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ORIGINAL ARTICLE

Relation Between Muscle Activation Pattern and Pain: An Explorative Study in a Bassists Population

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Abstract

Objective: To explore the muscle activation patterns in relation to pain complaints in bassists studied during a musical task. This study was based on the assumption that pain complaints are caused by increased muscle activation during playing or relaxation and/or faster onset of fatigue of muscles.

Design: Cross-sectional study.

Setting: Nonclinical.

Participants: Student bass guitarists (N=36) from conservatories in the Netherlands.

Interventions: Not applicable.

Main Outcome Measures: Bassists played a standard music piece for 30 minutes. Muscle activation levels and pain were recorded. Pain was registered with a Numeric Rating Scale (NRS 0−10). The muscle activation level of both the trapezius muscles and flexor carpi radialis was measured with sEMG: sEMG as the percentage of the maximal voluntary isometric contraction (%MVC) and the slope of the sEMG (slope of %MVC) were calculated. The %MVC as a function of time and the slope of %MVC were calculated during playing and for rest periods before and after playing. For statistic analysis, the Mann-Whitney *U* test and a multilevel multiregression analysis were used for comparing the sEMG data of bassists with and without pain.

Results: No significant differences in %MVC or the slope of %MVC were between the bassists with and without pain complaints.

Conclusions: The results surprisingly indicate that pain complaints of bassists may not be associated with another muscle activation pattern. It is, therefore, not likely that pain is caused by increased muscle activation during playing and/or relaxation, nor by faster onset of fatigue.

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Musculoskeletal problems are frequent among professional instrumental musicians as well as music students. A high prevalence of musculoskeletal pain is reported in the literature, with 40% to 60% of musicians in general,[1-3] and up to nearly 100% of flamenco guitarists and bassists who are men.[4] The impact of pain on playing is great and frequently leads to the end of the musician's career.[3,5] A complex of various intrinsic and extrinsic causes contribute to this very high prevalence of chronic pain.[1,3,6] Musicians are engaged in difficult, repetitive, long-lasting physical work. In this they resemble workers in other repetitive work situations.[7] Therefore, it is likely that the mechanisms of pain causation are identical to that of other workers with pain complaints. The underlying physiological mechanisms of pain in musicians and other low-intensity, high-frequency work-related pain complaints (eg, computer staff or cashiers) are still debated. In the chronification process of pain there is evidence indicating a change in motor control and muscle activation strategies during activity and relaxation.[8-12] Three studies have been made concerning this mechanism in musicians.[7,13,14] However, they showed conflicting results, ranging from higher[13,14] to lower[7] muscle activation levels in the musicians with pain compared with the nonpain group. Our strong clinical impression was that musicians with (chronic) pain have an enhanced level of muscle activation in the muscles of the neck and arms, both in rest and during playing, compared with musicians without any pain. Based

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on the previously described ambiguities and our clinical experience, the aim of this study was to explore the muscle activation patterns of musicians during a musical task in relation to pain complaints. The study is based on the assumption that pain complaints are caused by increased muscle activation during playing, relaxation, and/or faster onset of fatigue of muscles.[15] In order to be able to play the same musical piece, we restricted the study to players of 1 type of musical instrument, that is, the electrical bass guitar. We formulated and tested the following hypotheses: (1) bassists with pain have higher muscle activation levels during 30 minutes of playing and/or in the rest period before and after playing compared with bassists without pain; and (2) bassists with pain show an increased progression in muscle activation levels during 30 minutes of playing compared with bassists without pain.

Methods

Participants

Participants included 36 student bass guitarists from 3 different conservatories in the Netherlands, recruited from October 2010 to February 2011. They were informed and recruited through their teachers and were given further information by the researcher (P.vd.W.). Bassists who suffered from severe health problems not associated with playing the bass, or who were not able to fill out the questionnaire (because of a native language other than English or Dutch), were excluded. All subjects gave explicit consent. Because of the type of study, using healthy volunteers and a task compared with their daily activities, the medical ethics committee decided that no approval was obligatory.

Measures

Questionnaires

We used 3 types of questionnaires. A description of the subject was made by assessing the bassists' characteristics with the first questionnaire, the questionnaire general (appendix 1), which included questions about age, sex, pain medication, hours playing per week, and pain. A drawing of the upper part of the body was included; here the bassists could mark the location of their pain (maximum of 6 locations). No authorized pain questionnaire was available in the literature for this specific situation with bassists. Therefore, we formulated the questions concerning pain with regard to the location and duration of pain complaints, based on other questionnaires found in the literature.[16-19] A Numeric Rating Scale ([NRS] 11-point) was used to measure the intensity of the (average) experienced pain of the 4 most prominent pain locations. The questionnaire general was digitally completed, by the bassist at home, approximately 1 week before the test procedure. The second and third questionnaires, respectively, the questionnaire before and the questionnaire after playing the musical piece, were short versions of the questionnaire general. They assessed the intensity, location, and duration of pain if pain was present at that moment. An English and Dutch version was available, depending on the preference of the bassist.

List of abbreviations:

bpm	**beats per minute**
MVC	**maximal voluntary isometric contraction**
%MVC	**percentage maximal voluntary isometric contraction**
NRS	**Numeric Rating Scale**
sEMG	**surface electromyography**

Surface electromyography measurement

The registration was done with a bipolar surface electromyographic tool.[a] The muscle activity in the trapezius muscles (pars descendens) and the wrist flexors (above the flexor carpi radialis muscles) on both sides was recorded. The activity of the trapezius muscles was measured because of their stabilization (postural and supporting) function, and the wrist flexors were measured because of their dynamic function during playing. Moreover, their superficial locations make these muscles highly suitable for surface electromyography (sEMG) recording.

All 4 muscles were recorded simultaneously. The electrodes were placed on the skin above the previously mentioned muscles, conforming to European guidelines.[20] Two adhesive electrodes[b] were placed at each location, with an inter electrode distance of 3cm, to create bipolar sEMG recordings, which are much more reliable than unipolar recordings.[21,22] The electrodes on the trapezius muscles were placed halfway on the line between the processus spinosus C7 and the lateral end of the acromion parallel to the direction of the muscle fibers. In the region of the wrist flexors, the electrodes were placed halfway on the line, ranging from the lateral aspect of the biceps tendon insertion in the elbow near to the os pisiforme. This location is anatomically above the m. flexor carpi radialis; because of the phenomena of crosstalk of the adjacent muscles, we interpreted the sEMG recordings in terms of wrist flexors. The reference electrode was placed on the distal end of the ulnae. The sEMG module sent the 4 signals to a receiver, which was coupled with a laptop. The sEMG signal was recorded using the software program Biofeedback 2000 X-pert.[a] No specifications were available from the manufacturer of the sEMG device on bandwidth. It could be established from the waveforms that there was a strong low pass filter applied with a low pass frequency of about 10Hz, which makes a low sample frequency of 40Hz feasible.

The action potentials were amplified, rectified, and meaned by integration with a time constant of 250ms. The reported parameter therefore corresponds to the rectified mean of the reading. Afterward the sEMG was checked, and peaks of more than 1000mV were removed, because these peaks are caused by interference of the signal.

To exclude confounding variables in the sEMG registration, such as variable conduction of the electrode or level of subcutaneus fat, the maximal voluntary isometric contraction (MVC) was determined for the trapezius muscles and wrist flexors. There are no international guidelines to measure the MVC for specific muscles. The MVC of the trapezius muscles was obtained by recording the sEMG signal of these muscles when the bassist was standing on a platform with 2 iron chains on both sides. The participant had to pull the chains symmetrically, vertically using the trapezius muscles, maximally while keeping the elbows stretched along the body. The MVC of the wrist flexors was recorded while the bassist (keeping the elbow flexed at 90°, the underarm horizontal and the wrist in neutral position) was maximally trying to flex the wrist against resistance. This resistance was provided by the observer (P.vd.W.), who stood in such a position to give enough resistance to prevent the bassist from flexing his/her wrist. Both MVC measurements were recorded twice for 10 seconds, and the average of the peak values was calculated.