Effect of caffeine on the amount of perceived pain, joint range of motion and edema after delayed muscle soreness

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Annotation:

Delayed onset muscle soreness usually occurs after doing a new unusual physical activity, especially when, associated with repeated eccentric contractions and then it gradually disappears. There is not an extensive agreement in the case of treatment method of soreness signs quick reduction. This research was carried out with the aim of investigation caffeine consumption effect to find a good way in order to reduce the signs of delayed onset muscle soreness. In this semi-experimental with Double-blind design, 16 female volleyball player with an age average of 22.5±2.5 in 2 homogeneous 8 subject control and experimental group were studied. In this research, the effect of caffeine existing in coffee in 5 stages (24h before exercise, 12h before, immediately before exercise, after exercise and 12h after it) and 1mg per 1kg of body weight on amount of perceived pain and range of motion of the joint and edema due to delay onset muscle soreness because of 50 jumps and lands of a 1 meter stage was investigated. The results showed that caffeine consumption has a meaningful effect on reduction of all the expressed signs after eccentric contractions. So it is recommended that physio thrapysts, doctors and athletes use this method to reduce delayed onset muscle soreness consequences after the injury.

Сара Карабалаеифар, Мехрдад Нефзоллесан, Насер Бехпоор, Сохраб Гхалехгир. Влияние кофеина на величину болезненных ощущений в мышцах и диапазон движений после крепатуры. Боли в мышцах (крепатура) обычно происходят после выполнения новой необычной физической деятельности, особенно, когда она связана с повторными эксцентричными напряжениями, хотя в дальнейшем болезненость постепенно уменьшается. На сегодня не существует единого мнения относительно метода лечения болезненного состояния и признаков быстрого восстановления. Это исследование осуществлялось с целью изучения эффективности потребления кофеина и поиска возможных путей уменьшения болезненных ощущений в мышцах. В этом эксперименте принимали участие 16 волейболисток в возрасте 22.5±2.5, распределенные на 2 однородные группы. В этом исследовании эффект от кофеина в кофе изучался в 5 этапов: за 24 и 12 часов до тренировки, сразу перед тренировкой и сразу после тренировки и через 12 часов после нее. Дозировка из расчета 1 мг на 1 кг веса тела с целью отдаления болезненных ощущений после 50 соскоков с высоты 1 м. Результаты показали, что потребление кофеина имеет значимое влияние на сокращение всех выраженных признаков болезненности после эксцентричных сокращений. Таким образом, рекомендуется физиотерапевтам, врачам и спортсменам использовать этот метод, чтобы уменьшить отдаленные последствия наступления болезненности мышц после возможных телесных повреждений.

Сара Карабалаєіфар, Мехрдад Нефзоллесан, Насер Бехпоор, Сохраб Гхалехгир. Вплив кофеїну на величину хворобливих відчуттів в м'язах і діапазон рухів після крепатури. Болі в м'язах (крепатура) зазвичай відбуваються після виконання нової незвичайної фізичної діяльності, особливо, коли вона пов'язана з повторною ексцентричною напругою, хоча надалі хворобливі відчуття поступово зменшується. На сьогодні не існує єдиної думки щодо методу лікування хворобливого стану і ознак швидкого відновлення. Це дослідження здійснювалося з метою вивчення ефективності споживання кофеїну і пошуку можливих шляхів зменшення хворобливих відчуттів в м'язах. У цьому експерименті брали участь 16 волейболісток у віці 22.5±2.5, розподілені на 2 однорідні групи. У цьому дослідженні ефект від кофеїну в каві вивчався в 5 етапів: за 24 і 12 годин до тренування, відразу перед тренуванням і відразу після тренування і через 12 годин після нього. Дозування з розрахунку 1 міліграм на 1 кг ваги тіла з метою віддалення хворобливих відчуттів після 50 зіскоків з висоти 1 м. Результати показали, що споживання кофеїну має значущий вплив на скорочення всіх виражених ознак хворобливості після ексцентричних скорочень. Таким чином, рекомендується фізіотерапевтам, лікарям і спортсменам використовувати цей метод, щоб зменшити віддалені наслідки настання хворобливості м'язів після можливих тілесних ушкоджень.

Keywords:

delay onset muscle soreness, caffeine, edema, pain.

крепатура, кофеин, отек, боль.

крепатура, кофеїн, набряк, біль.

Introduction

Muscle soreness and pain are prevalent experiences that followphysical activities. These experiences come along withmovement limitation, muscular tension, pain, swelling, weakness and reduction of operational power (Abraham, 1997. Cheung, 2003. Cleak, 1992. Gulick, 1996). On the whole, according to the time of occurrence, muscular soreness can be classified as Delayed Onset Muscle Soreness (DOMS) and acute muscle soreness.

DOMS appears afew hours to some days after a session of active exercise.Most of people, who do new and hard physical activities, somehow experience DOMS. Delayed pain starts approximately 8 hours after exercise and gradually reaches its peak within 24 to 48 hours after damage (Abraham, 1997). This pain would disappear within 5 to 7 following days. Pain, soreness, tension, unusual sensitivity and muscular weakness are signs of this phenomenon (Hongling, 2005. Jones, 1987. Miles, 1994. Newham, 1993).

There is a variety of opinions explaining why muscular soreness is accompanied by signs such as pain and obstruction; some experts believe that pain is the result of theswelling which follows propagation ofproteins, ions, and extra cellular water in muscular myofibrils. Some also state that feeling of pain is due to the release of biochemical materials from damaged cells and incitation of the chemical receivers (Abraham, 1997. Jones, 1987).

Some researchers believe that muscular soreness is resulted from swelling reactions in muscles (Wilmore, 1994).

This phenomenon limits performance of athletes and reduced their proficiencyin later matches. Sometimes the pain and nervous strain arising from this phenomenon transfers to the other team members and the coach and leads to negative psychological influences on their performance. It also may hinder starting and continuance of a sportive activity and might annihilatethe individual's

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tendency for sport therapy during rehabilitation period. Physicians, sport coaches, physiotherapists and other specialists of sport medicine are interested in preventing or reducing the effect of DMOS at the least possible time. This interest is because of the pain and probably its resultant threatening factors such as reduction of movement extent, reduction ofpower, aggregation of surplus materials, swelling and increase of enzymes.Effective and helpful ways of therapy would increase athlete's sportive performance and accelerate returnee of nonathletic people to their normal lives. Different methods have been proposed to stop or reduce the troubles of this impairment which includes a broad spectrum of therapeutic ways like different kinds of thermotherapy, cryotherapy, massage therapy, electrical stimulation, pharmacotherapy, oxygen therapy, monotherapy and etc (Gulick, 1996). Prescription of these techniques depends on a wide variety of reasons.Preventing the start of impairment syndromesthat includes release of muscular enzymes in blood, early elision of surpluses after exercise, reduction of pain and increasing individual's tolerance of pain, is a basis of the prescriptions.But so far none of these ways have helped to heal pains of delayed onset muscle soreness.

Researchershave investigated effects of caffeine on reducing the pain of muscular damages. Caffeine exists in Alkaloids such as tea, coffee, chocolate and some drinks like Cola (Miles, 1994. Lopes, 1983. Van soeren & et al, 1998). Caffeine's mobility effects on brain and muscles have been proved; the caffeine in coffee is also sedative for muscles, improves body'sresistance during hard sportive exercises and heals muscles'fatigue (Graham, 2001. Gostill, 1978).

Caffeine is effective to reduce pain because of its role in haltering receivers related to Adenosin in brain (Stanelli 2007).

Adenosin is a molecule which is produced in brain and when it level is increased to the needed point, it joins to the Adenosinreceivers of the brain. This connection leads to fatigue, pain and sleepiness. It also can cause widening of brain's blood veins and consequent increase of oxygen transition to brain cells in time of sleep.The more Adenosinconnection to brain Adenosinreceivers, the more fatigue, pain, and sleepiness is felt by the individual(Daniels, 1998. Kalmar, 1999. Myers, 1997).Adenosinis also secreted in quick reaction to injury and activates pain receivers in body cells (Maclentosh, 1987). Increase of free Adenosin causes vein widening in muscles and increase ofblood circulation. Through this process, Adenosincauses faster expunction of pain-producing materials and increased enzymes during injury (Maugha & et al, 1977). Maridakis (2006) studied effects of caffeine on delayed onset muscle soreness on nine women and proved that caffeine can help to sedation of delayed pain (Maridakis & et al, 2006). In this research pain was investigated asthe only sign of delayed soreness. The research also expressednumerousnegative impairments for excessive consuming of caffeine including anxiety, palpitation,blood pressure increase, urine increase, and sleep disorder(Maridakis & et al, 2006. Edward & et al, 1977).Considering the scanty of researches related to the effect of caffeine on delayed onset muscle soreness, necessity of such studies isrevealed. In the only existing research in this field, Maridakisused caffeine tablet but this research focused on the effects of coffee's caffeine on delay onset muscle soreness. Undoubtedly people have less negative reaction to coffee use than drugs.

This research was carried out in five different steps (including 24 hours before exercise, 12 hours before exercise, immediately before and after exercise and 12 hours after exercise), which in every step the effect of mg of caffeine per 1kg of body weight on amount of perceived pain and range of motion of the knee joint and edema, in subjects' prime legs were investigated after delayed onset muscle soreness.

Methodology:

In this semi-experimental research, 16 female volleyball players were chosen among 37 volunteers and answered a questionnaire about their individual characteristics and health state.

Tests were conducted in 2 eight-member homogeneous groups, called control and experimental groups. The members of these groups didn't have any background of heart-blood and neuro-muscular diseases. They also had an average age of 22$\pm$ 2.5 years old, an average height of 163$\pm$ 0.5 cm and an average weight of 53.5$\pm$0.8 kg. The subjects should also have had at least one year of regular participation in weekly exercises. They were also asked not to take part in any activity beyond their routine daily and weekly activities for at least one week before and 24 hours after the test. Moreover, according to the food list provided by the researcher, the subjects were asked to avoided foods and drugs containing caffeine and Anodynes.12 hours to 24 hours before the exercise started, each subjects of experimental group was given a cup of coffee containing 1 mg of caffeine per 1 kg of their body weight and subjects of control group were given a cup of coffee-coloreddrink containing placebo. It is worth mentioning that the coffee used in this study contained 73.5 mg caffeine per 100 gr of coffee. Before starting the exercise that was preceded by measuring weight and height of all subjects, blood samples, all subjects were given theTalag questionnaire of pain perception and according to the pain on the groin muscles of their prime leg; they drew a protracted line which was graded from 0 to 24 on the basis of pain intensity.

The Motion range of subjects` knee joints were measured by goniometer in prone situation and to the maximum degree of painless knee flection and the amount of swelling increase was measured by a tape measure.

The subjects were asked to have the former drinks immediately before the exercise. After 10 minutes of general and exclusive warmup, subjects did 50 single jumpsfrom a platform of 1 meter height at 30 seconds regular intervals. It is necessary to mention thatmuscular soreness of this methodwas proved by a pilot study 3 weeks before the test. Immediately and 12 hours after exercise both groups had the same drinks and after every step, the above mentioned factors were measured again. Then the subject

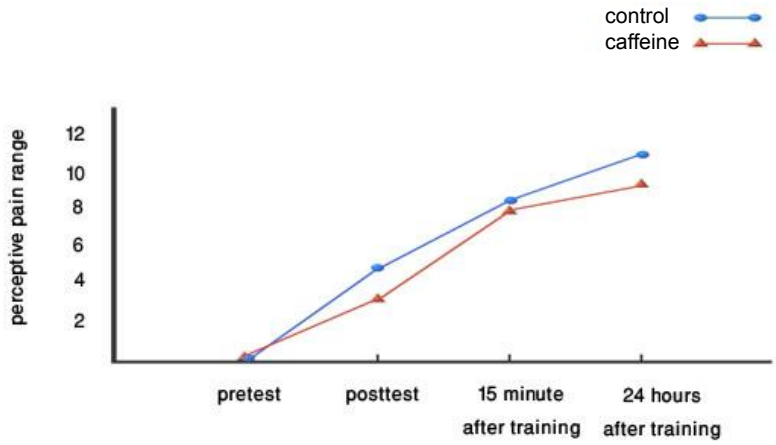

Fig.1. Comparison of pain changes in caffeine and control groups.

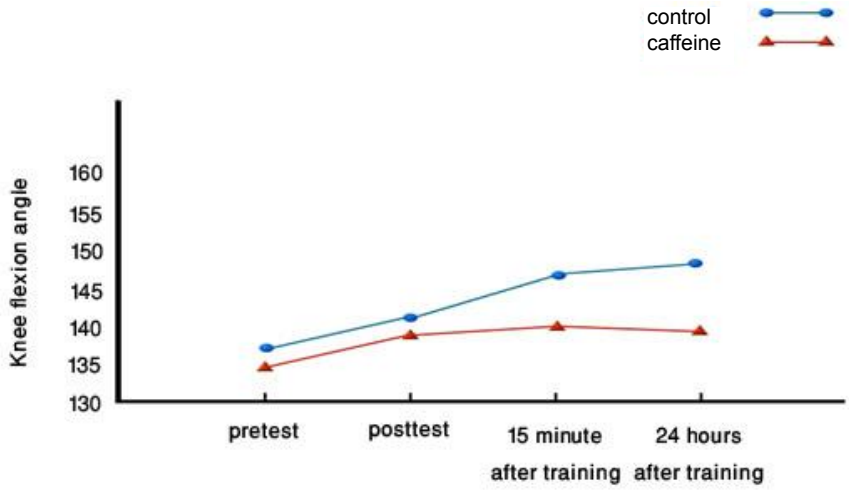

Fig. 2.Comparison of range of motion changes between caffeine and control groups.

were asked to go home, do their routine activities, avoid using any sedative drugs and come back after 24 hours to do the third step of the test which included measuring the same parameters like former steps. It should be mentioned that to increase the stability of test results of every step, the researchers measured every factor for three times and made use of their average value.

The resulted data from various tests were presented in special tables in different steps of researches, and then statistical analyses were done and research hypotheses were tested.Variability of dependent variables of two groups were analyzed in every step for both groups by ANOVAand Tukey statistical methodsand were compared with the other group's variables by T-Student tests. Meanwhile a statistical level of 0.05 was used to investigate the differences.

Results

As the figures show the cafein consumption has a meaningful effect on changes after eccentric contractions (figure 1). Dynamic range changes were also meaningful between the 2 groups in all of the measurement steps. (p=0.0001). It means that the caffeine consumption was able to prevent the further reduction of dynamic range (the 15 percent increase in comparison to 117 percent increase of control group) (figure 2). Also the results show that, 24 hours after caffeine consumption, the average of surrounding size of thigh muscle of caffeine group was meaningfully less than control group(p=0.0001). It means that caffeine was able to prevent the further increase of surrounding size of thigh muscle in the next 24 hours (figure 3).

Discussion

As it was discussed delayed muscle soreness usually comes after physical activities with new and unusual movement pattern especially when the exercise involves repeated external contractions (Cleak, 1992).

In this research caffeine consumption effect on reduction of delayed soreness impairments was found to be positive and meaningful. It seems that coffee consumption causes awareness of brain and the nerves, prevents the tiredness of muscles and lames the muscles of lung which makes the aspiration easier and because of eliminating the tiredness, increases the time period and amount of the activity, expertise and precision, gives the body truthless power and also improves muscular pain. This fact helps the subjects to use their dynamic range

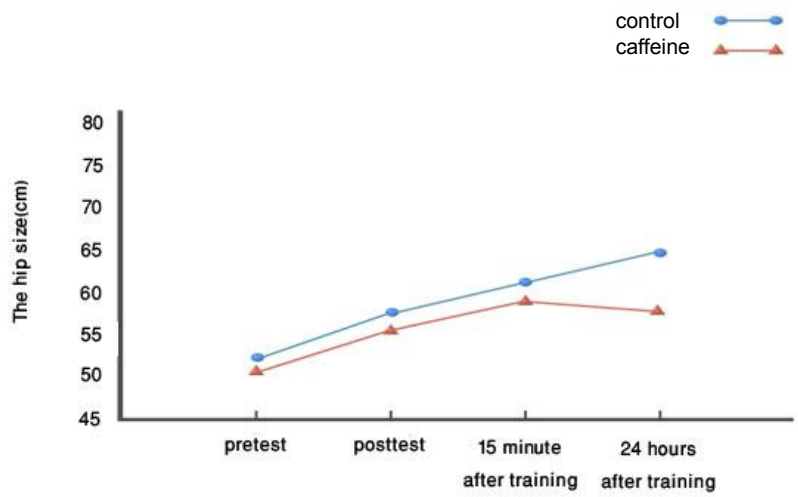

Fig. 3.Comparison of changes of surrounding size of thigh muscle between caffeine and control groups.

in a better way and increase their resistance and power. The mechanism of caffeine performance is to take the receivers of adnozine in the brain. Adnozine is a molecule which is produced in the brain and while its surface has got to its needed amount, connects to adnozine receivers in the brain. Connection of adnozine molecules to adnozine receivers causes pain and drowsiness feeling. Connection of adnozine molecules to adnozine molecules to these receivers also could make the blood vessels in the brain to get wide and makes carrying oxygen to the cells of the brain. The pain and drowsiness feeling has is proportionate to the number of adnozine molecules connected to the adnozine receivers in the brain (Gulick, 1996. Lopes & et al, 1983. Myers & et al, 1997. Maridakis, 2006).

The structure of caffeine molecule is like adnozine molecule. Because of this similarity, the caffeine molecule is also able to connect to adnozine receivers in the brain and because of this connection, caffeine is able to take the place of adnozine molecule to these receivers and consequently prevent the connection of adnozine to these receivers. Another mechanism of caffeine performance is to prevent the activity of phosphor di straz, which through this process prevents the destruction the secondary messenger molecules (camp), so that CAMP will be able to motivate neurotic cells for a longer time. This performance of CAMP in motivation of neurotic cells causes the improvement and increase of brain activity and consequently muscular activity.

It seems coffee consumption causes the pain decrease and it may prevent the increase of free ADNOZINE withdilation of blood vessels and subsequently increase of perfusion to the muscles causes the better waste disposal and consequently eliminate pain producers faster so that the pain of accumulation of metabolic material because of masculine fibril microscopic injury could be minimum. Also it seems that CAFEIN because of its ability of increasing the release of calcium from the SARCO PLASMIC causes the force and masculine power improvement.

CONCLUSION:

Results of this research expressed that consuming 5 mg of caffeine existing in coffee, per 1 kg of body weight, is effective in decreasing the syndromes of delayed onset muscle soreness from 24 hours before to 12 hours after DOMS. So it is suggested that physiotherapists, physicians, sport specialistsand athlete's use this method to minimize DOMS and afterwards to prevent decrease of routine operational strength and athletes operation. Also, they can use this method to prevent disappointment of nonathletic people after muscular soreness arising from hard damages.Of course, according to the negative impairments of excessive caffeine consumption on blood pressure, heart beat and etc, it is better to avoid the excessive consumption.

References:

1. Abraham W.M. Factors in delayed muscle soreness. *Medicine and science in sports and exercise*. 1997, vol.1, pp. 11-20.
2. Cheung K. Hume P. Maxwell L. Delayed onset muscle soreness. Treeatment strategies and performance factors. *Sports Medicine.* 2003, vol. 33, pp. 145-64.
3. Cleak M.J., Eston R.G. Delayed onset muscle soreness: Mechanisms and management. *Journal of Sports Sciences*. 1992, vol. 10, pp. 325-341.
4. Daniels J.W., Moles P.A., Shaffrath J.D., Stebbins C.L. Effects of caffeine on blood pressure, heart rate, and forearm blood flow during dynamic leg exercise. *Journal of Applied Physiology*. 1998, vol.85, pp. 154-159.
5. Edwards R.H.T., Hill D.K., Jones D.A., Merton P.A. Fatigue of long duration in human skeletal muscle after exercise. *The Journal of Physiology*. 1977, vol. 272, pp. 769-778.
6. Gostill D.L, Dalasky G.P., Fink W.J. Effects of caffeine ingestion on metabolism and exercise performance. *Medicine and Science in sports and Exercise*. 1978, vol. 10, pp. 155-158.
7. Graham T.E. Caffeine and exercise: Metabolism, endurance and performance. *Sports Medicine*. 2001, vol.31, pp. 785-807.
8. Gulick D.T, Kimura I.F. Delayed onset muscle soreness: What is it and how do we treat it? *Journal of Sport Rehabilitation.* 1996, vol.5, pp. 234-243.
9. Hongling N., Kawczynski A., Madeleine P. Delayed onset muscle soreness in neck, shoulder muscle. *European Journal of pain*. 2005, vol.1, pp. 100-106.
10. Jones D.A, Newham D.J, Clarkson, P.M. Skeltal muscle stiffness and pain following eccentric exercise of the elbow flexors. *Journal of pain*. 1987, vol.30, pp. 233-242.

11. Kalmar J.M, Cafarelli E. Effect of caffeine on neuromuscular function. *Journal of Applied Physiology*. 1999, vol.87, pp. 801-808.
12. Lopes J.M., Aubier M., Jardim J., Aranda J.V., Maclem P.T. Effect of caffeine on Skeltal muscle function befor and after fatigue. *Journal of Applied Physiology*. 1983, vol.54, pp. 1303-1305.
13. Maclntosh B.R., Gardiner P.F. Posttetanic potentiation and Skeltal muscle fatigue: interactions with caffeein. *Canadian Journal of Physiology and Pharmacology*. 1987, vol.65, pp. 260-268.
14. Maridakis V., Conner O., Dudley G., McCully K. Caffeine atteates Delayed onset muscle pain and force loss following Eccentric Exercise. *Journal of pain*. 2006, vol.12, pp. 123-129.
15. Maugha R., Gleeson M., Greenhaff P.L. *Biochemistry of Exercise and training*. New York: Oxford universit. 1977.
16. Miles M.P, Clarkson P.M. Exercise-Induced Pain. Soreness and Cramps. Jounal *of sports Medicine and physical Fitness*. 1994, vol.43, pp. 203-216.
17. Myers D.E., Shaikh Z., Zullo T.G. Hypoalgesic effect of caffeine in experimental ischemic muscle contraction pain. *Headache*. 1997, vol.37, pp. 654-658.
18. Newham D.J, Mills K.R, Quigiey B.M, Edwards R.H.T. Pain and faigue after concentric and eccentric contraction. *Clinical science* (*London)*. 1993, vol.64, pp. 55-62.
19. Van Soeren M.H, Graham T.E. Effect of caffeine on metabolism exercise endurance and catecholamine responses after vwithdrawal. *Journal of Applied Physiology*. 1998, vol.85, pp. 1493-1501.

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