Int J BioMed Public Health. 2020; 3(1):1-4
10.22631/ijbmph.2020.151960.1080

International Journal
of
BioMedicine and Public Health
http://www.ijbmph.com

Original Article

The effect of cold spray cryotherapy method on the shoulder joint position sense of healthy athletes

Open Access

Ramin Beyranvand[1], Ehsan Ebrahimipour[2], Rahim Mirnasouri[3*]

ARTICLE INFO

Article History:
Received 11 October 2018
Revised 1 January 2020
Accepted 18 January 2020

Keywords:
Position sense shoulder joint
Cryotherapy
Athletes

[1]Department of Sports Injuries and Corrective Exercises, Faculty of Sport Sciences, Shahid Bahonar University of Kerman, Kerman, Iran; [2]Department of Sports Biomechanics, Faculty of Sport Sciences, Shahid Bahonar University of Kerman, Kerman, Iran; [3]Department of Sport Sciences, Faculty of Humanities, Lorestan University, Khorramabad, Iran.
Correspondence:
Rahim Mirnasouri. Department of Sport Sciences, Faculty of Humanities, Lorestan University, Khorramabad, Iran.
Email: dr_mirnasouri@yahoo.com

ABSTRACT

Introduction: Application of cryotherapy modalities is common after an acute shoulder injury and as a part of rehabilitation. In sports events, the athlete may return to the game after treatment. The effects of cryotherapy on the shoulder joint position sense (SJPS) have been investigated in many studies. However, the research that used the cold spray for this purpose was not found. This study aimed to evaluate the immediate effect of using a short-term protocol of topical cold spray on shoulder joint position sense in healthy athletes.
Methods: Thirty physically active academic volleyball players with no history of neurologic conditions or musculoskeletal injuries on the throwing (dominant) shoulder voluntarily participated in this study. A within-subjects design with pre-posttest and selective sampling were conducted in this study. They took part in a reconstruction of the shoulder joint angle test at two sessions; so that their performance accuracy in this reconstruction was evaluated first time without using cold spray and the second time after using cold spray. The paired t-test was employed for SJPS scores comparison. Assessment assumption was done with 95 percent significance and $P \leq 0.05$.
Results: Despite a reduction in SJPS accuracy after using a short-term protocol of local cooling, there was no significant difference between the error of the estimated angle before and after cryotherapy ($P > 0.05$).
Conclusion: It appears that the use of a short-term protocol of topical cold spray only has an immediate effect on the more surface receptors, while the deeper receptors such as muscle spindles and joint receptors which have a key role in joint position sense are not affected.

Introduction

The shoulder joint has the greatest range of motion than the other joints of the body, which potentially compromises its stability (1). Therefore, muscular coordination is vital to maintaining joint stability. The shoulder relies upon proprioceptive feedback to maintain dynamic stability (2). Proprioception results from the integration of neural impulses from a variety of peripheral mechanoreceptors to the central nervous system (3). There are several mechanoreceptors in the skin, muscles, and also joint tissues and can be activated by tissue deformation, which subsequently sends afferent neural impulses to the central nervous system, and is used for joint stability and appropriate joint function. The integrity of the mechanoreceptors and neural pathways plays an essential role in allowing shoulder mobility and concurrent stability (4).
Most injuries that occur during an athletic event are immediately treated by cryotherapy modalities (5). The athlete may return to practice or competition following a cryotherapy treatment to the injured shoulder, after an acute shoulder injury in sport. Decreases in tissue temperature have been shown to decrease nerve conduction velocity, muscle force production, and muscular power (4, 6). Consequently, cryotherapy application to the shoulder may decrease proprioception and predispose an athlete to injury as a result of decrease in nerve conduction velocity, muscle force production, proprioceptive afferent information, or a combination of these factors (4).
In previous studies that addressed the effects of local cooling, the cold was applied for 15 min or longer, while this duration is more than allowed time for the injured athlete. Since applying such long-term cold may exceed holding one half of the game in a sports environment, it cannot be used for the athlete who intends to return to the game. Thus the data obtained from them cannot be reliably generalized to the sports environment (7). In this regard, Bleakley et al. conducted a comprehensive review, pointing out that conducting research on the use of local short term cold therapy is essential for the generalization of results in the sports environment (7). Furthermore, some other studies have

used other cooling techniques, such as immersion in ice or cold, while these methods are rarely used to preparing injured athletes, and returning them to competition or exercise. This is another problem that reduces the generalization of the results of previous studies to the sports environment (4, 8).
Therefore, since the cooling spray is a commonly used method for short-term cold therapy, and other studies have not yet examined the effect of short-term cold therapy on the SJPS using a cooling spray, the purpose of this study is to investigate the immediate effect of short-term cooling on SJPS, considering the appropriate time to use cold therapy and using the usual cooling method in the sports environment.

Methods

Design

A within-subjects design with pre-posttest and selective sampling were conducted in this study.

Participants

The statistical population of this study included voluntaries academic volleyball players with experience of regular practice over the past three years. The samples were selected purposefully, so 30 academic volleyball players with no history of neurologic conditions or musculoskeletal injuries to the throwing shoulder selected as the subjects of the study.

Ethical issues

Ethical approval for this research has been granted by the Ethics Committee of Tehran University of Medical Science. All subjects provided informed consent before entering the study. They took part in the reconstruction of the shoulder joint angle test in one group at two sessions; so that their performance accuracy in this reconstruction was evaluated first time without using cold spray and the second time after using cold spray.

Procedures

The Biodex Multi-Joint System (Biodex Corp, NY, USA) was used for the position sense test of the shoulder. The system includes an electro-goniometer, which is sensitive to 1° increments (9). Active angle repositioning was measured with the participants in a seated position, with their back vertical, the shoulder positioned at 90° of abduction and 90° of external rotation in the plane of the scapula (30° in front of the frontal plane), and the forearm perpendicular to the floor (90° of flexion at the elbow). This position was selected to simulate the abducted, externally rotated position of the shoulder required in many activities. Participants were blindfolded to eliminate visual cues related to joint position (10).
After warm up and set the starting position, the participant's shoulder was passively moved to one of the test angles (45° or 60° of shoulder external rotation) by the examiner. Participants were asked to concentrate on the sensation of the presented angle for three seconds. Then, the participant's shoulder was passively returned to the starting position by the examiner. Following a three-second rest period, the participant was asked to actively reproduce the presented joint angle. Once the participant felt that the shoulder was in the position of the presented angle, he pressed the hold switch, preventing the dynamometer from further movement. Each subject underwent a short mock test (45° of shoulder external rotation) to ensure comfort and understanding of the test protocol. Then, the procedure was repeated two more times for the 45° target angle (three times in total) and three times for the 60° target angle (10). Measurements were taken with a two-minute rest between trials. The average of the absolute error score (AES) (i.e., the difference between the reproduced angle and the target angle) was calculated and used for data analysis. This technique has been found to be an accurate and reliable method of measuring shoulder joint position sense (11, 12). Following the above test, the shoulder joint of the subject was cooled using cold spray (Pic Solution spray, made in Artsana Co, Italy). For creating quail conditions for all subjects, local cooling was done using two sprays simultaneously from both anterior and posterior side of the shoulder. Distance of the sprays to shoulder (30 cm), cold application angle (90 degrees) and location (shoulder joint line) as well as the duration of spray application (5 s), were considered the same for all subjects (13). Then, the joint angle reconstruction test was done similar to the first one immediately after local cooling and the results were recorded as the second test.

Statistical analysis

The data were statistically analyzed using SPSS v 21.0. (SPSS Statistics 21, produced by IBM Co, USA). For data distribution analysis the Shapiro-Wilk test was used. Moreover, for SJPS scores comparison the paired t-test was employed. Assessment assumption in this study was done with 95 percent significance and $P \leq 0.05$.

Results

Personal and demographic information of the participants such as age, height, weight, and BMI are presented in Table 1. After pre-test and post-test measurements, the Shapiro-Wilk test showed the distribution of variables is normal and considering this fact, paired t-test was used for comparison of the results. Table 2 shows the results of paired t-test comparing the reconstruction errors of the shoulder angle between the pre and post-test. The results of this comparison in pre and post-test showed that there is an increase in error level as 0.84-0.88 degree after applying cold spray. However, these changes were not statistically significant and P value showed no significant difference in angle reconstruction error in the movement before and after spray application ($P > 0.05$) (Table 2).

Table 1. General characteristics of the subjects (n = 30)

Variables	Mean	SD
Age (year)	24.77	1.46
Height (cm)	179.25	7.81
Weight (kg)	68.43	6.26
BMI	21.14	1.81

Table 2. Paired t-test results for comparing SJPS scores of pre and post test

Variables		Mean	SD	t	df	p
SJPS at 45°	Pre-test	3.86	1.74	1.18	29	0.109
	Post-test	4.70	2.07			
SJPS at 60°	Pre-test	4.51	1.26	1.31	29	0.095
	Post-test	5.39	1.83			

Discussion

The results of this study show that the application of the local cold using cold spray on the shoulder joint has no significant effect on the joint position sense. Various studies have addressed the performance of proprioception in different joints after cold application. In some studies, the cold application has a negative

effect on position sense performance (4), while in some others, it was not significant (8). The findings of the current study are consistent with the studies that reported no significant changes in joint position sense after cold application. In this regard, it should be noted that in this study, SJPS was impaired slightly following local cold application by cold spray in, although it was not statistically significant.

For example, Riemann et al. reported skin afferents to play a trivial role in position sense of joints, while muscle spindle and joint receptors play a much more important role (14). Hence, it seems local cold application protocols using short-term spraying cannot affect the deeper tissues. Therefore, considering the fact that skin receptors play a secondary role in position sense information creation and it is muscle spindles and joint receptors which provide most of the information related to joint position sense, it seems short-term cold application using cooling spraying affects only skin receptors and it has no significant effect on accuracy of reconstruction of the shoulder joint angle.

On the other hand, some other studies showed neural speed reduces due to reduced muscle tissue temperature depends on the type of cooling device and method; so that the tissue temperature is reduced more than the ice bag when applying ice massage; or a cold application protocol with immersion in cold water is more effective in preserving tissue temperature reduction compared to crushed ice pieces (15). Since different methods may generate different degrees of cold in a tissue, it is believed cold application method used in this study probably is not able to impair joint position sense and thus performance of the athletes is not impaired after exposure to cold sprays. It should be noted previously only once cold spray for local cooling was used for investigating the cold impact on position sense, where Surenkok et al. investigated the effect of cold spray on knee joint position sense, they reported knee joint position sense was impaired after cold spray application (16). Since Surenkok provided no information on the type of spray, manner, and duration of spray application, it is probable that used sprays as well as manner and duration of spray application in that study, is different from the current study. Although it seems receptors in the skin, joint capsule, ligaments, muscles, and tendons are involved in the perception of joint position sense, it should be noted that the role of muscle receptors is very important (17).

When the tissue temperature is reduced, the neural speed decreases relative to the rate and duration of this temperature change (18). It is not identical in neural fibers with different diameters; studies showed that the cold has the most effect on myelinated fibers and least effect on large non-myelinated fibers. Neural fibers of A delta have a small diameter and a high reduction in the speed of conduction of neural messages in response to a cooling factor (18). However, afferent nerves which are responsible for transferring proprioception data from muscle spindle to the central nervous system are of Iα and II type, have large diameters and are responsible for rapid information transfer.(19) Thus, it is possible this nerve is less influenced by the cold (20).

For using the obtained results of the current study, its limitations should be considered. First, the subjects of this study had healthy shoulders and since acute inflammatory processes or damage may affect the results, the generalization of these findings to injured populations should be done carefully. Besides, the mental and psychological conditions of the subjects were not controlled in, which may influence findings. It should be considered that proprioception performance mechanisms vary in different joints (ankle, knee, shoulder) and the results obtained from each joint cannot be generalized to the others (20).

Conclusion

This study showed that the short-term cold application using cold spray has no significant effect on the SJPS in healthy volleyball players. Furthermore, it seems that only surface receptors influenced by the cold spray and deeper receptors which have the main role in joint position sense were not influenced. Moreover, since the minor increase was developed in the shoulder joint error after local cooling, it is better to interpret the results obtained from the current study carefully.

Ethical disclosure

Ethical approval for this research has been granted by the Ethics Committee of Tehran University of Medical Science. All subjects provided informed consent before entering the study.

Acknowledgements

This study resulted from the research project approved by Physical Education and Sports Science Faculty of Shahid Bahonar University of Kerman. We thank and gratitude to everyone who helped us with this research.

Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved the submission.

Conflict of interest

None of the authors had any conflict of interest during this study.

Funding/Support

None declared.

References

1. Youm T, Takemoto R, Park BK-H. Acute management of shoulder dislocations. J Am Acad Orthop Surg. 2014; 22(12):761-71. doi:10.5435/JAAOS-22-12-761
2. Anu A, Anup P, Sujata Y. Effect of Cryotherapy on Throwing Accuracy of Shoulder Joint in Cricket Players. Indian J Physiother Occup Ther. 2014; 8(1):159-163. doi:10.5958/j.0973-5674.8.1.031
3. Ashworth S. Effects of Different Modes of Cryotherapy on Postural Control, Texas State University; 2015.
4. Wassinger CA, Myers JB, Gatti JM, Conley KM, Lephart SM. Proprioception and throwing accuracy in the dominant shoulder after cryotherapy. J Athl Train. 2007; 42(1):84-9.
5. Prentice WE. Rehabilitation techniques in sports medicine: William C Brown Pub; 1994.
6. Herrera E, Sandoval MC, Camargo DM, Salvini TF. Motor and sensory nerve conduction are affected differently by ice pack, ice massage, and cold water immersion. Phys ther. 2010; 90(4):581-91. doi:10.2522/ptj.20090131
7. Bleakley CM, Costello JT, Glasgow PD. Should athletes return to sport after applying ice?. Sports Med. 2012; 42(1):69-87. doi:10.2165/11595970-000000000-00000
8. Dover G, Powers ME. Cryotherapy does not impair shoulder joint position sense 1. Arch Phys Med Rehabil. 2004; 85(8):1241-6. doi:10.1016/j.apmr.2003.11.030
9. Drouin JM, Valovich-mcLeod TC, Shultz SJ, Gansneder BM, Perrin DH. Reliability and validity of the Biodex system 3 pro isokinetic dynamometer velocity, torque and position measurements. Eur J Appl Physiol. 2004;91(1):22-9. doi:10.1007/s00421-003-0933-0
10. Springer S, Gottlieb U, Moran U, Verhovsky G, Yanovich R. The correlation between postural control and upper limb position

sense in people with chronic ankle instability. J Foot Ankle Res. 2015; 8(1):23. doi:10.1186/s13047-015-0082-9
11. Carpenter JE, Blasier RB, Pellizzon GG. The effects of muscle fatigue on shoulder joint position sense. Am J Sports Med. 1998; 26(2):262-265. doi:10.1177/03635465980260021701
12. Herrington L, Horsley I, Rolf C. Evaluation of shoulder joint position sense in both asymptomatic and rehabilitated professional rugby players and matched controls. Phys Ther Sport. 2010; 11(1):18-22. doi:10.1016/j.ptsp.2009.10.001
13. Beyranvand R, Seidi F, Rajabi R, Moradi A. The immediate effect of short-term use of cold spray on ankle joint position sense in healthy individuals. J Res Rehabil Sci. 2013; 9(5):1-10.
14. Racinais S, Oksa J. Temperature and neuromuscular function. Scand J Med Sci Sports. 2010; 20(S3):1-18. doi:10.1111/j.1600-0838.2010.01204.x
15. Cameron MH. Physical agents in rehabilitation: from research to practice: Elsevier Health Sciences; 2012.
16. Someh M, Ghafarinejad F. The effect of cryotherapy on the normal ankle joint position sense. Asian J Sports Med. 2011;2(2):91-8. doi:10.5812/asjsm.34785
17. Hopper D, Whittington D, Chartier JD. Does ice immersion influence ankle joint position sense?. Physiother Res Int. 1997; 2(4):223-36. doi:10.1002/pri.108
18. Riemann BL, Lephart SM. The sensorimotor system, part I: the physiologic basis of functional joint stability. J Athl Train. 2002; 37(1):71-9. PMID:16558670
19. Costello JT, Donnelly AE. Cryotherapy and joint position sense in healthy participants: a systematic review. J Athl Train. 2010; 45(3):306-16.
20. Surenkok O, Aytar A, Tüzün EH, Akman MN. Cryotherapy impairs knee joint position sense and balance. Isokinet Exerc Sci. 2008; 16(1):69-73. doi:10.3233/IES-2008-0298