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Effectiveness of Post Activation Potentiation Versus Complex Contrast Training on Speed, Agility and Strength in Male Hockey Players - An Experimental Study

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ABSTRACT

BACKGROUND: Hockey is a sport which requires a high number of repeated near-maximal exertion. It is a physical activity that demands high levels of anaerobic and aerobic capacity in addition to physical strength and power. A successful shot in field hockey requires generating high velocity and power through body rotational movements. A technique called the "slap shot" or "push pass" is more often used by the hockey players to maximize the force transferred to the ball.
PURPOSE: To determine the effects of Post activation potentiation and Complex contrast training on speed, agility and strength in male hockey players.
METHOD: Total 34 players were included and divided into two groups (17 in each group). Group A was given Post activation potentiation training and Group B was given Complex contrast training for 4 weeks (3 sessions per week.) 20-meter sprint test, Modified agility T-test, 1 RM squat test and 1 RM bench press test were used as outcome measures and pre and post-intervention measures were taken.
RESULT: Intergroup analysis by independent t-test showed statistically significant improvement in speed, agility, lower limb strength and upper limb strength in hockey players with the use of Post activation potentiation training and Complex contrast training (P value $\leq$ 0.001).
CONCLUSION: Post Activation potentiation training was found to be more predominant in improving speed, lower limb strength and upper limb strength in hockey players than Complex contrast training. Also, Post Activation potentiation training and Complex contrast training were equally effective in improving agility in hockey players.
KEYWORDS: Post Activation Potentiation Training, Complex Contrast Training, Modified Agility T-test

INTRODUCTION

Hockey is similar to sports like ice hockey, basketball, lacrosse, and rugby in which it has been found to require a high number of repeated near-maximal exertion. It's a physical activity that demands high levels of anaerobic and aerobic capacity in addition to physical strength and power. Professional or semi-professional players have the time and resources to develop conditioning routines when these sports are played at the highest levels. A successful shot in field hockey

requires generating high velocity and power through body rotational movements. A technique called the "slap shot" or "push pass" is often used by the hockey players to maximize the force transferred to the ball, players rotate their torso, transferring energy from the lower limbs through the trunk and into the arms.[1]

Speed is crucial in hockey, especially when attacking and defending. Faster players may run faster, get the ball faster, and eventually create plays that are more effective. This is especially important while defending penalty corners, because the player has to run to cover the goal post. After proprioceptive training, some changes in speed and explosiveness are anticipated based on the above potential consequences, particularly the alteration in muscle force generation. In defensive movements like tackling or blocking, the knee flexion and ankle dorsiflexion are important to lower the body's center of gravity for balance and stability. The body uses a lot of lateral (side-to-side) motion, engaging the hip abductors and adductors, as well as the calf muscles for support when quickly moving across the field.[2]

Players need a number of skills in order to quickly change directions while moving, maintain posture control, accelerate and decelerate while going in the correct direction, and manage their space. Twisting actions are essential in field hockey for making quick turns or changing directions.[3,4].

Strength is crucial for a hockey player to optimize his ability to control the puck and shoot. Stronger body balls allow players to hit the ball harder, increasing the power of their shots. Enhancing one's ability to strike with precision and power can be achieved by upper body strengthening exercises, specifically targeting the arm and core musculature.[5,6]

Post Activation Potentiation (PAP): Long recovery intervals between a potentiating stimulus and the exercise that follows, however, are not practicable from a training standpoint in most strength training situations since they tend to lengthen the training session. Research indicates that if a strenuous resistance exercise is used as a potentiating stimulus, 18.5 minutes of rest may be necessary before a PAP effect is shown, with a recovery time of 7–10 minutes being ideal.[7,8]

Complex Contrast Training (CCT): Complex Training principles for hockey pair strength and plyometric perform a heavy strength movement → Follow with an explosive movement (same muscle group). Rest: 30-90 seconds between pairs Frequency: 2-3 times per week, depending on season phase.[9,10]Focus on hockey-specific movements prioritize exercises that mimic skating, shooting, and body contact. Train, Lower Body power: Improve skating acceleration, cutting, and stopping power. Upper Body power: Enhance shooting power and physicality in battles.[11'12]

MATERIALS AND METHOD

- The study was conducted on 34 National level hockey players after receiving ethical approval.
- Students were selected on the basis of purposive sampling and were divided into two groups: Group A and Group B for 4 weeks (3 sessions per week)
- Materials used:

a) Informed Consent form
b) Assessment form
c) Participant Information sheet
d) Stopwatch
e) Cones
f) Rope
g) Barbell
h) Dead lift bar
i) Foam Mattress
j) Bench (for bench press)
k) Kettle bell
l) Hex bar
m) Chin up bar
n) Squat racks with safety bars

- Outcome Measures:

1. 20-meter Sprint test:[13]

The outcomes of a 20-meter sprint test can show a major difference depending on age, gender, training background, and fitness

level. Basically, for adult males, completing a 20-meter sprint in around 3.5 to 4.5 seconds will be considered quite well. Elite sprinters can achieve times significantly below this range, sometimes even below 3 seconds.[16]

2. Modified Agility T-test (MAT): [ICC value = 0.99][14]

MAT is used to determine the speed with directional changes, including forward sprinting, left and right shuffling, and backward running. Cones at a height of 0.64 m will be placed at points A, B, C, and D and the players will be asked to sprint from A to B, perform a 90˚ turn from cone B towards cone C, then perform a 180˚ turn at cone C towards cone B, before performing a weave at cone B towards cone D, then performing a 180˚ turn at cone D towards cone B, and finally a 90˚ turn to the start/finish line. The players will complete the test with their back always facing the start/finish line Three trials will be performed with three-minute rest between trials and fastest trial will be selected for anlysis.[11]

3. 1 RM Squat test (LL strength):[15]

Figure 1: 1 RM Squat test

4. 1 RM Bench Press test (UL strength):[15]

Figure 2: 1 RM Bench press test

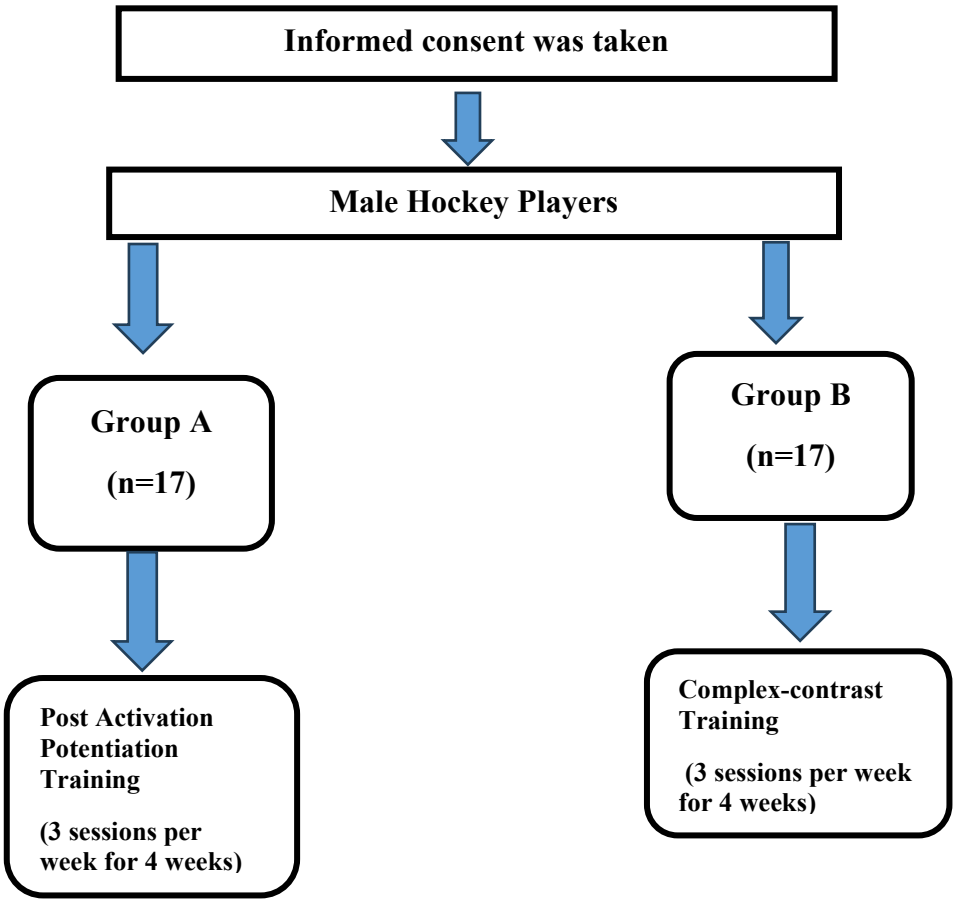
Group A: (n=17)

Post Activation Potentiation training (3 sessions per week for 4 weeks).

Group B: (n=17)

Complex-Contrast training (3 sessions per week for 4 weeks).

- **Flowchart of Procedure:**



- **Intervention:**[10]
  Before performing intervention in Group A and Group B, a 10- minute general warm-up was conducted in the form of jogging, dynamic stretching and body mass-based exercises (e.g., freehand squat, walking lunges, push-ups).

Group A: Post Activation Potentiation training [15]

Weeks	Heavy Strength	Rest	Explosive Power	Volume	Intensity
4 weeks	Back Squat	4 minutes	Jumping Lunges	3 set × 5 repetitions	85% - 90% of 1 RM
	Hex – Bar Deadlift	4 minutes	Drop Jump with Horizontal	3 set × 5 repetitions	
	Additional Exercises			Volume	Intensity
	Bench Press	1 minute	-	2 set × 8 repetitions	70% - 75% of 1 RM
	Chin up	1 minute	-	1 set × 8 repetitions	
	Rear foot split squat	1 minute	-	2 set × 8 repetitions	

Group B: Complex-Contrast training [16]

Weeks	High-load Resistance Activity		Low-load High-velocity Activity		Intensity
	Exercises	Sets × reps	Exercises	Sets × reps	65% of 1 RM
	Squat	3 × 15 repetitions	Squat jump	3 × 6 repetitions	
Weeks 1-2	Romanian deadlift	3 × 15 repetitions	Kettlebell swing	3 ×10 repetitions	
	Barbell lunges	3 × 15 repetitions	Barbell high knees	3 × repetitions	
	Bench press	3 × 15 repetitions	Plyo-push up	3 × 6 repetitions	
	Squat	3 × 10 repetitions	Squat jump	3 × 8 repetitions	75% of 1RM
Weeks 3-4	Romanian deadlift	3 × 10 repetitions	Kettlebell swing	3 ×10 repetitions	
	Barbell lunges	3 × 10 repetitions	Barbell high knees	3 × 20 seconds	
	Bench press	3 × 10 repetitions	Plyo-push up	3× 8 repetitions	

Regular Conditioning Training: [16]
Conditioning training was given on alternate days specific to speed, agility and strength alternatively (3 sets x 10 repetitions for each exercise)

Speed:
- High step walking
- Run shuffle
- Run speed
- Skipping
- Triple jump
- Lateral Low hurdle run
- Split jump

Agility:
- 3 cone drills
- L drills
- Tuck jump
- Deceleration drills
- Lateral plyometric jump
- Lateral drills

Strength:
- Squat
- Lunges
- Calf raises
- Hamstring curl
- Bench press
- Push up
- Pull up

DATA ANALYSIS
Data was analyzed by IBM SPSS 29.0 software and Microsoft excel 2023. Prior to performing statistical analysis test, data was screened for normal distribution by Shapiro-Wilk's test. According to normality test, tests were applied for within group (Paired t-test) and between group (Unpaired t-test) for 20-meter sprint test, Modified agility t-test, 1 RM Squat test and 1 RM Bench press test.

RESULTS

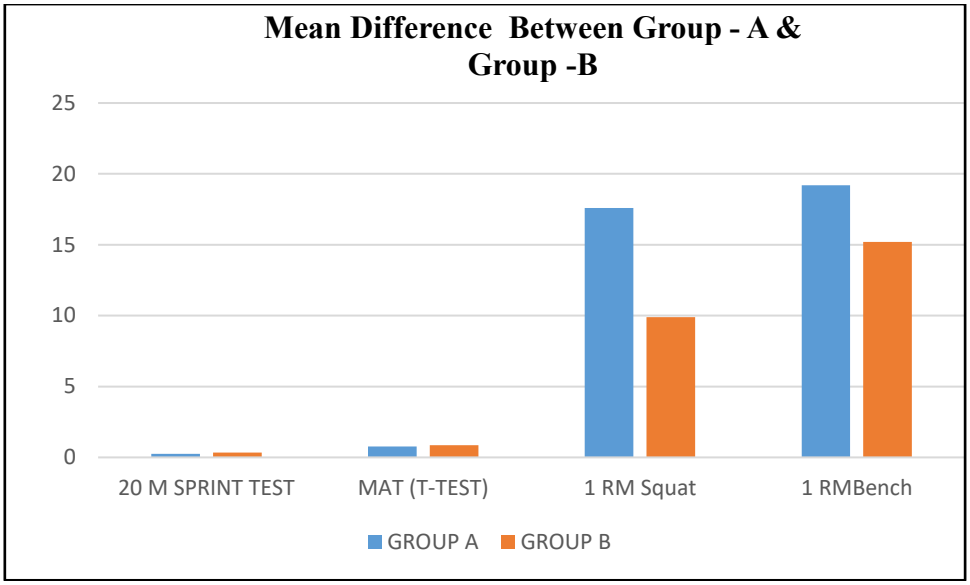
- In this study, a total of 34 Players were recruited, 17 in each group.
- Group A was given Post Activation Potentiation Training and Group B was given Complex Contrast Training. The descriptive characteristics of all variables were as follows:

Table 1: Baseline Data

GROUPS	GROUP A	GROUP B
NO. OF SUBJECTS	17	17
AGE	MEAN±SD	MEAN±SD
	20.8±2.09	21.4±1.72
BMI	19.6 ±1.30	20.6 ±2.03

Table 2: Intergroup Analysis Between (Group A and Group B)

OUTCOME MEASURES	GROUP A MEAN±SD	GROUP B MEAN±SD	t VALUE	P VALUE	REMARKS
20-meter sprint test	0.25 ± 0.11	0.34 ± 0.14	2.11	<0.001	SIGNIFICANT
Modified agility t-test	0.78 ± 0.57	0.85 ± 0.54	0.38	0.71	NOT SIGNIFICANT
1RM squat	17.6 ± 7.60	9.9 ± 4.32	3.63	<0.001	SIGNIFICANT
1RM Bench press	19.2 ± 5.32	15.2 ± 4.50	2.36	<0.001	SIGNIFICANT



Graph 1: Mean Difference Between Group A & Group B

Here, the absolute difference was measured by Unpaired t-test for 20-meter Sprint test, Modified Agility t-test, 1 RM Squat and 1 RM Bench press. It showed significant difference in 20-meter Sprint test, 1RM Squat and 1 RM Bench press. But, for Modified Agility t-test, it showed no statistical difference.

Hence, Post Activation potentiation training was found to be more predominant in improving speed, lower limb strength and upper limb strength than Complex contrast training. Also, Post Activation potentiation training as well as Complex contrast training were equally effective in improving agility in hockey players

DISCUSSION

In this study, the effects of Post Activation Potentiation versus Complex-Contrast training on speed, agility and strength in male hockey players were assessed by speed (20-meter sprint test), agility (Modified Agility T-test) and strength (1 RM test) in male hockey players.

First objective of this study was to analyse the effects of Post Activation Potentiation training on speed, agility and strength in male hockey players.

Post activation potentiation training can enhance performance in activities that require high-intensity, explosive movements, such as sprinting, jumping, and agility-based activities. By increasing muscle activation, PAP helps athletes develop greater strength and power, improving the performance in their respective sports. By combining strength and power training, athletes can maximize their results in a short span of time compared to training each component separately.[13]

Kassim Mohar et al. in 2018 performed a study entitled "The importance of Post-Activation Potentiation (PAP) training on physical fitness preparation for Malaysian female hockey players." A total of 18 well-trained athletes (age 25 ± 3.7 years) were randomly assigned into 2 groups: Experimental group (n=9) and Control group (n=9). Experimental group completed 16 sessions of PAP training while Control group completed 16 sessions based on coach training program, twice per week for a period of 8 weeks. The outcome measures used were 20-meter sprint time and counter-movement jump (CMJ) test during the preparation phase. The results of this study emphasized the contribution of kinetic and kinematic parameters for sprint and power performance and the experimental group showed significant improvements for athletic performance.[18]

Second objective of this study was to analyse the effects of Complex contrast training on speed, agility and strength in male hockey players.

Complex Training Principles for Hockey Pair Strength and Plyometric perform a heavy strength movement → Follow with an explosive movement (same muscle group).Rest: 30-90 seconds between pairs Frequency: 2-3 times per week, depending on season phase[8]. Focus on hockey-specific movements prioritize exercises that mimic skating, shooting, and body contact. [17]

Thapa Rohit et al. in 2023 conducted a study entitled "Effects of complex- contrast training on physical fitness in male field hockey athletes" Total 14 participants with mean age of (20.6±1.6) years were randomly assigned into 2 groups. Experimental group was given complex-contrast training (n =8) and Control group was given regular conditioning program (n = 6) for total six weeks. The outcome measures used were 30m linear sprint test, medicine ball throw, standing long jump (SLJ), counter movement jump with arm swing (CMJA), modified T-test (MAT) and unilateral isokinetic maximal strength test (knee flexion and extension) of both legs. This study suggested that supplementing regular field hockey training with CCT was recommended as an effective training strategy to improve the performance of liner sprint, vertical jumps, and muscle strength in amateur male field hockey athletes [16]

In the current study, patients were assessed at baseline and follow up was taken at the end of 4th week. The results of this study showed statistically significant improvement in speed, agility, lower limb strength and upper limb strength in hockey players with the use of Post activation potentiation training and Complex contrast training (within group analysis). But, in between group analysis, Post Activation potentiation training was found to be more predominant in improving speed, lower limb strength and upper limb strength in hockey players than Complex contrast training. Also, Post Activation potentiation training and Complex contrast training were equally effective in improving agility in hockey players.

CONCLUSION

The results of this study accepted the alternative hypothesis and showed statistically significant improvement in speed, agility, lower limb strength and upper limb strength in hockey players with the use of Post activation potentiation training and Complex contrast training (within group analysis) by paired t-test. But, in between group analysis by unpaired t-test, Post Activation potentiation training was found to be more effective than Complex contrast training.

Limitations

This study did not compare the findings with prior PAP and CCT studies in field hockey players due to paucity of evidence in this area.

Usage of hand stop watch instead of using electronic or video-based timing system which might provide greater precision.

This was a short-term study of 4 weeks and no further follow-up of the players were carried out.

Sample size was relatively small which potentially limited the generalizability of the findings.

Future Recommendation

Future research is recommended to include larger and more diverse samples of field hockey players to enhance the external validity of results.

Declaration By the Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest

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