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Ice Hockey Players Using a Weighted Implement When Training on the Ice: A Randomized Control Trial

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The purpose of this study was to investigate the potential for improving hockey players' performance using a weighted implement on the ice. Forty-eight players were tested using a grip strength dynamometer. They were also assessed on their abilities to stick-handle. The participants were randomly placed into a control or research group. The conditioning drills were performed for 10–15 min 3 days/week for 6 weeks. Use of the weighted implement resulted in a significantly enhanced grip strength endurance and stick-handling ability ($p < .05$). Using weighted implements prior to a regular ice hockey training session may be of benefit to young hockey players to enhance their grip strength endurance and stick-handling abilities.

Key words: conditioning, sport specific, stick-handling, weighted puck

Ice hockey is a unique sport in which a young athlete is required to learn an entirely new task (ice skating). These early developers learn the new task of skating and will then often be introduced to the more advanced physical and mental challenges of the sport. As the talented rookie hockey players grow into the sport, they and their trainers look for means to develop their skills. This often involves the dry-land training room, where they can mimick the way a hockey player moves (Ebben, Carroll, & Simenz 2004, Hedrick, 2002). Dry-land training poses numerous difficulties in re-creating on-ice skills, such as gliding, stick handling, and moving against other players. It is the opinion of both the authors and the National Hockey League that these skills are best accomplished on the ice (Schmidt & Toews 1970).

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A new product allowing players to do this is a weighted implement with the physical dimensions of a standard hockey puck (Stark 2004). The device is a cylinder 3 inches (7.62 cm) in diameter, 1 inch (2.54 cm) high, and in other ways identical to a standard ice hockey puck. A major difference is that the device is made of aluminum (http://XPuck.com.). After appropriate conditioning is achieved with the aluminum puck, the product developers suggest progressing to a smaller, metallic, yet heavier puck that is constructed of stainless steel.

These solid metallic pucks are marketed for use in stick handling and flat passing but not shooting. According to the product developers, a potential benefit of the conditioning hockey puck lies in its increased weight (aluminum: 10.5 ounces [.3 kg]; stainless steel: 14.4 ounces [.4 kg]) compared to a standard puck (5.5–6 ounces [.15–.17 kg]). Because of the increased weight (like other weighted rubber hockey pucks) one would think it would be slower on the ice. According to engineer Reuben Tschitter, North Dakota State University, Fargo, ND (personal communication, 2003), metal has approximately 40% less friction on ice compared to vulcanized rubber; thus, the weighted metallic pucks may theoretically be faster than standard playing pucks. Because the weight and speed of the metal puck, it notionally carries more momentum than a 6-ounce (.17 kg) vulcanized rubber puck. Although these claims may seem logical, further tests in this area need to be performed.

With these elements in mind, the product developers claim that enhanced grip strength, grip endurance, and stick handling ability will result. This pilot study was conducted to investigate a 6-week conditioning program involving a variety of progressive stick handling tasks using this aluminum puck.

Method

This study was approved through the Human Research Ethics Committee at Murdoch University, Perth, Western Australia. The parents of each participant signed an informed consent. The study was designed as a randomized control trial to study the affects of using a weighted metallic implement during stick-handling drills. Pre- and posttesting of maximum grip strength, grip strength endurance, and stick-handling ability through an obstacle course were performed.

Participants

Forty-eight hockey players, ranging in age groups from peewee (12 years and under) to bantam (14 years of age and under) including U14 girls (under 14 years old) participated in a 6-week study. The study started with a grouping of male and female players and groupings of skill levels, as determined by the team coaches. To avoid single bias, three coaches worked together to determine the high/low levels. The coaches' experienced opinions on the players' skating ability and stick handling skills were criteria to determine the skill level. The athletes' names were written on a piece of paper and placed in two bowls, one for the higher skilled players and the other for lower skilled players. Male and female players' names were randomly and equally selected from each bowl, and players were distributed into two equal skilled groups: research ($n = 27$) and control ($n = 21$). The control group initially had 27 participants, but because of an inability to commit to the 6-week study, 6 were eliminated from the study. Of the 27 research group players, 14 were higher skilled and 13 were lower skilled. The 21 players in the control group consisted of 11 higher skilled and 10 lower skilled athletes.

Procedures

The ice hockey players were informed that they would be participating in a study involving stick-handling drills to enhance their ability. They were also informed that because the group was so large they would have to be on the ice at two different times. This allowed for blinding the players (i.e., the control group did not see the research group practice).

The athletes participated in a multifaceted process that included testing of (a) maximum grip strength, (b) grip strength endurance, and (c) the ability to stick-handle through an obstacle course. The grip strength test has been validated (Mathiowetz, Kashman, Volland, Weber, & Dowe, 1985; Schmidt & Toews 1970). The testing techniques were implemented as described by the American Society of Hand Therapists (Fess & Moran, 1981) in which athletes use a Jamar Dynamometer **[AQ: Include mfg's name, city, & state.]** to perform a maximum grip trial lasting 1 s each with a subsequent 20-s rest between attempts. Athletes performed this three times, and the average was used in the calculations.

There is little literature on grip strength endurance tests and submaximum grip testing (Samnani, Khanna, & Gupta 2005). Thus, we chose endurance test methods generally used for assessing other regions of the body. An example is Sorenson's Test (a valid and reliable isometric back extension endurance test) for the lumbar spine (Biering-Sorensen, 1984; Kankaanpaa, Taimela, Laaksonen, Hanninen, & Airaksinen, 1998; Moreau, Green, Johnson, & Moreau, 2001; Nicolaisen & Jorgensen, 1985). Because Sorenson's Test may involve a submaximal contraction for 2–4 min at 60% of maximum voluntary contraction—pending the health of the lumbar spine—we needed a shorter amount of time consistent with the time a hockey player may withstand a moderate load. Transposing this method, we took 80% of the maximum grip strength and asked the athlete to maintain this level for as long as possible. A red stationary needle on the dynamometer gauge was set at the 80% mark, and the attempt involved maintaining a black needle at or within 2 lbs/in^2 (.9 kg/cm^2) of the preset red needle. A stopwatch was used to measure the time until the athlete was unable to maintain this range. When the athlete first showed fatigue (i.e., the black needle moving lower than the red needle location), he/she was warned once to maintain the position. This method is also used in Sorensen's isometric endurance test (Biering-Sorensen, 1984; Kankaanpaa et al., 1998; Moreau et al., 2001; Nicolaisen & Jorgensen, 1985). Athletes performed this test only once during pretesting.

An obstacle course was designed to challenge the athletes' ability to control a standard weighted (5.5–6 ounces [.15–.17 kg]) vulcanized rubber puck. Such challenges included (a) starting from a stopped position, (b) controlling the puck while reaching wide to the left and right (c) controlling the puck through a tight and fast obstacle region, and (d) performing a figure eight around obstacles with a puck. Players then returned to the obstacle course. Such wide reaching skills as well as the short-and-fast drills, followed by changing direction, are all stick-handling and skating tasks necessary to excel in this sport. A stopwatch was started when the athlete first touched the puck on the starting line and stopped when the athlete returned and crossed the start/finish line (see Figure 1).

When testing all 48 participants, no athlete was able to perform the course without losing the puck or knocking off an obstacle (signified by a cone in the figure). If this happened, the timing was stopped and the athlete was sent to the back of the line. Many athletes required four to five attempts before successfully accomplishing the course. The athlete was not allowed to continue on the obstacle course if he/she knocked off a cone on an attempt, because it could have shortened the overall course time and skewed the data. Athletes were allowed a maximum of three successful tries through the course to acquire their best time.

Both groups performed the same 10-min drills prior to starting their normal practice time. Prior to this training session, they were instructed to perform a light warm-up, which was identical in time and activity between both groups. The conditioning drills were categorized into three different training modes.

Endurance Drills. These drills included long and slow stick travel with long periods of puck-stick contact times. An example of this drill is noted in Figure 2, where the athlete skates straight down a center line between two rows of cones approximately two hockey stick lengths away from the center line. The player would skate down and back with good control yet as quickly as possible. A total of three repetitions were completed with a short rest (30 s) between repetitions. Because the cones were spread quite far apart, the player was forced to control

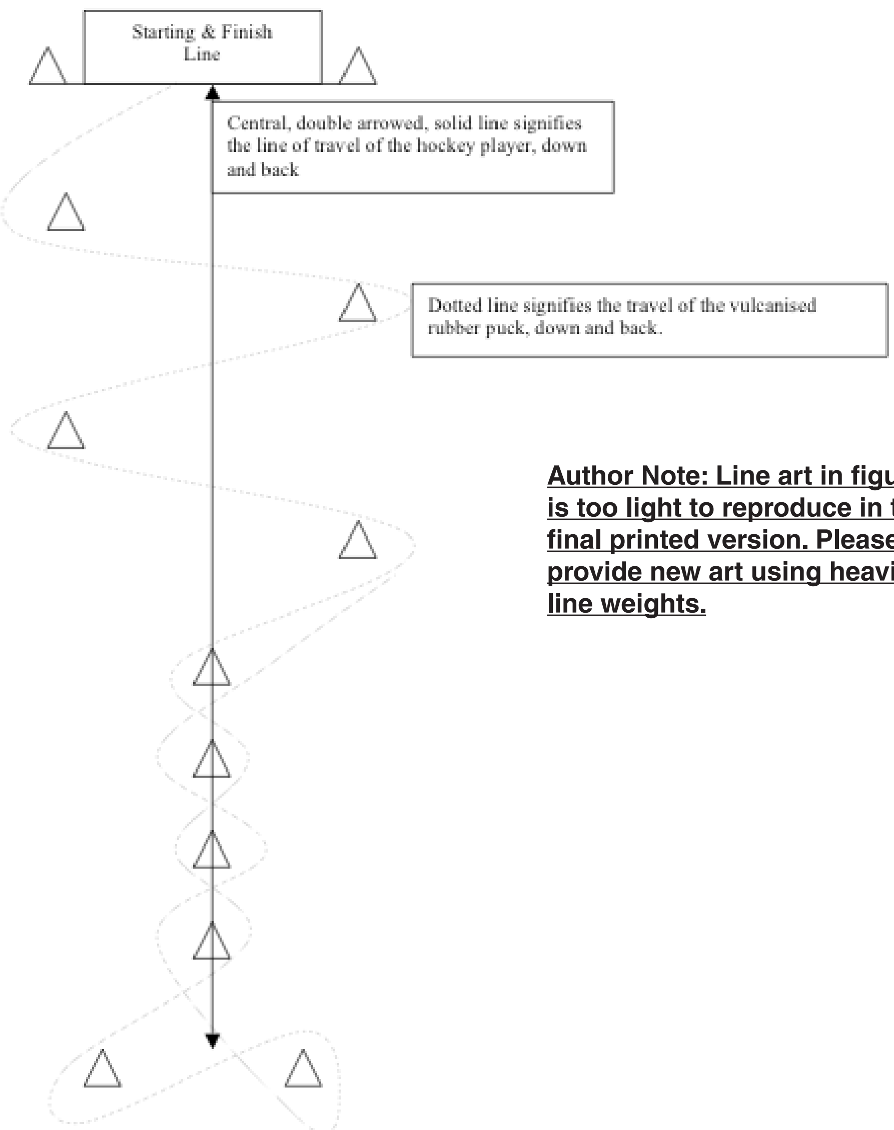

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Figure 1. [AQ: Include Figure caption.]

the stick and puck with one hand, with long contact periods between the stick and puck.

Power/Strength Drills. These drills involved faster moving and moderate stick travel distances with shorter puck-stick contact times. One drill was similar that in Figure 2, except that the cones were spaced only one hockey stick from the center line. The player was encouraged to pull the puck from one cone across the center line to the second cone as quickly as possible. Again, the player would skate between the cones and over the center line, down and back. Each player completed three repetitions with a 30-s rest between.

A second drill also required moderate speed and stick-puck contact times. Two cones were placed one hockey stick apart. The player stood in one spot facing both cones. He/she performed a figure 8 around the cones as fast as possible with good control (see Figure 3). Each player started performing this drill for 30 s and progressed to 75 s over the 2-week period. They performed two repetitions with a 1-min rest in between.

Speed Drills. These drills involved quick and short stick travel distances with short puck-stick contact times. In one speed drill, a single cone was placed in front of the player, who was instructed to circle the cone with

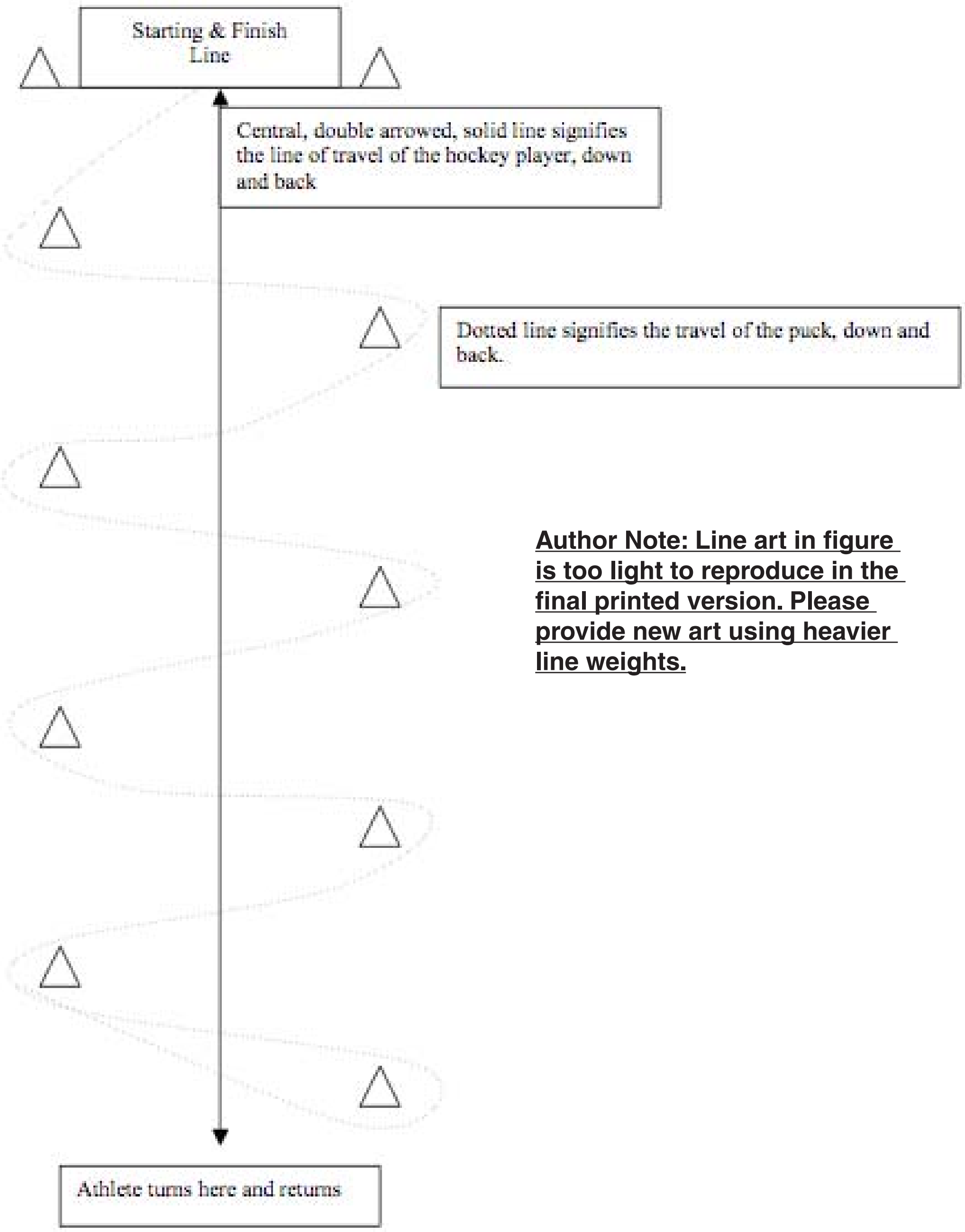

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Figure 2. **[AQ: Include Figure caption.]**

the puck as many times as possible in 30 s. This time progressed to 75 s in the 2-week period.

A second drill required positioning a line of cones with about 2 feet (.6 m) in between. The player was instructed to develop momentum then skate over the top of the cones (with the cones between the player's skates). The player was required to move the puck quickly between the cones as noted in Figure 5. The greater the momentum the player initially built up, the faster he/she would have to control the puck through the cones.

These stick-handling drills are typical of most hockey programs. Further details of the drills are available from the author. Players trained three times per week for 6 weeks. The control participants used a black vulcanized rubber puck (1 inch high x 3-inch diameter; 2.54 cm x 7.62 cm) during all 6 weeks of the training; otherwise their training was identical. The research participants trained with a solid 10.4-ounce (.4 kg) aluminum metallic-colored conditioning hockey puck (1 inch high x 3-inch diameter; 2.54 cm x 7.62 cm) and progressed to a 14.4-ounce (.4 kg) stainless steel metallic-colored conditioning hockey puck (1 inch high x 2-inch diameter; 2.54 cm x 5.08 cm).

- The first 2 weeks involved training drills for puck-handling endurance; the research group used the aluminum puck for the first week and progressed to the stainless steel puck for the second week.
- The second 2 weeks involved training drills for puck-handling power/strength; the research group used the aluminum puck for the first week and progressed to the stainless steel puck for the second week.
- The third 2 weeks involved training drills for puck-handling speed; the research group used the aluminum puck for the first week and progressed to the stainless steel puck for the second week.
- At the end of the 6 weeks, participants performed identical physical tests: maximum grip strength, endurance grip strength, and the obstacle course.

Analysis of variance (ANOVA) single-factor tests were performed on each group's pretraining scores to determine whether an initial difference existed between the research and control groups for (a) endurance hold at 80% maximum grip strength of the right hand, (b) endurance hold at 80% of maximum grip strength of left hand, (c) stick-handling course times, (d) right-hand maximum grip strength, and (e) left-hand maximum grip strength.

To determine whether research groups were statistically different from the control groups for all four variables, each participant's pretraining score was subtracted from the posttraining score to obtain the dif-

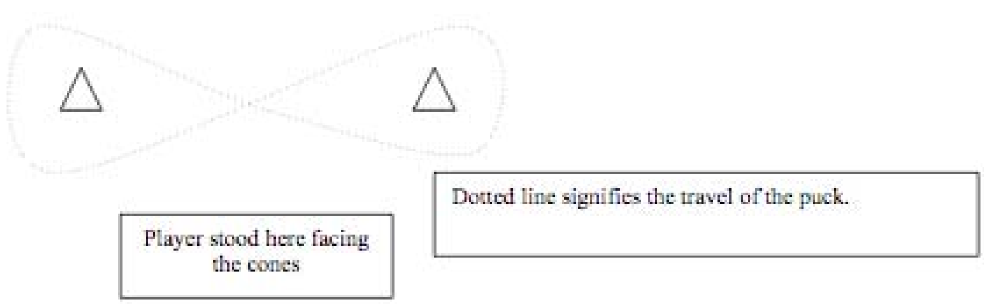

Figure 3. **[AQ: Include Figure caption.]**

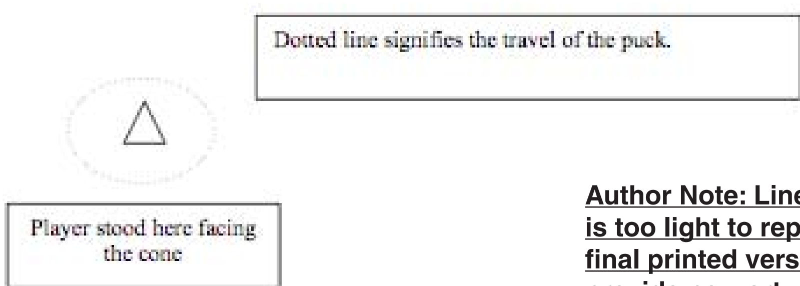

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Figure 4. **[AQ: Include Figure caption.]**

ference (delta score). Delta scores were analyzed using ANOVA single-factor tests between research and control groups on all variables. ANOVA single-factor tests were performed on pre- and postscores of the research and control groups for all variables to determine statistical significance. Statistical analysis was performed using Microsoft Office Excel 2003 SP2; statistical significance was set at $p < .05$.

Results

As shown in Table 1, the only statistically significant pretraining differences were between the initial scores of the research and control groups for stick-handling times. However, the 1.4-s difference between groups is considered small and real terms of minimal relevance (see Table 2).

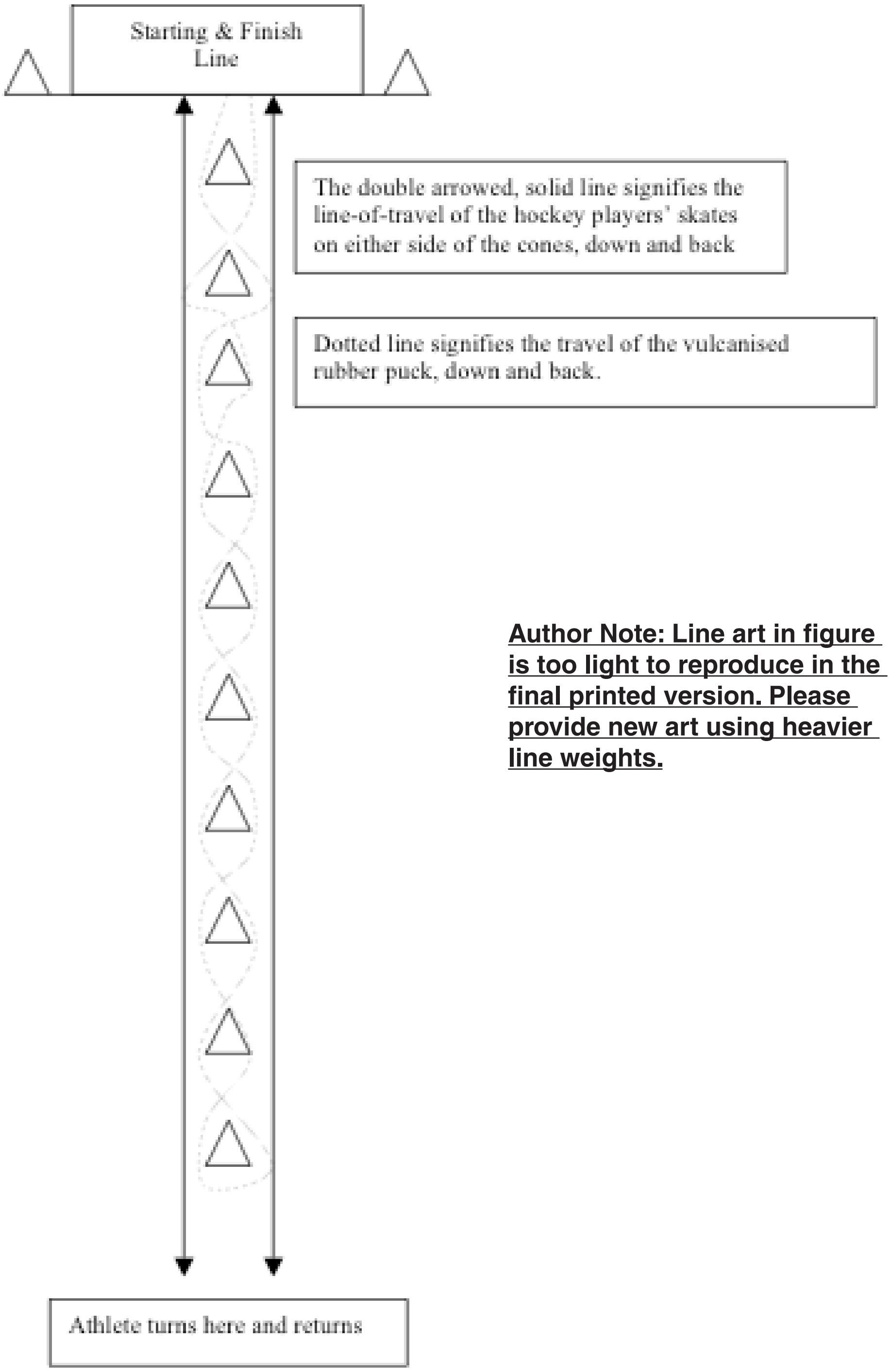

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Figure 4. [AQ: Include Figure caption.]

According to the data in Table 2, the research group delta score (3.7 s ± 1.1) was significantly enhanced for endurance hold at 80% maximum grip strength of the right hand when compared to the control group ($p < .01$). In addition, as seen in Table 2, the research group showed a statistically significant difference between posttraining (14.1 s ±1.2) and pretraining (10.6 s ± .8) scores ($p = .01$), while the control group showed no improvement when comparing posttraining (9.6 s ± .9) to pretraining (9.8 s ± 1.1) scores ($p = .75$).

In Table 2, the data show that the research group delta score (4.0 s ± 1.0) displayed a statistically significant greater improvement in the endurance hold at 80% maximum grip strength of the left hand than the control group's delta score ($p = .04$), which showed only a small increase in the mean (0.6 s ± 1.3). The post- and pretraining scores statistically improved in the research group ($p = .03$) but did not in the control group ($p = .69$).

The research group statistically improved within its own group ($p = .02$), and the control group did not ($p = .16$). However, the improvement in time to travel around the stick-handling course on average did not reach statistical significance for the research group when compared to the control group ($p = .18$). There was no difference between research and control groups in maximum grip strength of the right left hands.

Table 1. Initial comparison metween mean pretraining score of the research group and the mean pretraining score of the control group for variables

Variable	ANOVA test within groups (*p*)
H 80% MGS R	.70
H 80% MGS L	.81
SH times	.01
M GS R	.32
M GS L	.80

Note. ANOVA = analysis of variance; H 80% MGS R = endurance hold at 80% of maximum grip strength of right hand (s); H 80% MGS L = endurance hold at 80% of max grip strength of left hand (s); SH Times = stick-handling course times (s); M GS R = maximum grip strength of right hand; M GS L = maximum grip strength of left hand.

Discussion

A 6-week stick-handling program including 2 weeks of endurance training, 2 weeks of power/strength training, and 2 weeks of speed work using a weighted metallic implement while training on the ice statistically demonstrated an enhancement of grip strength endurance. While there was a trend toward better stick-handling ability, the data did not support this. Anecdotally, there appeared to be fewer errors in the research group, and this variable should be tested in any future research.

With the ever popular catch phrase of sport-specific training in the strength and conditioning field, it is always an added challenge for the coach to make conditioning lifts, movements, and other challenges truly sport specific. In a recent article, most of the National Hockey League coaches were asked what they would like to do differently with their strength programs. The second most common response was "on-ice specificity training" (Ebben, Carroll, & Simenz, 2004.).

Table 2. Summary of results

Variable	Group	Pretraining *M*	Pretraining *SE*	Posttraining *M*	Posttraining *SE*	Delta score *M*	Delta score *SE*	% Change	95% CI for Delta score	ANOVA within groups (*p*)	ANOVA between groups (*p*)
H 80% MGS R	Research	10.6	.8	14.1	1.2	3.7	1.1	33.0	1.4, 6.0	.01	< .01
	Control	9.8	1.1	9.6	.9	-.4	.7	-2.0	-1.9, 1.1	.75	
H 80% MGS L	Research	9.0	.9	13.0	1.6	4.0	1.0	44.4	2.0, 6.0	.03	.04
	Control	8.6	1.2	9.2	.8	.6	1.3	7.0	-2.1, 3.3	.69	
SH times	Research	21.2	1.0	18.6	.6	-2.7	.6	-12.3	-3.9, -1.5	.02	.18
	Control	22.6	.8	21.0	.7	-1.6	.5	-7.1	-2.7, -.5	.16	
M GS R	Research	66.4	2.5	69.8	2.8	3.4	.9	5.1	1.5, 5.3	.37	.92
	Control	71.2	4.4	74.5	4.0	3.3	1.3	4.6	.5, 6.1	.58	
M GS L	Research	67.3	3.0	70.4	2.9	3.1	.7	4.6	1.7, 4.5	.47	.23
	Control	68.5	3.7	70.0	3.7	1.6	1.1	2.2	-8, 4.0	.76	

Note. M = mean; *SD* = standard deviation; CI = confidence interval; ANOVA = analysis of variance; H 80% MGS R = endurance hold at 80% of maximum grip strength of right hand (s); H 80% MGS L = endurance hold at 80% of max grip strength of left hand(s); SH Times = stick-handling course times (s); M GS R = maximum grip strength of right hand; M GS L = maximum grip strength of left hand.

This is the first study of weighted implement training, specifically a weighted puck, to enhance ice hockey skills. There appears to be no research this topic; however, there are a number of articles on the use of medicine balls for enhancing core and extremity strength, endurance, and power (Faigenbaum et al., 2001; King, 2005; Mayhew et al., 2005).

This study shows potential for specifically enhancing ice hockey players' physical abilities. Further research in this understudied area of ice hockey and sports-specific conditioning may provide tremendous benefit to this growing sport. However, this study has limitations, including the relatively small number of participants in the trial and instrument/rater measurement error. Future research should involve a larger group of players, including those from advanced skill levels.

Practical Applications

Conditioning elements for ice hockey players in full gear on the ice, moving and performing athletic tasks as they would when competing, is an integral part of training (Pollitt 2004). Using weighted implements in this "competitive" environment for only a few minutes a day may provide the young, and possibly advanced, hockey player with sport task-specific enhancements. As with all training equipment, there is risk of injury. Using weighted implements, such as the one described in this manuscript, are no exception. This training device should be used for stick-handling drills only. Players must be discouraged from using this device for shooting and elevated passing activities.

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Authors' Notes

The primary author is the inventor of this product and formatted the paper for publication. He has pecuniary interests. The fourth author provided data collection only at that time of this study and has subsequently come to have pecuniary interests. The second, third, and fifth authors provided statistical analysis and editing and have no pecuniary interest. Our gratitude to all of the young participants in this study as well as their parents and coaches, allowing time and energy to successfully complete this study. Data acquisition and hockey conditioning were performed at the Moorhead Ice Arena in Moorhead, MN. Data analysis was performed at the University of Mary. Please address all correspondence concerning this article to Timothy W. Stark, Senior Lecturer, Murdoch University Health Science Division, School of Chiropractic, Amenities Building, Room 301a, South Street, Murdoch, Western Australia. Australia 6150.

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