

Conservative Management of Biceps Brachii Spasticity and Pain with Vibration at the Proper Frequency Range Produced By Oscillating Percussion: Case Report

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Abstract

Objective: Case reports of a patient suffering from biceps brachii spasticity and pain accompanied by limited range of motion in flexion and extension.

Clinical features: Patient presented with right arm pain at the glenohumeral area and the elbow. Patient was assessed and treated accordingly. There was glenohumeral pain and muscle fatigue from overuse.

Intervention and outcome: A treatment with an instrument generating vibration within specific frequencies to facilitate or inhibit voluntary muscles. The treatment resulted in pain relief and normal range of motion.

Conclusion: This case report describes the use of a new technology specific to facilitation and inhibition of voluntary muscles with subjective and symptomatic improvements.

Keywords: Pain; Chiropractic; Vibration; Percussion

Introduction

The shoulder is a unique anatomical structure with an extraordinary range of motion (ROM) that is crucial in most interactions with our environment. A loss of mobility of this joint will cause significant morbidity [1].

The shoulder is the most mobile joint in the body. However, it is an unstable joint because of its great ROM. This instability increases the likelihood of joint injury, often leading to a degenerative process associated with tissue break down and loss of function. Shoulder pain is then a common complaint and there are many causes including: tendinitis and tear to different muscles of the shoulder joint, bursitis or adhesive capsulitis. The goal of the initial treatment is to decrease inflammation and increase the shoulder ROM.

Mechanical vibration was introduced in the 1950's by Fulford [2]. Later, Eklund et al. reported the benefit of patient activated rhythmic motions to induce relaxation [3]. This line of research using rhythmic motions was further developed by; Hebert and Boucher [4] that demonstrated that hand manipulation at a 3-4 Hz frequency produced inhibition of the tendon reflex, Tanosaki et al. [5] demonstrated that an electrical current pulsating at 3-4 Hz also produced inhibition in muscular activity and Carignan et al. [6] that demonstrated in their work on Parkinson that specific frequencies have specific effects on the musculature, namely: 0-4 Hz creates inhibition of voluntary muscles, 4-8 Hz creates stimulation of the voluntary muscles and 8-12 Hz creates stimulation of the involuntary muscles. The use of different frequencies in the approach presented in the following case report is based on the work of, Hébert and Boucher [4], Tanosaki et al. [5] and the work of Roll et al. [7], and his collaborators [8-13].

However, vibration with a selectable frequency and matching the evaluation frequency to the treatment frequency is a more recent technology. Sigma Instruments [14] has been producing the instrumentation since 1996 under the trademark name Pro Adjustor™, Ultralign™ and Spine Align™. Their recent innovations have introduced the capability for the clinician to select a specific frequency for a given treatment. Other technologies, such as Sense Technology Inc. [15] with the Pulstar™ instruments, use sweeping frequencies and Neuro Mechanical Innovations Inc. [16] uses fixed and specific frequencies.

Case

A 57 year old female grade-5 teacher came to the clinic with a chief concern of right arm pain and limited ROM with the elbow flexed at ninety degrees as if she was ready to shake hand. The onset of her symptoms occurred following the displacement of heavy pieces of glass, which required that each piece be lifted and supported by her right arm only. It took her the entire day to remove a pile consisting of approximately 100 pieces measuring 24x36 inches and ½ inch in thickness. She had to move the glass pieces from one building to the next, representing a 5 minute walk in between stations. Her medical history did not show any prior injuries in the shoulder area or any areas related to the thoracic spine. The patient was unable to flex or extend the elbow and pronation/supination of the right forearm was painful as well. Examination using a verbal subjective pain scale yielded a score of 10 (1 being no pain and 10 being her worst pain). Prior study using verbal or visual analog scales demonstrated this approach to be a valid and reliable way to measure pain intensity [17]. Physical examination was irrelevant except for the limited ROM in flexion and extension of the elbow, no internal or external rotation and no abduction or adduction either at the shoulder joint. Deep tendon reflexes were elicited and accompanied with a pain reaction. Sensory examination was within normal limits bilaterally. Motor examination was not performed due to the pain generated by trying to move the forearm.

Treatment Methodology

For each case, the Ultralign G2 (Sigma instruments, Cranberry

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Received January 30, 2014; **Accepted** February 08, 2014; **Published** February 10, 2014

Citation: Roy R, Boucher JP (2014) Conservative Management of Biceps Brachii Spasticity and Pain with Vibration at the Proper Frequency Range Produced By Oscillating Percussion: Case Report. J Pain Relief 3: 133. doi:10.4172/2167-0846.1000133

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Townships, PA, USA) was used for the treatment. The frequencies between 0.1 To 4 Hz were used to induce muscle inhibition [4,5], and the frequencies between 4.1 and 8 Hz was used for stimulation or facilitation of the voluntary muscles [6]. The instrument was used according to the manufacturer's treatment mode for the trigger point therapy [13]. The instrument and software did allow the choosing of the inhibition frequency which was executed during the treatment. The clinician was certified in the use of this instrument and the different treatment protocols.

The calibrated pre-tension of the instrument was measured on force plate and corresponded to the manufacturer's claim of 6.0 pounds (unpublished laboratory results using a force plate were of 6.01 pounds). The treatment force varies from 10 to 35 pounds in increment of 5 pounds. The instrument was tested in our laboratory on a force plate for the 10-pound choice and it corresponded exactly to 10 pounds (unpublished). The other treatment settings were not evaluated since only the 10 pound force was used for the treatments. In the evaluation/treatment mode, the clinician exerted a pressure to release tension of the instrument that measured the frequency response of the tissues. Then, the software identified a sub-harmonic frequency and the treatment response was then matched to this sub-harmonic frequency.

The targeted muscles were the biceps brachii and the triceps brachii. The stimulation of each muscles lasted for a maximum of 50 percussions per contact point. The contact points were the proximal and distal tendons of each muscle and the belly of the muscle. Only one visit was necessary to accomplish all the contact points and it lasted approximately 10 minutes in its entirety. Patient was asked to perform all her duties without restriction. The outcome measure was reevaluated with the same functional examination done on the initial visit for this condition and we also recorded the verbal analog scale from the patient, the patient stated that she had no pain left or any movement restriction in her arm and or shoulder.

Intervention and Outcomes

Treatment protocol for Case 1

The patient was seated. First, the clinician selected the delta frequency range (0.1-4.0 Hz) to inhibit [4,5] the elbow flexion agonist muscles with the specific aim of reducing the tension in the biceps brachii. After the biceps brachii treatment was terminated, the theta frequency band (4.0-8.0 Hz) was selected to induce facilitation of the antagonist muscles [6], the triceps brachii.

The Biceps brachii responded immediately and as the treatment progressed the forearm lowered from its initial ninety degree position and reached approximately 160 degrees. At that moment, the patient reported a pressure and a tension and the patient pointed at the insertion of the Triceps brachii. We then proceeded to stimulate the triceps brachii and the remaining 20 degrees were achieved to reach 180 degrees. This procedure needed to be repeated on one other visit one week later, for a total of two treatments. Since then (12 months), there has been no relapse and no other signs or symptoms have been reported.

Discussion

The following question is at the center of the procedure proposed herein: How are these vibrations perceived by the peripheral and central nervous system?

We will present what the fundamental research and clinical research have to say to help us answer our question.

Fundamental discussion

Vibration as a treatment mode is not new [5]. Tardy-Gervet et al. [18] mentioned that vibration has been used empirically in medicine for a long time. However, it was only in 1983 [2] that it began to be investigated scientifically.

Bongiovanni et al. [16] mention that prolonged periods of superimposed muscle vibration caused a reduction of electromyographic (EMG) activity. They suggest that the contributing mechanisms might be vibration induced pre synaptic inhibition and/or transmitter depletion in the group Ia excitatory pathways which constitute the afferent link of the γ -loop. In cats, the monosynaptic reflex was suppressed by vibration of the hind limb with innervation intact [19]. It was shown to be mediated by presynaptic inhibition by the demonstration of primary afferent depolarization and normal excitability of motoneurons to direct stimulation.

Vibration induced presynaptic inhibition is mediated through group Ia fibers rather than groups Ib and II or afferent fibers arising from Pacinian corpuscles [19]. Presynaptic inhibition can be explained by the depression in the size of the excitatory post synaptic potential without any detectable change in the resting membrane potential or in the excitability of the post synaptic cell [20].

Wierzbicka et al. [21] also concluded that sustained Ia sensory inflow, evoked by vibration, has a powerful after-effect on the motor system at the postural level. Aimonetti et al. [11] analysed the directional coding of two-dimensional limb movements by cutaneous afferents. It is suggested that the common movement-encoding characteristics exhibited by cutaneous and muscle afferents, as early as the peripheral level, may facilitate the central co-processing of their feedbacks subserving kinaesthesia and ligament afferents [22] may participate in a continuous control of the muscle activity through feed forward, or programming, mechanisms. This suggests that ligament mechanoreceptors have an important role in muscle coordination and in the reflex regulation of the functional joint stability, by contributing to the preprogramming of the muscle stiffness through reflex modulation of the gamma-muscle spindle system.

The spinocervical tract is established as a cutaneous sensory pathway, because of its powerful input from skin receptors and also its central connections [23]. Casini et al. [9] investigated cortical activity associated with perception of illusory hand movements elicited by tendon vibration in humans. Their results confirmed the role of posterior parietal areas as well as motor areas in the arising of kinesthetic sensations. The⁸ raised hypothesis was that there may be an interaction between the angular gyrus and the primary motor area occurring about 400 ms after the beginning of the vibration.

Calvin-Figuère et al. [13] demonstrated and confirmed the close relationship between the parameters of an antagonist vibratory response and those of the kinesthetic illusion. These strong relations between the perceptual and motor effects of tendon vibration once again suggest that the antagonist vibratory response may result from a perceptual-to-motor transformation of proprioceptive information, rather than from spinal reflex mechanisms. Ribot-Ciscar et al. [24] suggested that post-vibratory contraction may mainly involve a supraspinal tonic drive, but the possibility that these involuntary contractions may have a spinal origin cannot be completely ruled out.

Smith et al. [25] demonstrated that the mechanical vibration applied to muscle tendons exerts an inhibitory effect on cutaneomuscular responses. This supports the hypothesis that mechanoreceptors that mediate body kinesthesia can be used as a vehicle to alter the spinal

excitability state. The data suggests that tendon vibration could be utilized in neurological disorders to induce exogenous-mediated potentiation of presynaptic inhibition.

Clinical discussion

Eklund et al. [3] concluded that segmentation of reflex EMG responses to sudden joint displacements to a large extent depends on the inherent resonance characteristics of the musculo-tendinous structures. Primary spindle endings with their high vibration sensitivity and their segmental projections to α -motoneurons are believed to be the receptors primarily responsible for reflex adaptation of the motor impulses.

Duclos et al. [10] mentioned that muscle vibration has been shown to induce long-lasting and oriented alterations of standing posture in healthy individuals and Gay et al. [12] concluded that vibratory stimulation may significantly improve ROM and reduce pain in patients with complex regional pain syndrome type. It was also demonstrated that muscle vibration induces a tonic vibration reflex [26] and prolonged vibration increases the short latency component of the stretch reflex [26]. Pre-existing physiological tremor is also enhanced during muscle vibration [27,28]. The inhibitory effect increases with the amplitude of the vibration, but decreases when the vibration frequency is increased [29].

Albert et al. [8] state that vibrations within the "natural" frequency range of Ia fibres firing (around 30 Hz) produce clear illusions of movements in all the tested subjects. In their recent work, Ikeda and McGill [30] write that immediate pain reduction can be achieved by altering muscle-activation and movement patterns.

Lee et al. [31] findings suggest that local vibration stimulus is an effective method for improvement of the postural sway, gait and upper limb motor performance [32] of reaching movement in chronic stroke patients. Paoloni et al. [33] concluded that segmental muscle vibration and botulinum toxin-A reduces spasticity and improves fatigue in patients with multiple sclerosis.

Saxena et al. [34] writes that segmental vibration therapy treatment is more of focal area stimulation. Vibration therapy is a mechanical stimulus, it is thought to stimulate the sensory receptors, as well as decrease inflammation. Therefore, vibration therapy could be a valuable tool in treating athlete effectively and decreasing their recovery time. Peer et al. [35] stipulated that segmental biomechanical muscle stimulation therapy appears to have significant acute benefits for improving flexibility and reducing perceived stiffness in healthy adults with ankle or hamstring injury.

Summary

In summary, at the beginning of this section, we posit the following question: How are these vibrations perceived by the peripheral and central nervous system? In an effort to answer this question, the cited research on vibration offered information on the following relevant topics: presynaptic inhibition [1,3,19], tonic vibration reflex [26], inherent resonance characteristics of musculo-tendinous structures [3], spinocervical tract established as a cutaneous sensory pathway [9,13,16], supraspinal tonic drive [23] and mechanical stimuli thought to influence sensory receptors, as well as decrease the cell and receptor inflammatory responses [33]. All of these possibilities warrant more basic and clinical research aimed at understanding the mechanisms underlying the effects of vibration at different frequencies. Vibration with matched frequency in a specific frequency band seems to be a safe and promising treatment with a positive effect on pain and function.

Conclusion

This case report results support the view that vibration with matched frequency in a specific frequency band can reduce pain and increase muscle and joint mobility. Further fundamental and clinical research focussing on the underlying mechanisms and the effectiveness of this technology should be conducted.

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