Assessment of Resisted Trunk Rotation Exercise With and Without *Kiai* Double-Pulse Breathing Technique on Hockey Shot Velocity: A Pilot Study

Georges Dagher, DC, CSCS, and Mark Owen Papuga, PhD

ABSTRACT

Objective: The purpose of this study was to assess the feasibility of a study to measure the effect of resisted band antirotation exercises with the use of a double-pulse (DP) breathing *kiai* exercise on slapshot and snap shot velocity and subjective assessment of performance.

Methods: Ten participants between 20 and 30 years of age who play ice hockey were recruited. The study was conducted over 3 weeks, and participants were randomized into 2 groups; group 1: resisted band antirotations with DP *kiai* (a shout used in martial arts) exercises, and group 2: resisted band antirotations alone. After week 1, there was a 1-week washout period, after which group 1 performed resisted band antirotations alone, and group 2 performed resisted band antirotations with DP *kiai* exercises.

Results: Data were successfully collected on all 10 participants. There appeared to be no difference between groups regarding slapshot and snap shot velocity.

Conclusion: The design for this study appears to be feasible. Preliminary data show that the average shot velocity before and after the intervention did not show a positive relationship between DP *kiai* breathing and hockey shot (slapshot and snap shot) velocity. (J Chiropr Med 2018;17:244-255)

Key Indexing Terms: *Exercise; Athletic Performance; Chiropractic*

INTRODUCTION

The relationship among breathing patterns, movement patterns, motor control, stability, and movement coordination has been discussed.¹⁻¹⁰ Breathing is essential in relation to building a resilient abdominal corset activation pattern and for movement in general.^{1,3-11} An aberrant diaphragmatic pattern can be associated with both mechanical and physiological means through the interaction of the deep corset muscles, such as the transversus abdominis muscle, which is the deepest of the corset muscles.^{1,6,9,12}

The use of breathing (eg, normal and pulsatile) can alter connective tissue tone, thereby affecting the measured activity.^{1,13-15} This method of optimizing connective tissue may be referred to as priming to affect neural drive.⁴

Priming in this context is defined as a method using connective tissue contraction instigated via pulsatile breathing to alter neural tone of muscles primarily being stressed from the shoulder to the hip. Upper-extremity, spine, and lower-extremity problems can derive from both overuse and underuse.¹⁶

Among hockey athletes, 80% of injuries are a result of direct trauma, whereas 20% are a result of overuse.¹⁷ Most injuries take place during a game; however, not all injuries are typically a result of 1 isolated event. An association between hours of ice time and injuries can occur between 7 and 100 hours depending on age and type of injury.¹⁷ In other studies, fatigue and fitness levels also were linked to injury among hockey athletes.¹⁸⁻²⁰

Most hockey injuries occur in game-related situations, and when assessing location of injuries associated with respect to the shoulder, spine, and hip area, 14% of injuries are located in the thigh area; 4% in the hip or groin; 5% in the pelvis or low back; 2% in the abdomen; 4% in the chest, ribs, or upper back; and 12% in the shoulder. This tallies up to 41% of injuries within the professional hockey population,^{16,21,22} and depending on the definition of thigh injuries (some may and others may not fit directly within the functional and spiral line pathways), the injury tally still accounts for 27%.^{16,17} Other studies have noted the

Research Department, New York Chiropractic College, Seneca Falls, NY.

Corresponding author: Georges Dagher, DC, CSCS, 2360 New York 89, Seneca Falls, NY 13148. Tel.: +1 416 895 0474. (e-mail: gcdagher@gmail.com).

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following injuries: acromioclavicular joint separation, glenohumeral dislocation, hip pointers, and femoral acetabular impingement.^{16,23-25}

Song et al in 2009 stated that, “Motor learning may initially rely on more explicit and prefrontal areas, but after extended practice and expertise, shift to more dorsal areas, but thinking about the movement can shift activity back to the less skilled explicit areas.”²⁶

It is unknown for athletes who have had previous injuries and are now practicing and refining movements that were once second nature if a double-pulse (DP) *kiai* approach could be a useful tool to assist subconscious movement adaptations.

A rotational athlete is one who uses the functional line similar to that of hockey players.²⁵ It is purported that there are connective tissue relationships that connect the opposite shoulder and hip, both the anterior and posterior aspects of the body. The functional and spiral lines also can be extended through its connection with other fascial lines (eg, arm lines) to connect the entire lower and upper extremity in these diagonal patterns.²⁷ These fascial relationships allow for energy buildup and transfer^{22,28} and are seen in athletes who play unilateral ballistic-dominant sports such as hockey.

The purpose of this study was to assess the feasibility of a study to measure the effect of resisted band antirotation exercises with the use of a DP breathing *kiai* exercise on slapshot and snap shot velocity and subjective assessment of performance. The hypothesis was that if participants use DP breathing and DP antirotation exercises, then snap shot velocity and subjective assessment of performance will improve. Secondary outcomes aimed to measure how the participant felt after performing the exercises with different breathing styles.

METHODS

Participants

Inclusion criterion for this study was league ice hockey experience (a minimum of 5 years). Exclusion criteria consisted of anyone who had lung disease, heart disease, asthma, angina, low back pain, hypertension, pregnancy, chest wall deformities, or injury causing pain or requiring treatment within the past 6 weeks, and smokers. All participants were recruited from the college student body.

Ethics

This research study received institutional review board and research ethics approval in 2014 with informed consent from all participants involved in the study in 2015. Consent is held on file securely at the New York Chiropractic College research department.

Study Design

The study was conducted over 3 weeks using 2 intervention groups to test the effect of the *kiai* DP

breathing technique. Participants were randomized using a Microsoft Excel spreadsheet using a random number generator and placed in 2 groups as they were enrolled in the study (group 1: resisted band antirotations with DP exercises [first, before washout period] or group 2: resisted band antirotations alone [first]). Neither the participants nor the investigators were blinded to the intervention. Deidentified datasets were used for purposes of data analysis.

Research Procedures

Participants were randomized into either group 1 or 2 and were administered a questionnaire to evaluate level of activity ([Appendix A](#)). Participants received instructions that delineated that male participants do not wear shirts, and female participants wear a sports bra or clothing that reveals the trunk, and both wear spandex or fitted shorts above the knee to ensure minimal migration of the markers. Reflective markers were placed on both the proximal and distal shaft of the hockey stick, both acromion, both anterior superior iliac spine, xiphoid process, costal margins of the rib cage, lateral femoral condyles, and lateral malleoli ([Fig 1](#)).

Synthetic ice was used to mimic on-ice mechanics, and participants practiced several shots to become accustomed to the experimental setup. Immediately thereafter, the participants took 3 slapshots and snap shots, which were recorded using a high-speed camera (250 frames/s). Kinovea (the most commonly used open-source software in sports) is a video player that enables researchers to analyze the technique of different sport skills (Kinovea.org, France). For the purposes of this pilot, footage of hockey shots was taken, and speed was measured through distance and points between distance. Kinovea was used to calculate the velocity of slapshots and snap shots by following the puck from point of stick release to entry into net.

The breathing and exercise intervention was introduced after the first round of shots. The first group completed resisted band antirotations both to the left and the right side while performing 3 sets of 15 DPs, whereas the second group performed the same antirotation exercises with regular breathing.

Contracting the diaphragm with specific tempo inhalations (priming the diaphragm) and exhalations (priming the abdominal corset) was conducted to see if there was a positive correlation with force generation²⁹ and increase in both the snap shot and slapshot velocity.

To measure subjective feedback about aspects of shot quality before and after the exercise, a questionnaire was administered (see [Appendices A and B](#)).

Shot velocity was measured within the ice hockey athlete to better understand the functional response to externally derived core stressors (exercise band rotary load) and internally derived core stress via DP breathing relationships. Analysis was conducted to determine if band-resisted antirotation trunk exercises with DP breathing

Fig 1. A participant performing the breathing exercise. Both groups of participants were placed in the following position; the only variation was the breathing: double-pulse versus normal breathing.

Fig 2. Study flow diagram.

Prime

- Subject enters wide stance.
- Subject internally rotates both feet, pulling feet towards each other while remaining in static position.
- Subject anteriorly and posteriorly tilts hip, then sets hip in neutral position.
- Subject activates gluteal muscles slightly, maintaining throughout exercise.
- Subject inhales deeply, filling torso from the bottom up, followed by exhalation while depressing ribcage. Repeat inhale to ensure prevention of ribcage flare.
- Subject will maintain enough stiffness in torso to prevent movement outside neutral set position.

Move

- Subject initiates movement by hinging at hip, with slight bend in knee following hinge. Trunk will move with hip in flexion while in a neutral position.
- Subject reaches forward with both arms, forming a fist around a resistance band.

Breathe

- Subject performs the double pulse kiai energy shout, maintaining a stable spine and pelvis during breathing.
- Subject takes a rapid, full breath while maintaining hinge and torso position, followed by two rapid pulses/kiai energy shouts, shouting the letter "c" twice in a row, followed by an inhale. This is repeated 15 times. The control group breathes 15 regular breaths.

Fig 3. Double kiai energy shout description.

technique are associated with an acute increase in hockey shot (slapshot and snap shot) velocity.

Outside of the laboratory, group 1 performed resisted band antirotations with 3 sets of 15 DPs (90 repetitions) per day for 1 week, while group 2 did the same antirotation exercises with regular breathing. This allows each participant to serve as their own baseline in addition to determining whether there is a group trend. There was then a 7-day washout period where no group performed any prescribed exercises (Fig 2). After this period, the groups switched: group 1 performed the exercises with regular breathing whereas group 2 began to use the DP (Fig 3).

Feasibility

The design for this study is feasible. One hundred percent of participants recruited were enrolled and retained throughout the duration of the study. There were 4 data collections scheduled, and 100% of participants attended each data collection. In total, 480 hockey snap shots and slapshots were recorded, and 464 of those shots were successfully analyzed (96.6%).

RESULTS

The analysis included a total of 10 participants (8 men, 2 women) with an average age of 25.9 ± 1.85 years. Average height of the participants was 178.75 ± 11.27 cm, and average weight was $194.3 \text{ lbs} \pm 64.79$. The average height and weight for female participants was $140 \text{ lb} \pm 28.28$ and 162.56 ± 10.77 . Average male height was 182.80 ± 7.28 , and average weight was 207.88 ± 65.03 .

Velocity was calculated using Kinovea. On day 1, the mean velocity for the control group was 15.1 ± 2.77 m/s, compared to the treatment group 12.4 ± 1.45 m/s; group 2 had the greater velocity in week 1. During week 2, 7 days after home exercise prescription, mean velocity for group 2 dropped to 13.32 ± 1.96 m/s, whereas the group 1 velocity increased to 18 ± 13.3 m/s. After a 1-week washout, group 1's baseline velocity was comparable to their week 1 velocity; week 1 was 12.4 m/s, and week 3 was 12.3 m/s, revealing washout was successful among this group. Group 2's baseline velocity was 15.1 ± 2.77 m/s; during week 3, their baseline was 13.34 ± 2.68 m/s. This decrease in velocity after washout made comparisons between treatments difficult.

In summary, group 1 experienced a decrease in velocity for the slapshot when they did not incorporate DP breathing, whereas group 2 experienced no increase or decrease when they incorporated the DP. After the washout period, both groups decreased in velocity when it came to the snap shot.

Subjective Description

Reported joint and muscle restriction or discomfort in both groups decreased from time 1 and time 2 (Fig 4) when measuring the sum of slapshot discomfort by region. Group 1 had a consistent decrease in discomfort that continued during the normal breathing exercises. However, during the normal breathing protocol, the decrease was not as pronounced as during the DP exercises. Group 2 had an inconsistent description of discomfort (Fig 4). During the DP protocol for group 2, the decrease was more consistent relative to normal breathing protocol but markedly less than

Fig 4. The number of slapshots taken before participants complained of discomfort in various regions of the body.

Fig 5. The number of snap shots taken before participants complained of discomfort in various regions of the body.

found in group 1. In summary, there seemed to be some carryover effect of the DP protocol in group 1; however, when group 2 was performing the DP, their reported discomfort decreased further.

Within the snap shot, however, both groups 1 and 2 had a decrease in total discomfort from time 1 to time 4, and this continued to be true after switching exercise breathing techniques during times 4 and 8 (Fig 5).

Subjective Results

With the slapshot, both groups 1 and 2 had an increase in subjective question score, indicating an improved participant satisfaction with performance (Appendix B), irrespective of the breathing exercise (Fig 6).

When it came to the snap shot, both groups again experienced an increase in subjective score (Appendix B). Group 2, however, demonstrated more variability (Fig 7).

Fig 6. Subjective measures of slapshot execution on a scale of 1 to 10.

Fig 7. Subjective measures of snap shot execution on a scale of 1 to 10.

Fig 8. Slapshot velocity in m/s over measured times (T). T1 and T2 were day 0, T3 and T4 were day 7 (1 week later). There was a 1-week washout between T4 and T5, and then groups switched.

Velocity

In measuring slapshot velocity, there was an increase when looking at group 1's time 1 and 4 (DP). During the last 4 times with normal breathing, the shot velocity

decreased relative to the first 4 times. Group 2 shot velocity during the first 4 times decreased from time 1 and 4; the last 4 times resulted in a set point velocity (no increase or decrease) (Fig 8).

Fig 9. Slapshot velocity in m/s over measured times (T). T1 and T2 were day 0, T3 and T4 were day 7 (1 week later). There was a 1-week washout between T4 and T5, and then groups switched.

Snap shot velocity increased from time 1 to time 4 in group 1, whereas there was a decrease in group 2 in those same times. During the last 4 times after the washout period, the snap shot velocity went down in both groups. There was a steady decrease in group 1 (during last 4 times of normal breathing), leveling off with an increase in time 6, but then a decrease in time 8 with group 2 during the double pulse (Fig 9).

DISCUSSION

This is the first study to test the influence of the *kiai* on hockey shot velocity. By testing the effects of breathing manipulation with respect to hockey performance, this feasibility study explores the relationship between the *kiai* energy shout and hockey shot velocity. This study builds off of research that the diaphragm is central in respiration but also is involved in spinal stability; more specifically, it is involved in postural stability during “sudden voluntary movement of the limbs,”⁷ such as during the slapshot (a hard shot that slaps the puck from waist-high stick positioning) or snap shot (a shot made with a hard flick of the wrist from below knee level) in hockey. Increased demand for respiration supersedes the role the diaphragm plays in postural stability, which is the premise behind the necessity for exercises that train, coordinate, and dissociate the role of the diaphragm in breathing and stability. Anatomically, the diaphragm is in the shape of a dome,³⁰⁻³² which is correlated to its function in moving caudally during inhalation, externally rotating the ribs and cephalad during exhalation and internally rotating the ribs.¹ The central tendon, or apex, is located around the level of T8, which is the proximal attachment site for both the right and left hemidiaphragms,³⁰⁻³² and the distal attachments are located on the lumbar vertebrae asymmetrically (L1-L3 and L1-L2, respectively). The costal border is composed of attachments from the xiphoid process and ribs 7-12.¹ The fiber attachment on the costal cartilages of ribs 7 to 12 theoretically could be inhibited via a dominant chest-breathing pattern. This pattern is seen within the hockey population through player positioning, which reinforces an extenuated lordotic position within the lumbar spine, along with a larger extension position in the mid to lower thoracic spine³ that compromises the action of the anterior-inferior rib muscles in addition to the shape and position of the diaphragm. This negatively affects breathing patterns that also can be seen with altered breathing patterns in normal individuals after wearing a thoracolumbar corset.³³ These negative effects result in compromised breathing patterns via the chest and abdomen, as evident through hypertonic upper chest and neck musculature, and lax abdominal corset musculature.²

The anatomy and location of the deep corset muscles with respect to the diaphragm, the hockey player's position, and the resulting muscular adaptations have an effect on core stability and can be seen in injuries such as sports

hernia in athletes, which in hockey is similar to what has been termed “slapshot gut,” wherein athletes experience symptoms in the left groin if they shoot right-handed, for example.^{16,28,33-36} A healthy functioning transverse abdominus muscle can achieve proper core activation, possibly decreasing anterior core strain or dysfunction^{16,28,33-36}; in hockey, this could be associated with both the functional and spiral lines, which respectively connect one side of the body to the other in an x-like fashion and rotationally.²⁵ This activation would be facilitated via the diaphragm, which again would be in an optimal position to create core intra-abdominal^{24,36} and transdiaphragmatic pressure within a neutral spine position. Spine stability is ensured through continuous muscle activation of the surrounding trunk muscles.^{1,3-10,24} Thus, proper function of the intrinsic core connective tissue and thoracolumbar range of motion (ROM) achieved through breathing can be of relevance to a clinician's treatment and rehabilitation protocol, a strength coach's training protocol, and an athlete's performance.^{1,13-15}

One concept tested in this study was the myofascial kinetic chain's adaptive potential via its ability to withstand, serve, and transmit force generation from the lower extremity, trunk, upper extremity, and hockey stick, and into the puck. Adaptive stability seems to be a cornerstone in achieving foundational and optimal kinetic human performance. A lack of spine stability or core strength can predispose both lay and athletic populations to injury.^{2,9} That being said, in an injured athlete performance is compromised. The diaphragm has been noted to be a key player in attaining stability through its role in respiration; inhalation activates the diaphragm, and forced exhalation increases abdominal activity.^{9,29,30,37,38} It is a skeletal muscle and thus has the tissue potential to adapt to stressors similar to its surrounding abdominal corset skeletal muscle counterparts, hence the rationale for consecutive DP *kiai* energy shouts in an abdominal isometric contractile environment while demanding inspiration between double pulses. In elite mixed martial artists, the athletes' shouts (known as a *kiai* or *energy shout*) have been shown to increase the strike's speed and force,¹² creating an interesting parallel to the role of the diaphragm in increased performance. Janda previously has stated that axial stability will lead to paraxial mobility³⁹; therefore, whether we are dealing with a strike from a martial artist or, as in this study, the slapshot of a hockey player, optimal core hygiene is thought to be critical for peak performance.

Both groups performed the exercises coupled with normal breathing and the DP. The DP had a steeper learning curve compared with normal breathing because the participants were required to adapt to creating 2 forced expiratory breaths followed by a sharp inhale while maintaining a cocontraction of the abdominal muscles and diaphragm.^{8,10} This requires the ability to resist rotation from the exercise band and maintain motor control and stability yet still be resilient enough to dissociate an

abdominal brace primed by the DP *kiai* (forced expiration) and the later sharp inhalation that is repeated up to 15 times primed by the diaphragm simultaneously. As noted earlier by Song et al in 2009, this may assist the athlete in driving the resisted movement pattern of core contraction subconsciously coinciding with the transverse abdominus muscle's role as the unconscious muscle, all while challenging inspiration primed by the diaphragm.²⁶ The use of a repetitively resisted DP *kiai* technique thereby can be a strategy used by athletes to transfer trained skills from a conscious level to a subconscious level, which is relevant in a real game experience.

Within a unilateral dominant rotational sport such as hockey, the ability to drive and normalize transverse abdominus muscle unconscious activation during both inspiration and expiration on ice can be a useful strategy to prevent mid to lower torso complaints (abdominal pain and low back pain)³⁶ and potential energy leak during a quick snap shot or slapshot, or when taking a hit during the shot. This supports the idea that axial stability encourages paraxial mobility,⁴ which is necessary in athletic longevity. This thereby allows the hips (femoroacetabular joint) and shoulder (glenohumeral joint) to communicate through the axial musculoskeletal system (core) through the athlete's entire functional or active ROM.

The sample of participants does not allow us to make any conclusions; however, we noticed some trends in the data. There did not appear to be any positive relationship between DP breathing and slapshot velocity. Regarding snap shots, there was both a negative and positive relationship between DP exercise and snap shot velocity; however, both findings could be attributed to the study being underpowered. Comparing treatment (DP) and control (normal respiration) exercise effects on velocity (in m/s), a positive and consistent relationship with the treatment group relative to baseline shots was noticed with the slapshot both immediately after the baseline postexercise shot and after the first postexercise shot a week later. The baseline effect of the snap shot and treatment group was negative; however, there appeared to be a training effect that was revealed during the shots taken in the week later after treatment.

The preliminary results from the study suggest a possible positive acute relationship between the DP groups and the speed of the snap shot; however, these results did not reveal an acute positive relationship with the slapshot. In addition, there were secondary positive reports, such as a decrease in restrictive complaints in both groups with a more consistent decline when the DP was used. The participants' perception and shot feel were measured and results revealed a steady rise when executing the exercises and DP, with varied results when the DP was not implemented. Regarding the slapshot, there were similarities to the snap. Both groups increased: group 1 increased steadily throughout all times, whereas group 2 increased but not as consistently and steadily

as group 1. There appeared to be a positive association with the DP exercise; the shot, subjective perception, and complaint by region seemed to be consistently and steadily improving. This may indicate an order effect of such treatments. However, a full study needs to be completed to determine if these relationships are present.

Recent studies have noted the value of specific training strategies aimed at increasing functional and neural adaptations as a potential highly efficient approach toward increasing function.⁴⁰ This then could be used to develop applications of the DP exercise with respect to hockey training and any other unilaterally dominant sport that demands core stability, mobility, and coordination of these variables while breathing, divorcing the diaphragm from its role as a core stabilizer by driving the deepest corset muscles, such as the transverse abdominus muscle in its theoretical unconscious spine stabilizer role, because it only can be accessed via its sister muscle internal oblique. This thereby allows the relative superficial stabilizer such as latissimus dorsi, quadratus lumborum, and gluteal muscles to promote athletic dexterity and ROM.^{41,42}

Limitations

The number of participants and the treatment effect size were too small to make any conclusions about effect. The length of the washout period was perhaps too brief; an increased washout period would act to limit the carryover effects of any one treatment protocol. A longer protocol also may have acted to reduce the learning effects experienced by the participants becoming accustomed to the laboratory environment, including the synthetic ice.

Future Studies

A follow-up study looking at this DP-specific training strategy among professional-caliber hockey players, with a larger sample size, the use of an alternate method of calculating velocity such as a radar gun, and the use of an ice rink outside of the laboratory, should be completed.

CONCLUSION

The design for this study appears to be feasible. Preliminary data show that the average shot velocity before and after the intervention did not show a positive relationship between DP *kiai* breathing and hockey shot (slapshot and snap shot) velocity.

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FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): G.D.
Design (planned the methods to generate the results): G.D.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): M.O.P.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): G.D.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): G.D.
Literature search (performed the literature search): G.D.
Writing (responsible for writing a substantive part of the manuscript): G.D.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): M.O.P.

Practical Applications

- The addition of a breathing technique would be measured most easily if used on an elite population that has mastered the fundamental movement pattern of their sport.
- The intervention may provide an effect if measured in the correct group of unilateral-dominant athletes and under the right environmental conditions.

APPENDIX A. QUESTIONNAIRE

Questionnaire

Circle all that apply for each question.

1. Did you workout today?
 - a. Yes. For _____ minutes.
 - b. No.
 - c. I focused on strength training and weightlifting.
 - d. I focused on cardiovascular activity.
 - e. I did both cardiovascular and strength training activity.
 - f. Other: _____
2. How many days of the week do you go to the gym?
 - a. 1
 - b. 2
 - c. 3
 - d. 4
 - e. 5
 - f. 6
 - g. 7
3. Approximately how long have you been sitting today?
 - a. _____ hours.
4. Did your day include any walks?
 - a. Yes. For _____ minutes.
 - b. No.
5. Did your day include any other movement that should be noted?
 - a. Yes. Describe:

_____.
 - b. No.
6. Did any of your movements today resemble the movements being tested?
 - a. Yes. Describe:

_____.
 - b. No.
7. Did you eat and/or drink before today's session?
 - a. Yes. Describe:

Items & quantity consumed (ex. 2 c water, 8 oz. beef):

_____.
 - b. No.
8. Are you sore?
 - a. Yes. Where?

_____.
 - b. No.
9. How many times have you worked out in the gym during the last 2 weeks?
 - a. _____.

Proceed to b ONLY after your first visit. If it is blank, proceed to c.

 - b. Did you complete your exercises during each session? Yes/ No
 - c. If no, how many times did you complete your prescribed exercises:

APPENDIX B. LAB QUESTIONNAIRE

Lab Questionnaire

Circle all that apply for each question.

Circle AND mark the VAS SCALE beside each option.

1. My _____ shots felt:
 - a. Explosive 0-----10
 - b. Fluid 0-----10
 - c. Choppy 0-----10
 - d. Slow 0-----10
 - e. Delayed 0-----10
 - f. Controlled 0-----10
 - g. Sloppy 0-----10
2. When taking the shot, I felt:
 - a. Unbalanced |-----| Balanced
 - b. Unstable |-----| Stable
 - c. Uncoordinated |-----| Coordinated
3. What was the limiting factor to your shot?
 - a. Upper back 0-----10
 - b. Lower back 0-----10
 - c. Shoulder 0-----10
 - d. Hips 0-----10
 - e. Other: _____ 0-----10
 - f. None
4. My _____ shots felt:
 - a. Explosive 0-----10
 - b. Fluid 0-----10
 - c. Choppy 0-----10
 - d. Slow 0-----10
 - e. Delayed 0-----10
 - f. Controlled 0-----10
 - g. Sloppy 0-----10
5. When taking the shot, I felt:
 - a. Unbalanced |-----| Balanced
 - b. Unstable |-----| Stable
 - c. Uncoordinated |-----| Coordinated
6. What was the limiting factor to your shot (discomfort by region)?
 - a. Upper back 0-----10
 - b. Lower back 0-----10
 - c. Shoulder 0-----10
 - d. Hips 0-----10
 - e. Other: _____ 0-----10
 - f. None
7. How many shots did you take before feeling fatigued?
 - a. _____ shots.
 - b. I never felt fatigued.

VAS, visual analog scale.

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