

Vibration as preventive therapy and treatment of delayed onset muscle soreness. A systematic review

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Summary

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In recent years the vibration therapy has received great importance in the treatment of delayed onset muscle soreness. Pain that occurs between 12 and 24 hours after an unaccustomed exercise. So the aim of the present study was to determine the preventive and therapeutic effect of vibrations on delayed onset muscle soreness. Conducted a searching in PubMed, Web of Science, Scopus, SportDiscus, PEDro and Cochrane Library databases, for which keywords were used; delayed onset muscle soreness and vibration. 403 articles were identified in the different databases, 10 were selected that met the criteria for review. Besides before, 6 other items that were identified by the search engine Google Scholar were included, in all cases retrieved in full text. 75% of the articles have less than 5 years of have being published. Kleber Burton index, measured by the median, was 2,5 years. The average frequency applied to the participants was $37,4 \pm 15$ Hz, with a displacement of the platform $3,7 \pm 2,3$ mm and a length of $9,4 \pm 8,8$ min. While the average methodological quality of the studies was $4,9 \pm 1,1$. After analyzing the selected studies it was concluded that the topic is present and that the vibrations are effective both in the prevention and treatment of delayed onset muscle soreness.

Key words:

Delayed onset muscle soreness. Eccentric exercise. Vibration therapy. Frequency. Displacement.

La vibración como terapia preventiva y tratamiento del dolor muscular tardío. Una revisión sistemática

Resumen

En años recientes la terapia vibratoria ha recibido gran importancia en el tratamiento del dolor muscular tardío. Dolor que se presenta entre 12 y 24 horas después de haber realizado un ejercicio desacostumbrado. Por lo que el presente estudio tuvo como objetivo determinar el efecto preventivo y terapéutico de las vibraciones sobre el dolor muscular tardío. Se llevó a cabo una búsqueda en las bases de datos Pubmed, Web of Science, Scopus, SportDiscus, PEDro y Cochrane Library, para lo cual se usaron las palabras clave; delayed onset muscular soreness y vibration. De 403 artículos identificados en las diferentes bases de datos se seleccionaron 10 que cumplieron con los criterios establecidos para la revisión. Además de los anteriores, se incluyeron otros 6 artículos que se identificaron por medio del buscador Google Académico, en todos los casos se recuperó en artículo en texto completo. El 75 % de los artículos tiene menos de 5 años de haber sido publicados. El índice de Burton Kleber, medido con la mediana, fue de 2,5 años. El promedio de la frecuencia aplicada a los sujetos de los estudios fue de $37,4 \pm 15$ Hz, con un desplazamiento de la plataforma de $3,7 \pm 2,3$ mm y una duración de $9,4 \pm 8,8$ min. Mientras que el promedio de la calidad metodológica de los estudios fue de $4,9 \pm 1,1$. Después de analizar los estudios seleccionados se concluyó que el tema es actual y que las vibraciones son efectivas tanto en la prevención como en el tratamiento del dolor muscular tardío.

Palabras clave:

Dolor muscular tardío. Ejercicio excéntrico. Terapia vibratoria. Frecuencia. Desplazamiento.

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Introduction

Delays onset muscle soreness (DOMS) is considered to be a transitory effect of intense or unaccustomed exercise¹. Armstrong² defines DOMS as the feeling of discomfort or pain that occurs in the skeletal muscle after performing unaccustomed physical exercise. This pain appears between eight and twelve hours after performing unaccustomed physical exercise, with the greatest intensity appearing between 24 and 72 hours after, with a possible duration of between 5 and 7 days³. Pain that gets worse after performing exercises with greater eccentric content. Examples of activities that include this type of contraction are walking downhill, and opposing the pull of gravity while lowering a weight or object⁴.

Over a hundred years have passed since Hough⁵ first distinguished between pain that appears during exercise and pain that appears the following day, explaining the latter as a result of muscle damage produced during muscle contractions. Despite the fact that the mechanism that produces this pain is still not known, over the years diverse theories have been developed that aim to explain this phenomenon. In 1983 while reviewing the issue, Francis⁶ defined four theories; lactic acid, muscle spasm, tissue tears and damage to the connective tissue. In a later review, Dierking and Bemben⁷ added to these four previous theories, with that of cell inflammation. Finally, Cheung *et al.*⁸ also carried out a review of the DOMS producing mechanisms. As well as the previous theories, they included the enzyme efflux theory. However, they also mention that the DOMS producing mechanism cannot be explained with just one theory, but rather by the sequence of events that combine the muscle damage, enzyme efflux and inflammation theories. Figure 1 shows the sequence of events that produces DOMS proposed by Foschini *et al.*⁹.

Due to the discomfort caused by DOMS, both for those that perform regular physical exercise as well as for sedentary people, studies have

been done in which diverse strategies have been assessed to counteract this pain, among which include: anti-inflammatories¹⁰, anti-oxidants¹¹, physical therapies¹², among which vibrational therapy has recently gathered significant importance.

In view of all the foregoing, the following question arises: is the use of vibrational therapy effective in preventing and treating delayed onset muscle soreness?

In response to the question, the following objective was proposed: carry out a systematic review of the main databases in the field of health to establish the effectiveness of vibrational therapy in both preventing and treating delayed onset muscle soreness.

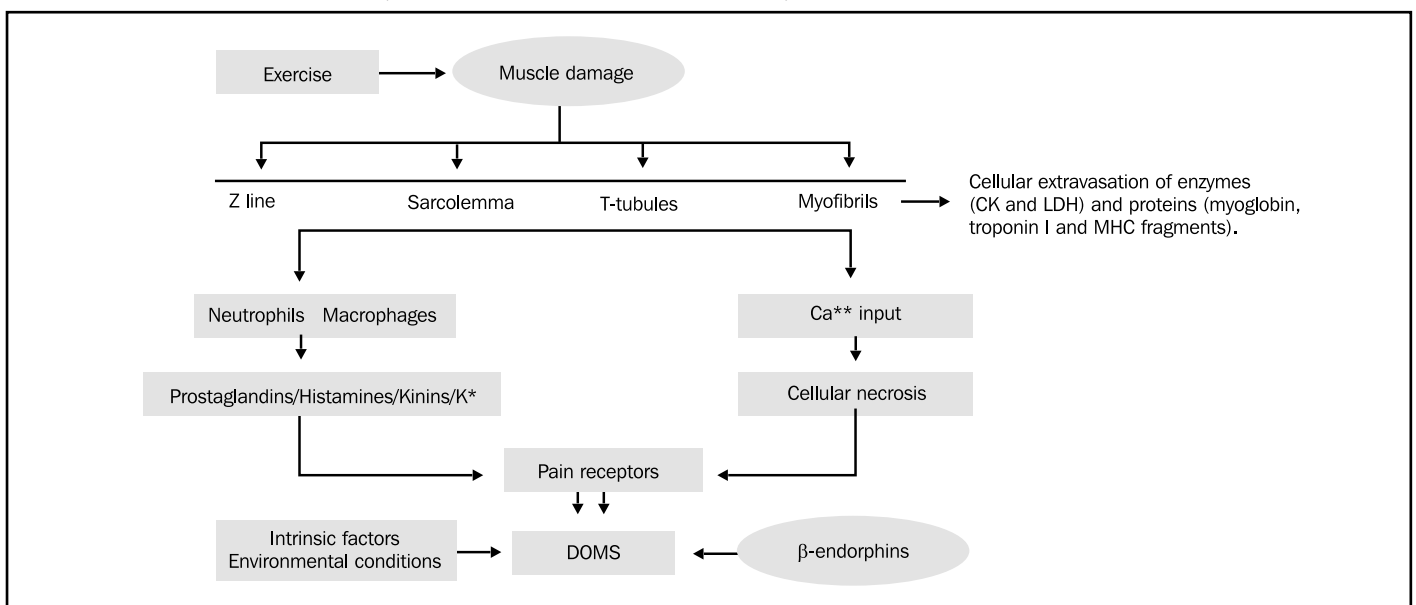
Vibrational therapy

Vibrational therapy is given using mechanised stimuli characterised by an oscillating movement determined by the extent, number and acceleration of the oscillations¹³. Some of the acute effects of the vibrations on the body are increased oxygen consumption, increased muscle temperature and blood flow¹⁴, which may have an influence on counteracting DOMS.

In accordance with Albasini *et al.*¹⁵, therapy using vibrations dates back to Ancient Greece. However, over recent years it has grown in popularity as an alternative way to develop strength, power and flexibility, as well as coordination. This explains why it is now commonplace to find vibrating platforms in gyms, rehabilitation and medical centres.

Although the first research carried out on the use of vibrations was done so from the perspective of their negative effects on the health¹⁶. Today, the focus has changed and studies are mainly conducted on the development of muscle strength on diverse populations.

Figure 1. Possible mechanism of delayed onset muscle soreness proposed by Foschini *et al.*⁹



Material and method

Article search strategy

The search for the articles was performed on the following databases: Pubmed, Web Of Science (WOS), Scopus, Physiotherapy Evidence Database (PEDro), Cochrane Library and SportDiscus. The Google Scholar search engine was used to identify studies that were found in databases other than those consulted. In terms of the search details, below are the terms used for each database PubMed; ("vibration" [MeSH Terms] OR "vibration"[All Fields]) AND "delayed"[All Fields] AND onset [All Fields] AND ("myalgia" [MeSH Terms] OR "myalgia" [All Fields] OR ("muscle" [All Fields] AND "Soreness"[All Fields] OR "Muscle Soreness"[All Fields])), WOS; "vibration delayed onset muscle soreness" (Tema), Scopus; [All Fields], PEDro; (simple search), Cochrane Library; [All Text] and SportDiscus; vibration (TX Complete text) AND delayed onset muscle soreness (TX Complete text).

The criteria for the selection of studies: one of the variables measured in the study must be DOMS, original research, published in peer review journals, in English, therapy applied to humans, no restriction on the publication date. The first search was performed in July 2015 and the second in January 2016..

Assessment of the methodological quality and study selection

The quality of the studies was determined based on the PEDro scale. Of all the studies included in this review, six were qualified in the PEDro database. The rest were all analysed by two independent researchers. In the event of discrepancy, the article was assessed by a third researcher.

Regarding the selection of the first studies, the title was read, if it included a link between delayed onset muscle soreness and vibrational therapy, the abstract was read. If it met all selection criteria, the entire text was recovered and was included in the review.

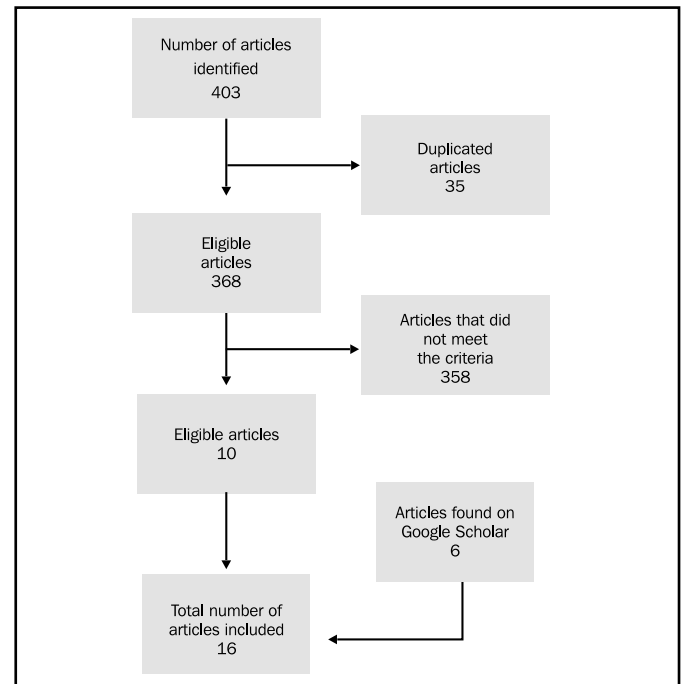
Resultados

Figure 2 displays the selection process for the studies.

Of all the studies identified, 16 met the selection criteria, of which one is a case study and the others are experimental. The methodological quality of the studies was 4.9 ± 1.1 on the PEDro scale from 1 to 10. No methodological quality assessment was performed on the case study. In terms of obsolescence, the Pierce index (percentage of studies performed less than 5 years ago) was 75%, whilst the Burton Kleber index, measured with the median, was 2.5 years. Table 1 displays the summary of the studies analysed and it can be observed that the majority were published less than five years ago.

The average frequency used in the studies in this review was 37.4 ± 15 Hz (range from 5 to 73). Regarding the movement of the platform, the average was 3.7 ± 2.3 mm (range from 0.5 to 8) and the duration was 9.4 ± 8.8 min (range from 1 to 30).

Figure 2. Flow chart for the selection of articles.



Study summary

One of the first studies dealing with DOMS with vibrational therapy was performed by Koeda *et al.*¹⁷ in 2003, in which a comparison was carried out between the application of vibrational therapy on two separate occasions: on 8 subjects it was applied immediately and on 8 others it was applied two days after performing exercise. The DOMS reduced during the arm flex with the application of vibrations two days after the exercise. Bakhthary *et al.*¹⁸ applied vibrations before the subjects performed the exercise; within their conclusions they reported that vibrations can prevent and control DOMS. Broadbent *et al.*¹⁹ found that the subjects that were given vibrational therapy for five days after running downhill for forty-five minutes reduced DOMS and the interleukins-6 in great measure compared to subjects from the control group. Rhea *et al.*²⁰ carried out a study that aimed to analyse the effectiveness of vibrations, massage and stretching on reducing muscle pain. They reported that including whole-body vibrations in recovery is effective in reducing muscle pain.

Most of the studies performed within the past 5 years aimed to establish the effectiveness of vibrations on DOMS. In 2011, Lau and Nosaka²¹ concluded that vibratory therapy was an effective intervention in reducing DOMS and in recovering the range of arm movements after undergoing a session of eccentric exercises. In the same year, Aminian-Far *et al.*²² performed a study in which they aimed to research the acute effect of vibrational therapy applied before exercise and the prevention of DOMS. The experimental group revealed a reduction in DOMS symptoms compared to the control group. In a case report with a similar objective to the previous study, with a healthy subject and

Table 1. Summary of the studies of the effects of vibrations on DOMS.

Authors	Sample	DOMS production	Other variable measurements	Measurement of pain after exercise	Effect on DOMS	Application and duration of the vibrations
Koeda <i>et al.</i> 2003	24 subjects	Flex of the elbow until exhaustion	ROM, blood flow, arm circumference	0,2 and 7 days	The pain in the total passive flex diminished with the application of vibrations two days later	20 minutes after exercise and two days after
Bakhtiyari <i>et al.</i> 2007	25 EXP 25 CONT	Treadmill sloping down at 10°	Isometric strength, CK	1 day	Greatest DOMS in the group not treated	One minute before exercise
Broadbent <i>et al.</i> 2008	15 EXP 14 CONT	40 minutes on the treadmill sloping down by 10°	Inflammatory indicators and CK	24,48,72,96 and 120 h	Less DOMS 96 hours later in the calves of the treated subjects	3 minutes during recovery
Rhea <i>et al.</i> 2009	16 subjects	4 x 8-10 squats, leg extension and curl, heel lift and dead weight. 10 40-yard sprints.		12,24,48 and 72 h	Less muscular pain in the group treated with vibrations	Two sessions of 6 minutes per day for three days
Aminian-Far <i>et al.</i> 2011	15 EXP 17 CONT	6 x 10 ECC knee extensions	Thigh circumference, muscle strength and CK	1,2,3,4,7 and 14 days	Less DOMS in the experimental group after 24 and 48h	60 seconds before exercise
Lau y Nosaka 2011	15 subjects	10 series of 6 reps. ECC elbow flexes	ROM, arm circumference, CK	0,1 h,1,2,3,4,5 and 7 days	Less muscular pain in the group treated on the second day	30 minutes after exercise on 1st, 2nd, 3rd and 4th day
Pinto <i>et al.</i> 2011	1 subject	Running	Difficulty running and limitation of movements	0 and 24	Pain reduced after applying the therapy	3 minutes after exercise and 24 h
Mohammadi y Sahebazamani 2012	15 EXP 15 CONT	5 series of 10 reps of arm flexes	Arm circumference and ROM	0,24,48 and 72 and 96 h	Less muscular pain in the subjects of the treated group	One minute after exercise
Kamandani <i>et al.</i> 2013	10 EXP 10 CONT	25 min running on a treadmill sloping down by 5°	CK	24 h	Less pain on 15 cm pressure of the knee cap in the experimental group	3 minutes before exercise
Xanthos <i>et al.</i> 2013	7 EXP 6 CONT	60 minutes walking on a treadmill sloping down by 13°	Muscular power, gait analysis and CK	0,1,2,4 and 7 days	No difference in the DOMS between the vibration and control groups	10 series of 1 minute after exercise, 1,2,3 and 4 days
Wheeler <i>et al.</i> 2013	10 EXP 10 CONT	3 x 10 strides with dumbbells	Power and flexibility	Immediately	No difference in the DOMS between groups	10 minutes between assessments
Imtiyaz <i>et al.</i> 2014	15 massage 15 EXP 15 CONT	30 reps. Arm ECC	ROM, isometric strength, maximum strength, lactate dehydrogenase and CK	0,24,48 and 72 h	Both massage and vibration reduced the DOMS	For 5 minutes before exercise
Dabbs <i>et al.</i> 2014	27 women	4 series until the split squats fail	Vertical jump, peak power strength, reaction strength upon stepping and muscle activation	0,24,48 and 72 h	Less muscular pain in the experimental group after 72 h	2 series of 30 seconds before assessments
Dabbs <i>et al.</i> 2015	16 EXP 14 CONT	4 series until the split squats fail	ROM and thigh circumference	0,24,48 and 72 h	Vibrational therapy did not help alleviate the DOMS	2 series of 30 seconds before assessments
Fuller <i>et al.</i> 2015	25 massage 25 EXP	100 maximum ECC of knee extensions	Isometric torque, CK, serum myoglobin and inflammation	0,24,48, 72 and 168 h	There was no pain difference between two treatment types	20-minute sessions twice a day for seven consecutive days
Nepocatyč <i>et al.</i> 2015	8 active males	3 series of squats until fatigued	Peak power and anaerobic capacity	24,48 and 72 h	No significant benefit with the application of therapy	For 10 minutes after the test

CK Creatine Kinase; CONT Control; DOMS: Delayed Onset Muscle Soreness; ECC Eccentric actions; EXP; Experimental; ROM: Range of movement.

following a run, Pinto *et al.*²³ concluded that the inclusion of an acute treatment protocol with a low-frequency vibratory platform with the subject in different positions, reduces DOMS.

In 2012, Mohammadi and Sahebzamani²⁴ analysed the preventive effect of vibrations against some functional markers of DOMS in a group of young people. Among the results, they mention that training with vibrations displays the positive effects on the range of movement, DOMS and circumference of the limb treated.

In 2013, Kamandani *et al.*²⁵ also used a treadmill to cause DOMS, but downhill. They discovered that subjects that had vibrations applied before running suffered less DOMS than the control group. Xanthos *et al.*²⁶ also compared vibrations with passive stretching and light exercise on a stationary bicycle as recovery methods after walking backwards on a treadmill for 60 minutes. They concluded that the vibratory therapy they performed was not recommended after DOMS producing exercise. Wheeler and Jacobson²⁷ compared vibrations with light exercise and the effect on DOMS, flexibility and muscle power. Their findings revealed that the two recovery types were equally as effective in treating the variables mentioned.

Imtiyaz *et al.*²⁸ compared the effect of vibratory therapy with massage and the effect on DOMS. They found that both therapies were equally as effective in its prevention.

Recently, in 2014, Dabbs *et al.*²⁹ performed a study on a group of subjects, carrying out squats on a flat surface whilst the other group did the same on a vibratory surface. They did not find a difference in the DOMS between the groups participating in the study. This same group of researchers³⁰ evaluated the effect of vibrations on the whole body over a short time on DOMS after performing high intensity exercises. They concluded that treatment with vibrations did not alleviate DOMS. Fuller *et al.*³¹ also compared vibratory therapy with sports massage and stretching applied after performing exercises and their effects on DOMS. The application of therapy (25 subjects per group) was performed over seven days following the exercise. They found that vibratory therapy was more effective than massage in alleviating DOMS in untrained men.

In a design study, Nepocatyck and Balillions³² cross-compared the vibrational therapy with and without ice applied to the lower limbs and the effect on different performance variables. Regarding DOMS, the authors concluded that the therapy did not provide significant benefits to recovery.

Discussion

In accordance with the methodological quality scale, the studies included in the review are categorised as regular. Though due to the difficulty of administering a placebo in this type of study³³, assessing the methodological quality should be done with eight points and not ten as it is currently. Furthermore, in this respect, the comparison with passive groups is not considered valid, as the groups undergoing the vibrational therapy experience extra activation or muscle work, a factor that is absent from the control groups³⁴.

In terms of obsolescence, it is observed that both the issue and the articles are valid, as the majority (three quarters) of them have been published within the past five years.

Regarding the magnitude and movement, the average (37.4 ± 15 Hz and 3.7 ± 2.3 mm, respectively) coincides with values habitually used in studies seeking improvements in flexibility and proprioception, as well as relaxation and muscle strengthening³⁵. This intensity promotes different metabolic responses, including an increased heart rate and blood flow to muscles³⁶, which would be the elements responsible for reducing DOMS. In terms of the platform movement, the average with which subjects worked allowed them to maintain contact with the platform throughout the entire training session³⁷. With regards to the duration of vibration application, the average (9.4 ± 8.8 min) coincides with Rauch¹⁴ who mentions that a typical session should last for approximately 9 minutes.

Although the average values of the studies coincide with those of the authors mentioned³⁵⁻³⁷, which revealed positive effects in different aspects, when we look at the range we can observe that it is very wide and greatly variable, making it difficult to analyse these studies.

In this search, an update on the issue was encountered³⁸, which included 3 studies that aimed to review the role of vibrational therapy in the prevention of DOMS. They concluded that vibratory therapy, as well as improving physical performance, helped prevent DOMS. A review on the issue was also found³⁹ and just as in this study, it was revealed that vibratory therapy is effective on both a preventive and therapeutic level when treating DOMS. In their brief review, Kosar *et al.*⁴⁰ mention that research suggests that vibrations are considered to be a promising strategy in alleviating muscle pain.

Conclusions

In accordance with the analysis of the studies included in this review, it can be concluded that vibrational therapy is effective in both preventing and treating DOMS, though more studies are required in order to establish the optimum duration, frequency and movements for the therapy.

DOMS is often the reason why people that start practising physical activity give it up, and why athletes are affected on a training level, which is why aside from traditional therapies, vibrations can be included as an effective preventive method as well as a treatment to alleviate symptoms.

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