Journal of Physical Education and Sport ® (JPES), 17(3), Art 163, pp.1061 - 1067, 2017
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

The use of technology associated to the control of strength training in elite clubs of roller hockey.

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Published online: September 30, 2017
*(*Accepted for publication August 20, 2017*)*
DOI:10.7752/jpes.2017.03163

Abstract:
Aim: determine the use of the technology associated to the control of strength training in teams of the Spanish roller hockey. The following aspects were examined: physical conditioning coaches profile and the percentage of the teams than utilize an encoder, to measure the displacement time of the bar, and the Optojump system. **Methods:** A survey was administered to the responsible of the physical conditioning preparation of each team by means of personal interview. The response rate was 83.3%. **Results:** There were differences between categories in the utilization of the encoder (21.4 vs 12.5%) and of the Optojump (35.7 versus 25.0%). The two vertical jump height tests more used were the countermovement jump (CMJ) (33.9%) and the squat jump (SJ) (20.5%). Due to the variability of practical applications of the Optojump and especially of the encoder, and the difficulty to control numerous parameters by means of another methodologies. **Conclusion**: the results of this study show, that at least in great part in the teams examined exist absence of scientific control of the strength training. The poor scientific formation of the physical conditioning coaches and various aspects associated to the team sports, requirements of the competition calendar, variability of performance factors and the numbers of players can explain these results.
Key words: exercise test; physical conditioning; isotonic contraction; elite athletes; strength diagnosis.

Introduction

Time-motion analysis show that the activity patterns of team sports are intermittent in nature, fluctuating randomly from brief periods of maximal or near maximal work to longer periods of moderate- and low-intensity activity (Glaister, 2005). Although the majority of the total player game time is spent in the low-intensity motions of walking, jogging and standing, the numerous explosive bursts of activity required, including jumping, kicking, throwing, tackling, turning, sprinting, and changing pace can be determinant for the performance (Spencer et al., 2005).

The strength in team sports must be applied in relation to and official weight ball (throws, kicks), opposing players (tacks, blockages, pushes) and the players´s own body mass (jumps, sprints, turns). As velocity = (force x time)/weight, only is possible increase throws and kicks velocity with and increase in force. In the same way, height jump and sprint velocity only can increase with the force improvement and/or decreasing body mass. However, decrease body mass only is possible until the optimal values for each sport. Therefore, strength training must be included in the team sports conditioning programs. In this way, strength training has been effective for the velocity improvement specific tasks of team sports, as shoot in soccer (Taïnana et al., 1993), throwing in baseball (Lachovetzt et al., 1998, McEvoy and Newton, 1998), netball (Cronin et al., 2001) and handball (Gorostiaga et al., 1999, Cardoso and González-Badillo, 2006), and specific jump in volleyball (Newton et al., 1999). In addition, strength training has been effective for injuries prevention (Wedderkopp et al., 1999, Caraffa et al., 1996), and to maintain optimal levels of physical capacity during the season (Cardoso and Gonzalez-Badillo, 2006).

A number of field and laboratory tests are currently used in elite team sports in order to evaluate training status of the players and to determine the effect of training. In relation to muscular explosive power, specific tests field, as 10-m sprint performance and throwing or shooting velocity determined using a Speed Check Radar, have advantage to predict match performance. However, with these tests the physical conditioning coach has difficulty discerning the neuromuscular processes that determine the results. In consequence, specific tests have less validity to guide the training program.

One of principal objectives of the tests is to provide data which identify specific areas of relative deficiency than can be used to determine individual training programmes that maximize athletic performance. Exactly which training option is best for any given athlete at any given time is difficult to determine with accuracy, however, test results can provide data upon which such a decision may be base (Wilson and Murphy, 1996)

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For example, in sports that require explosive power, Hakkinen et al. (1985) proposed strength diagnosis by means of the force-time curve analysis of isometric muscle action: in athletes with relatively good maximal force but poor rate of force development (RFD) should maximize performance gains through plyometric training, whereas athletes with relatively good RFD but poor maximal force should achieve the best performance gains through the use of heavy strength training. Although several investigators have determined significant relationships between isometric force-time curve characteristics and dynamic muscle actions (Haff et al., 2005, Wilson and Murphy, 1996), today is accepted than the determination of crucial variables of dynamic muscle actions, specially with free weights, has more applicability than the isometric or isokinetic evaluation (Stolen et al., 2005).

The applied engineering to sports has developed the necessary technology to determine, in dynamic movements, some variables that can be used to guide the strength training. Probably, the instruments with greater application are the encoder, to measure in the work with free weights the bar displacement over time, and the Optojump system to evaluate ballistic movements .

According to Smith (2003), in order that tests have utility to guide the training, the athlete must be evaluated systematically, at least three times during the season.

The principal purpose of these important technological advances is its application in the daily practice of athletics' training. Therefore, the purpose of this study was to determine the use of technology associated to the control of strength training in elite Spanish Clubs of roller hockey.

Material & Methods

Participants

To accomplish the proposed objectives we decided to interview the responsible of the physical conditioning preparation of the male teams that participated during the 2014/15 season in the Spanish league of roller hockey: Ok Lliga (N = 14, elite teams) and roller hockey first-division (N = 16) (League of the roller hockey Clubs Association) . There are two maximum categories of the roller hockey.

Survey

The survey was created by the authors with the help of experts in questionnaire design and was pilot tested with and informal advisory group of physical conditioning coaches (Reverter et al., 2009). The survey was divided into 3 areas of inquiries: (a) physical conditioning coaches profile, (b) utilization of the encoder, to measure in the work with free weights the bar displacement over time, (c) utilization of the Optojump system. 12 items associated with formal education and sources of information were developed to know the profile of the physical conditioning coaches. 2 items were designed with purpose to know the percentage of teams that utilize the encoder and the Optojump system. The physical conditioning coaches that declared use the encoder and/or the Optojump system were invited to indicate the tests performed.

The survey instrument and the research design were approved by the Committee of Ethics of the Catalonia Government, Spain.

Data collection

In order to contact with the physical conditioning coaches, a letter describing the project was mailed to the address of the official headquarters of all the teams. The objectives of the letter were to explain the purpose of the survey, the confidentiality of information, and the researchers´ motivation for conducting the survey. After 2 weeks, a telephone call to the official headquarters of the club was conducted so as to speak personally with each responsible of the physical conditioning preparation. Several attempts were made to contact by telephone, letter and e-mail with the responsible of the physical conditioning preparation that initially were not located. All the addresses and telephones were obtained from the official web pages of the clubs or from the information facilitated by the Spanish Federation. Finally, 28 coaches accepted to collaborate in the study. The remainder coaches declined to participate, or did not respond to the e-mail, mail letter or telephone messages. It agreed with each coach a date with purpose to administer the survey by means of personal interview (Tab. 1).

Table. 1. Physical conditioning coaches response rate.

League	**Ok Lliga**	**First Division**
Number of teams n = 30	14	16
Number of teams interviewed n = 28	12	16
Total interviewed rate 93.3%	93.3%	100%

All the interviews were accomplished by an experimented researcher in qualitative methods of sports science research and content analysis.

Analysis

Statistical analysis was performed with software (Statistical Package for Social Sciences, Version 25.0). Data are expressed in percentages. The α level was set at 0.05.

Results

The profile of physical conditioning coaches: differences among categories

80% of the physical conditioning coaches of Ok Lliga degree in Physical Activity and Sport Sciences in contrast to a 40% of the physical conditioning coaches of First Division ($p < 0.001$)

Respectively, a 45% and a 20% of the physical conditioning coaches had a Master and Doctoral degrees in related fields of human performance. A high percentage of physical conditioning coaches attended at least to one course of more than 20 hours in the last three years (80%), and know the physical preparation work developed by at least one team of his league (90%).

The majority of physical conditioning coaches consult specific journals related to their professional activity (75%), however only a 10% consult journals included in the Science Citation Index (ISI).

Technology associated to the control of strength training: differences among categories

Respectively, a 57.1% and a 12.5% of the team used the encoder. A greater percentage of Ok Lliga teams in comparison with the remaining First Division use the Optojump system (35.7 vs 25.0%) (Tab. 2).

Table. 2**.** Percentage of the teams that utilize the encoder and the Optojump system

	Ok Lliga n = 14	**First Division = 16**
Encoder	57.1	12.5
Optojump system	35.7	25.0

The percentage of equipment that works properly, maximum speed not muscular failure with encoder, is approximately one third of the total (8 teams Ok Lliga and 2 teams First Division). This teams work in different intensity ranges.

Table. 3. Percentage of teams working with the combination of execution speed and muscle failure for each load intensity range

	Maximum speed and no muscle failure	**Maximum speed and muscle failure**	**No maximum speed and no muscle failure**	**No maximum speed and muscle failure**
< 30% de 1RM n = 4	100.0	0.0	0.0	0.0
30-50% de 1RM n = 5	100.0	0.0	0.0	0.0
50-70% de 1RM n = 10	90.0	0.0	10.0	0.0
70-90% de 1RM n = 9	100.0	0.0	0.0	0.0
90-100% de 1RM n = 2	100.0	0.0	0.0	0.0

The physical conditioning coach manifested to utilize the encoder exclusively to measure the maximum power with different load intensities. The two vertical jump height tests more used were the countermovement jump (CMJ) (67.8%) and the squat jump (SJ) (41.1%).

Another jump tests were indicated by a lower percentage of the physical conditioning coaches, CMJ with the arm swing (CMJA) (7.1%), bounce drop jump (BDJ) (21.4%), loaded CMJ (LCMJ) (0.0%) and CMJ 15 seconds (0.0%) (Tab. 4).

Table. 4. Vertical jump height tests used for the physical conditioning coaches

	Ok Lliga n = 14	First Division n = 16
SJ	28.6	12.5
CMJ	42.8	25.0
CMJA	7.1	0.0
BDJ	21.4	0.0
LCMJ	0.0	0.0
CMJ 15 s	0.0	0.0

SJ = squat jump, CMJ = countermovement jump, CMJA = countermovement jump with the arm swing, BDJ = bounce drop jump, LCMJ = loaded countermovement jump, CMJ 15 s = countermovement jump during 15 seconds.

Discussion

This work represents the first study that determines the use of technology associated to the control of strength training in the roller hockey. Then, the analysis accomplished can be a reflection of the real impact of the new technologies in the development of the roller hockey.

The knowledge of the force and power performed at different loads intensities is essential for the control of strength training (e.g., Crewther et al., 2005). The encoder permits to measure the displacement time of the bar and therefore using a finite differences algorithm to determine velocity and acceleration data, the force (multiplying the mass by the acceleration data), and the power (multiplying the force by the velocity data). This permits a great variability of practical applications in the control of strength training (a) determining force-velocity curve, power-load curve, force deficit, and the optimal load for maximum mechanical power, in each exercise, athlete and moment of season (Izquierdo et al., 2002), and (b) examining at different loads the repetition speed during the sets of repetitions in each exercise, athlete and moment of season.

The results of this study showed that only a 35'7% of the teams utilize the encoder. This implicates that a great percentage of the physical conditioning coaches does not have scientific data to reorient and individualizing strength training and do not know for each player and exercise the load intensity to accomplish the maximum power. Of special interest, that in only ten team, the physical conditioning coach utilizes the encoder to measure the repetition velocity in the resistance training sessions. Today, some authors stand out that the execution of the repetitions at maximum speed can be one of the most determinant variables for an optimum transfer of the resistance training to the strength manifestation in specific motor skills (Izquierdo et al., 2006, Munn et al., 2005).

It has been reported that over a set of repetitions to failure the speed of the repetition slows naturally as fatigue increases (Izquierdo et al., 2006, Lawton et al., 2006). For this motive, some authors suggest a potential beneficial stimulus of performing sets to no failure for improving strength and power (Izquierdo et al., 2006). Special interest is that the repetition velocity can be associated with a selective hypertrophy of muscle fibers and with fiber type transformations. The differences experienced in the ratio of type II/type I areas for competitive lifters (weighlifters, 1.54; powerlifters, 1.42; and body builders 1.19) suggest a preferential hypertrophy of the type of fibers for the type of training performed (Fry, 2004). According with Tidow (1995), to approach in the training to the execution of the number of repetition than can be performed at maximum speed for each RM load can probably prevent the conversion of fibers type IIB to IIa that is inherently related with resistance training (Fry, 2004). It is confirmed that different rest periods lengths influence the fatigue in continuous sets of the same exercise, determining the number of repetitions performed (Willardson and Burkett, 2006) and the decrease in muscular power (Abdessemed et al., 1999). Consequently, only with the encoder we can establish in each group of population, intensity of load and exercise, the number of sets and the optimum rest that permit to maintain the execution of the repetitions at maximum speed.

When performing traditional lifting exercises, there is always the limitation that the load must be stopped at the end of the concentric movement. To avoid this problem, the bench press can better be replaced by a king of bench throwing, and the squat can be changed into squat jumping. As a result, the higher velocity of movement and the reduced deceleration phase provide superior loading conditions for the neuromuscular system, greater force and power production (Cronin et al., 2003; Newton et al., 1996). Besides, ballistic training would provide potentially greater transfer of training effects for optimal adaptation and successful performance thereafter due that the velocity profile is more closely resembling that occurring during most athletic (Crewther et al., 2005). Therefore, strength analysis with ballistic technique can be relevant in the control of training program.

The technology required for the evaluation of ballistic resistance exercises of the arms is recent and requires a complex modification of the Smith Machine. However, a machine was designed 30 years ago for the evaluation of ballistic exercises of the lower extremities (Optojump system). The machine consisted of a portable contact mat connected to a laptop computer via a way data cable. The system calculated jump height (cm), flight time (millisecond), ground-contact time (milliseconds), and absolute power output using customized software. Although today the evaluation can be made by means of ultrared rays or in a force plate, the scientific based of the tests performed continue being the same.

With regard to this matter, Bosco designed a variety of vertical jump tests, with a great popularity in the daily practice of athletic´s training, in order to evaluate neuromuscular processes with the objective of comparing performance between subjects and long-term monitoring of training (Komi and Bosco, 1978).

Probably the popularity of the vertical jump tests justify than a 30.1% of the teams analyzed in this study utilize the Optojump System in the control of strength training.

In the SJ, the subjects start from a stationary semisquatted position emphasizing the concentric action of movement. In the CMJ the subjects start from an upright position and performed a very fast preliminary downward movement, flexing his knees and hip. The height achieved in a CMJ is higher than in a SJ due to that part of the energy accumulate during the eccentric phase could be stored in elastic elements and reutilized to perform work in the concentric phase (Bosco et al., 1982). We consider that measurement SJ and CMJ is useful to know muscular explosive power of the lower extremities in team sports. SJ and CMJ height are highly related with specific sprint performance (5-10-20-30 meters) in rugby (Cronin and Hansen, 2005) and soccer players

(Wisloff et al., 2004, Young et al., 1996). However, the more important is that relating SJ and CMJ height we can calculate the elasticity index (Bosco et al., 1986). Due to than the reutilization of elastic energy is greater with a fast stretch-shorten cycle (SSC) (Henchoz et al., 2006), a player with an optimal SJ height and poor elasticity index should based the trainer in plyometric exercises, whereas players with relatively good elasticity index but poor SJ height should achieve the best performance gains thought the use of exercises with slow SSC.

Only a 7.1 % of the physical conditioning coaches determined the CMJA height. A deficit in the relation CMJA/CMJ height can be indicative of poor intermuscular coordination.

In the BDJ, the subjects stepped form a box and, and performed a maximal jump immediately after landing on the floor. In BDJ only a small downward movement occurs. This means that hip flexion, knee flexion and dorsiflexion velocities are decelerated quickly, and concomitantly only a short time elapses between the instant at which peak pre-stretch speeds of muscles are reached and the star of concentric muscle action. Cronin and Hansen (2005) suggesting that the different jumps to some degree measure different explosive leg-power qualities, such as slow and fast SSC performance. This can explain why on the contrary than with the SJ and CMJ, BDJ height is not related with specific sprint performance (5-10-20-30 meters) (Cronin and Hansen, 2005; Young et al., 1996). The absence of a statistically significant relationship between BDJ performance and 5 to 30-m sprint times can be proper for differences in the duration of SSC. BDJ is characterized by fast SSC, while the sprint duration found, for example, en field hockey, 1.8 ± 0.4 seconds (Spencer et al., 2004) and basketball, 1.7 ± 0.2 seconds (McInnes et al., 1995) determine slow SSC. In consequence, we consider than BDJ performance does not have validity to determine the strength manifestation of the majority of specific motor skills of team sports.

In relation to the specific test field, probably the jump test than can contribute the information added more useful in order to evaluate the effect of strength training is the execution of SJ or CMJ with progressive increment of load. This test contributes in a ballistic movement the relation load-height, an indirect measure of the force-velocity curve, and the power-load curve. In addition, the physical conditioning coach can determine the force deficit by means of the Bosco index and the optimal load for each player to perform the maximum power. However, no one the physical conditioning coaches interviewed indicated the utilization of the LCMJ.

Due to the variability of practical applications indicated for the Optojump system and especially for the encoder, and the difficulty to control numerous parameters by means of another methodologies, the results of this study show, that at least in great part, in the teams examined exist absence of scientific control of the strength training.

Conclusions

Various factors may have influenced in the results found in this study: (a) the scarce permanent scientific education of physical conditioning coaches due to that during the long time few continued his academic education (Master and Doctoral degrees) and the consultation of journal included in ISI; (b) possibly the requirements of the competitive calendar make difficult an optimum training and evaluation of the strength; (c) due to the variety of factors that determine team sports performance, it is possible that some physical conditioning coaches opt to reorient the training on the base of global analysis of competition; and (d) due to the numbers of players, an exhaustive control of strength training requires several machines, long time and qualified professionals. It is possible that in some teams these conditions are unreal.

Independently of these hypothesis, these results should serve of reflection so as to the physical conditioning coaches of these teams question their methods of the strength diagnosis and they justify the need that they undertake a continuous scientific education, based especially on the carrying out of specialized Master degrees and the consultation of scientific journals.

In the same way, the results presented should serve of feedback to the scientific community and to the physical conditioning coaches of others teams, from a triple perspective: (a) the knowledge of the strength diagnosis developed in most of the sports specialities by teams with success in European competitions, (b) the need of improvement strategies in the dissemination of scientific knowledge associated to the control of strength training toward the coaches involved in the development of elite athletes, and (c) the analysis accomplished in this study can be used as model to accomplish similar works in order to know the impact of new technologies at another Countries, sports and Institutions, as well as for determining the changes in the teams analyzed in this study.

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