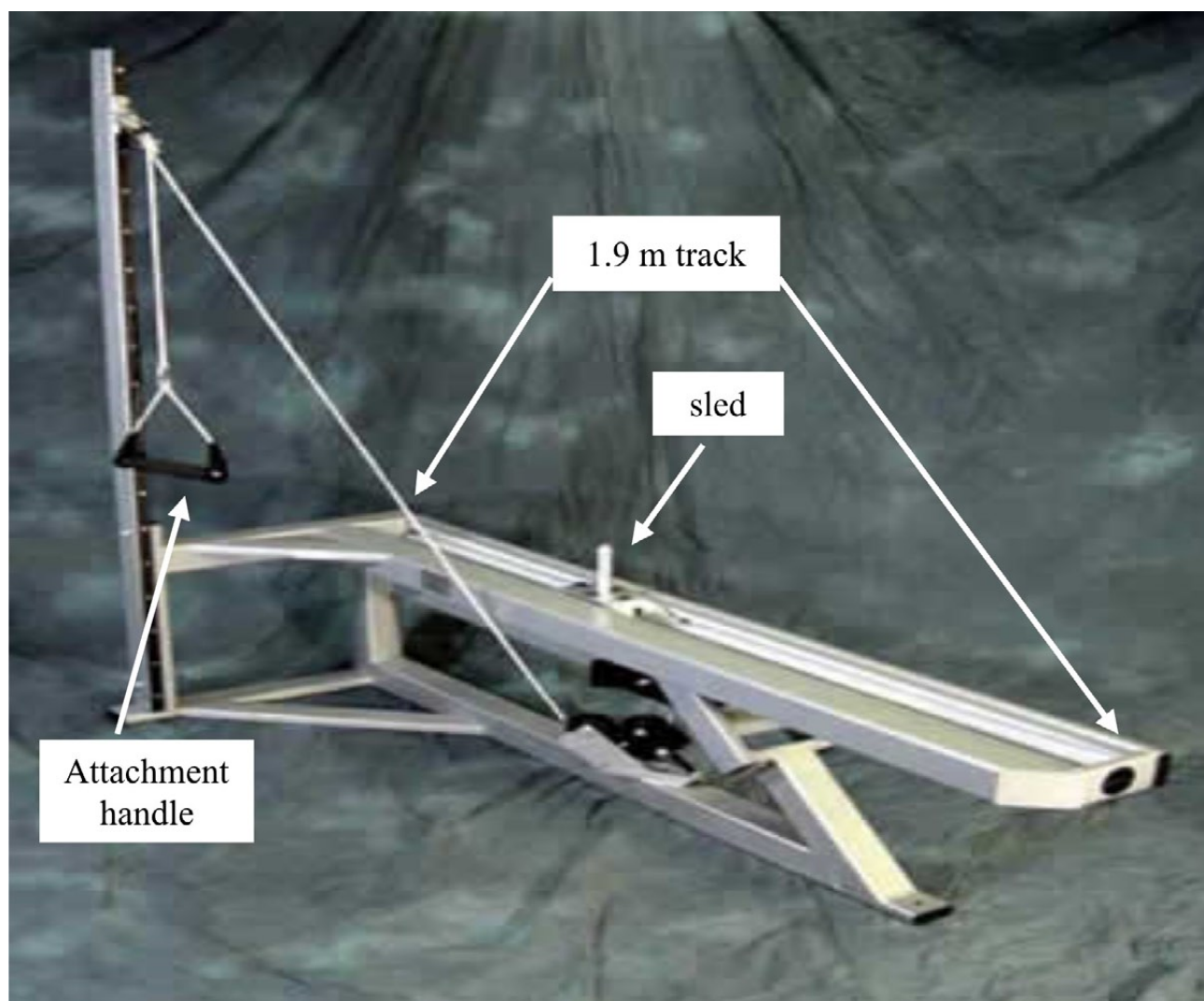


Figure 1. Photograph of the IET

a calibrated (Jugs Sports, Tualatin OR) radar gun. He weighed 46 kg and was 1.6 m tall. His dominant arm's upper (from the acromion-clavicular joint to the ulna's olecranon process) and lower (olecranon process to the styloid process of the ulna) lengths were 28.6 and 23.2 cm, respectively.

Two tests were administered at roughly two week intervals over the 140-day period. One test assessed maximum pitch speed with a standard baseball and calibrated radar gun, while the second measured the dominant arm's internal rotation force on the IET. The latter test entailed 30 seconds of internal rotation without added sled mass in order to maximize acceleration per repetition and to make the measurement more sport-specific to pitches performed during a game [8]. The IET track includes smooth and grooved guide rails made of ultra high molecular weight plastic that the sled moves on; its wheels are made of high alloy steel and remain lubricated for life [8]. The composition of the guide rails and wheels allows the sled to glide against very low friction. Sled

resistance, without added mass, equals 1.04 kg; yet higher accelerations occur on the IET versus typical resistive exercise devices. High accelerations result from the IET design and the mass of the attachment handle used for workouts and tests. For our case report, repetitions were done with a lightweight (70 g) handle. The sled moved parallel to the Earth's surface and not against the pull of gravity; yet as force was exerted the pulley position allowed the sled to accelerate in a similar biomechanical vector as for a baseball pitch. Thus the IET, with its low-friction track and light handle, allowed our subject to incur higher accelerations than workouts on typical devices [1, 5, 6]. Force was assessed with a calibrated load cell (Transducer Techniques; Temecula, CA) anchored to a pulley located midway on the underside of the 1.9 m track. As the sled moved the load cell sent data to signal conditioners (DATAQ Instruments; Akron, OH) and an acquisition card at 4000 Hz [9].

For workouts and tests, the STAR (stance, target, activation, release) program ensured proper pitch



Figure 2. Subject's body position to test internal rotation force on the IET

Table 1. *List of workout exercises*

1. external humeral rotation (arm overhead)	17. elbow flexion (shoulder hyperextended)
2. internal humeral rotation (arm overhead)	18. hip rotation with hand at hip
3. humeral adduction	19. trunk rotation with hand at hip
4. humeral extension (arm at 120° angle)	20. knee extension
5. scapular press	21. knee flexion
6. kneeling internal humeral rotation	22. hip extension
7. seated shoulder extension (arm overhead)	23. scapular lift (arm overhead)
8. scapular retraction (shoulder flexed 90°)	24. shoulder flexion
9. scapular protraction (arm ventral)	25. shoulder abduction
10. shoulder adduction	26. elbow extension (shoulder flexed 120°)
11. humeral abduction (arm ventral)	27. hip abduction
12. humeral adduction (arm ventral)	28. hip adduction
13. external humeral rotation (arm at side)	29. side (lateral) leg raise
14. internal humeral rotation (arm at side)	30. scapular elevation (arm at side)
15. elbow flexion	31. femoral adduction
16. shoulder extension	32. hip flexion

technique was used [8]. The subject's body position for IET tests appears in Figure 2, in which his dominant arm mimics the pitch release point. IET workouts occurred three times per week. With 3.4 kg of added sled mass, workouts entailed 32 exercises for the whole body. The amount of mass added to the sled was based upon information that showed force and power output were maximized at that load [8]. Table 1 lists the exercises in the order they were performed. A visual representation of each exercise appears at the following url: <http://www.impulse-power.com/its/stabilization.html>. Per workout, all exercises were done with the right side of the body before they were repeated on the left. Rest between exercises was kept to a minimum and workouts lasted

25 minutes. For the first three weeks, each exercise lasted 30 seconds as the subject performed as many repetitions as possible in good form. Thereafter workouts entailed only 30 repetitions per exercise. Unlike most exercise devices, the added mass makes IET repetitions easier to perform, as less acceleration limits force output [8]. Our subject was told to exert as much force as possible per repetition.

Results

Table 2 shows performance test results over the 140-day period incurred by our subject. Results include large internal rotation force (+338%) and pitch velocity (+28%) gains over the 140-day period. Before the intervention, our subject had no prior IET

Table 2. *Test session results*

Test date	Maximum internal rotation force in Newtons	Maximum pitch velocity in m·s ⁻¹
11/19/08	104.1	27.3
12/8/08	113.4	27.3
12/22/08	198.3	29.1
1/5/09	276.6	30.8
1/26/09	237.2	31.8
2/9/09	304.0	33.1
2/23/09	324.9	N/A
3/9/09	227.9	32.2
3/23/09	354.4	33.1
4/12/09	411.9	N/A
4/23/09	455.8	34.9

experience, thus his force gains may be partly due to a learning effect. Yet he was very familiar with throwing a baseball; thus his large gains in pitch velocity cannot be attributed to a learning artifact. Our results far exceed those from studies [1-3] and summarized reviews [5, 6] that examined strategies to improve pitch velocity in more physically mature baseball players. At the conclusion of the 140-day period, the maximum pitch velocity of our 14-year old subject was comparable to that of a high school baseball player [4]. The low-friction design of the IET, as well as the current workouts employed, likely helped our subject to achieve adaptations that included greater overvelocity development and higher pitch speeds than other exercise modalities [1-3, 5, 6].

Discussion

Our results show large gains in pitch velocity and internal rotation force from IET workouts. Such increases far exceed prior study outcomes [1, 5]. Workouts to improve pitch speed have included overload and overspeed exercise strategies [6]. Overload programs usually elicit significant force gains but to modest changes in pitch speed [1, 5]. A literature review shows specific workout protocols most consistently yielded pitch velocity increases [5]. Specific protocols use both over- and under-weighted baseballs, as the latter more likely induces overspeed adaptations [6]. To support this statement, research that compared chronic over- versus under-weighted workouts on pitch velocity offered noteworthy results [2, 3, 5, 6]. Male high school pitchers were assigned to an over-, under-weighted or control treatment group for ten weeks with no crossover to note the impact each intervention had on ball velocity [3]. For a ten-week period the over-weighted group threw gradually heavier balls until a 170 g implement was reached [3]. In similar fashion, the under-weighted group pitched progressively lighter balls until those with a 113 g mass were thrown [3]. Controls only threw standard balls over for ten weeks. Results showed significant velocity gains only for the over- and under-weighted groups [3]. While the under-weighted group improved the most, its gains were not significantly greater than the over-weighted condition [3]. A subsequent ten-week study assessed workouts with balls of various masses on pitch speed [2]. While two of the three conditions used implements of different masses over the ten weeks, a control group only threw standard balls [2]. Like the earlier study [3], only controls failed to improve their pitch speed [2].

Table 2 improvements far exceed those reported from other studies [1, 5, 6]. One factor that helps to account for this disparity in the level of improvement is the age of our subject. Typically when a treatment is applied to very young or untrained sample, large

changes often occur. Perhaps an appropriate investigation to compare current results to, given the topic of our case report and the subject's age, was a study on throwing kinetics and kinematics done with standard and underweight balls in adolescent male pitchers [4]. Results collected from 34 pitchers suggested lighter balls were preferable for younger athletes to achieve proper biomechanics and motor unit recruitment, as well as limit their risk of injury [4]. However, by the end of the 140-day period, our subject's maximum pitch velocity far exceeds those reported for adolescent athletes and was comparable to values achieved by high school players [4]. Thus given the age similarities for the current case report and prior study [4], some of the maximum pitch velocity improvements may be attributable to IKE workouts. As compared to results from typical resistive exercise workouts, the IET likely aids development of ball speeds due to the higher acceleration achieved per repetition and degree of overvelocity incurred.

Coupled to the large current pitch velocity improvements are the even higher relative gains in force, which is the product of mass and acceleration. Since IET force tests entailed no added mass for greater resistance, the current gains were facilitated by very large increases in acceleration that occurred over time to our subject [9-12]. Recent research noted the level of acceleration attainable on the IET [9-12]. With data collected from 60-second sets, average and peak acceleration values of 7.1 and 85.7 $\text{m} \cdot \text{sec}^{-2}$ respectively, were recorded [12]. A comparison of current results to studies [1, 5, 6] that employed standard resistive exercise workouts suggests the IET may induce more overspeed adaptation and acceleration per repetition [8]. The design and operation of the IET, with its low-friction track, likely allows such adaptations to occur over time from repetitive workouts. Thus the IET may be a unique device that allows young athletes to exercise and incur neuromuscular adaptations that induce overvelocity with minimal strain placed upon their skeleton and connective tissues. Based upon our report, new research on the effects of the IET to improve pitching velocity is warranted.

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