Research Article
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Does Stretching of Pectoralis Major Stretch the Muscle or The Neural Tissue? The Use of Structural Differentiation as a Tool for Discrimination

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Abstract

Background: Stretching of the pectoralis major muscle is very similar to the neural tension position for the median nerve. This raises doubts about the specificity of the stretching technique on the muscle tissue. In this research, we propose to use structural differentiation (SD) as a maneuver that has shown to be specific for modifying neural tension without varying muscle length.

Objectives: To analyze if the tension experienced by healthy subjects during the stretching of pectoralis major has a muscular or neural origin.

Methods: A descriptive cross-sectional study was designed. 57 healthy volunteers (113 upper limbs) were recruited for the study. A frequently used stretching technique of the pectoralis major was selected and the subjects were asked to perform it. When tension appeared, the SD maneuver was performed and the responses were classified as muscular (when tension didn't change) or neural (when tension changed).

Results: 54.8% (n=62) of the cases obtained a neural response. Ventral aspect of the arm was the region where the tension sensation was felt by the greater percentage of the cases (40.35%).

Conclusion: The stretching of the pectoralis major could produce tension in the median nerve in half of the subjects. Adding SD into the stretching technique could provide insight on the structure that receives tension during the stretching.

Keywords: Stretching; Nervous System; Pectoralis Major; Median Nerve

Bullet Points

- Pectoralis major stretching can produce tension in the median nerve.
- 50% of subjects provoke tension in the nerve during the stretching.
- Structural differentiation can help in the differentiation of tension origin.

Introduction

Muscle stretching is a form of physical activity in which the muscle is subjected to elongation for a given time, producing a variable modification of muscle length[1]. Its use in sports practice is common, with the clear goal of prevention or correction of muscle imbalances or in the treatment of dysfunctions caused by the loss of muscle length [1-5]. For its realization, we can find different procedures that refer to the application time (static or dynamic) or to the specificity (global or analytical), as well as other techniques that combine muscle contraction and relaxation (proprioceptive neuromuscular facilitation) or just isometric contraction while the stretching is performed. In all types of stretching, the final joint position is reached by placing the muscle in the desired position by applying external forces, either gravity or the action of other body muscles [1].

Pectoralis major muscle is one of the most used muscles in sports activities involving the use of the upper limbs. Because of this, it is a muscle on which a wide variety of stretching techniques have been described [1-3,6-8]. When observing the final positions of many of the stretching techniques

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Figure 1: Pectoralis major stretching technique used in the study.

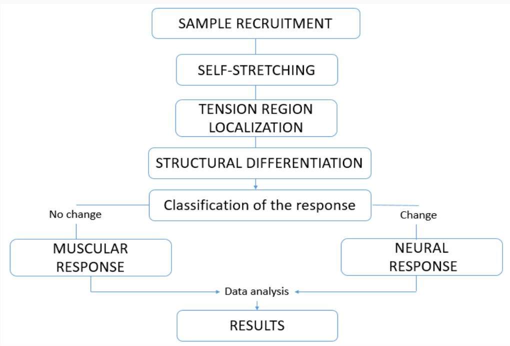

Figure 2: General procedure followed in the study.

described in the literature, they are found to be very similar to the neural lengthening positions, also known as neurodynamic tests (NDTs) or neural tension tests [9-13]. An example of this is the stretching of the pectoralis major, which has a final position similar to the NDT of the median nerve, which is designed to assess the sensibility of the median nerve and the cervical plexus to tensioning in injuries such as carpal tunnel syndrome or thoracic outlet syndrome [10,14-18]. This raises doubts about the specificity of some stretching techniques on muscle tissue and leads us to ask the question whether the stretching felt by the patients when performing the pectoralis major stretching is of muscular origin or it is produced by the tensioning of the nerve, as it has been evidenced in other regions [19].

Another factor that adds to this problem is that the sensation that is perceived during the nervous system tensioning can be very similar to the one generated by the tensioning of a muscle [9-13]. Neural sensations such as tingling, cramping or paresthesia have been reported with relative high frequency. However, the studies performed in order to establish normal NDT responses in healthy subjects have shown that tensioning of a healthy nerve can only be perceived as a tension sensation by the subjects [9-13].

Structural Differentiation

During the assessment of the nervous system, clinicians use a procedure called structural differentiation (SD) in order to discriminate whether the tension produced by a NDT corresponds to muscle or neural tissue. The SD is a maneuver that can modify tension on the nervous system in a specific way, without generating any change in the tension of adjacent muscular structures [9,10,12,20-

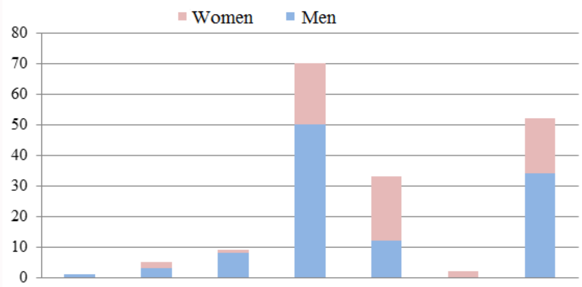

Figure 3: Tension predominance regions during the stretching divided by gender.

22]. This is due to the anatomical continuous nature of the nervous system that allows the tension generated at a point of the system to transmit to great distances to more distant areas. In this way, when the perceived tension sensation during the test is modified after the SD maneuver, the tension is considered to be of neural origin. And, on the contrary, when there is no change after SD, the tension is attributed to the muscular structures.

The SD procedure could be applied to the stretching of the pectoralis major, applying the same principles as those used for the NDTs. This would allow to know if the tension experienced by the subjects during the stretching comes from the muscle or from neural structures. In addition, it could help avoid those that can generate tension on the nervous system.

Therefore, the objective of this study is to analyze if the tension experienced by healthy subjects during the stretching of the pectoralis major comes from muscle or neural tissue. In order to do this, the authors propose to perform the SD maneuver as a movement capable of specifically modifying neural tension without modifying the tension of adjacent muscular structures.

Methods

Study design

In order to achieve the general objective of the study, an observational, descriptive and cross-sectional study was designed. This study was approved by the Asturias regional CEIC date 11/12/2015 (number 135/15). Ethical principles in the Declaration of Helsinki for medical research on humans, last revised in Fortaleza in October 2013, were followed.

Selection of study population

57 healthy volunteers (35 men/22 women) between the ages of 19 and 59 were recruited for the study. All were informed of the object of the study and signed and informed consent. Inclusion and exclusion criteria were applied to ensure a homogeneous sample, limiting the variation between subjects.

- The inclusion criteria wereHave the age of majority (>18 years).
- Sign informed consent.

Exclusion criteria were:

- Any injury to the neck or upper extremities in the last 12 months.
- Any contraindication for performing stretching, such as acute injury to the musculature under study.

Table 1: Characteristics of the sample.

Characteristics of the participants	Total (n=57)
Men (%)	35 (61.4)
Women (%)	22 (38.6)
Age (years), mean (SD)	31.14 (9.66)
Weight (kilos), mean (SD)	72.28 (12.4)
Height (cm), mean (SD)	174.10 (8.7)
BMI	23.76 (3.25)

Note: SD: Standard Deviation; BMI: Body Mass Index.

- Any movement restriction in any of the joints of the upper limb.
- Pain during the performance of the stretch.

Procedure

For the study, a pectoralis major stretch which is commonly referenced in the literature and in other media was selected (Figure 1) [8].

Once the personal data of the subjects was collected, they were individually instructed to perform the selected stretch. Those subjects who didn't know the stretch were shown the picture as a guide (Figure 1). In no case, supplementary instruction was required. In addition, all subjects were instructed to actively perform the movement of SD, so that they were able to do so in the stretching position. The movement of the SD consisted of a contralateral side-bending of the cervical spine. This is a movement that has shown to increase tension in the median nerve along the entire upper limb without modifying the tension in the adjacent muscular structures, the change reaching the wrist region [9,10,12,14]. Once the procedure was explained, the subjects proceeded to perform the stretching individually and freely, without the assistance of the examiner. When the subjects began to perceive tension, the examiner stabilized the upper limb in the final position and the subjects proceeded to perform the contralateral side-bending of the cervical spine. Once the procedure was completed, the examiner recorded the region where the subject had experienced tension and whether or not changes were felt during the SD man oeuvre. After the SD, the answers obtained were classified into two different categories. If the tension modified with SD, the response was classified as neural, and in the case that there was no change of tension, it was classified as muscular. Figure 2 shows the general procedure followed in the study.

Statistical analysis

Once all the data were collected, they were analysed using the statistical software SPSS version 20.0 for Windows.

A descriptive analysis of the variables related to the characteristics of the sample was carried out. For the quantitative variables, the central tendency indexes (mean and median) and the dispersion indexes (standard deviation) were used. For the qualitative variables, a study of frequencies was made to know the absolute and relative frequencies. The absolute and relative frequencies were calculated for the response to the SD manoeuvre and the tension predominant regions.

Comparisons between men and women groups was performed by using the *Fisher's Exact statistic* for nominal variables, *Student's t test* when data was normally distributed and *Mann-Whitney U test* when data was not normally distributed. Prior to the use of these tests, the normality assumption was evaluated by using the *Kolmogorov-Smirnov test*. Statistical decisions were calculated by taking a significance level of $p<0.05$.

Results

Of the 57 subjects recruited (114 upper extremities), one upper limb was excluded because of a wrist injury in the last 12 months, so that the total sample of the study consisted of 113 upper limbs. Table 1 shows the characteristics of the final study sample.

Of the 113 cases reported, 62 showed a neural response (54.8%). As to the location of the tension feeling, the ventral aspect of the arm was the region with the highest percentage (40.35%), followed by the pectoral region (30.41%) and the ventral aspect of the shoulder (19.30%) (Table 2). For the men, the region with the greatest frequency of tension feeling was the ventral aspect of the arm (28.65%), whereas for the women it was the ventral face of the shoulder (12.28%). This difference was statistically significant ($p<0.002$) according to Fisher's Exact statistic. Figure 3 shows the regions of predominance where the subjects manifested tension.

Discussion

One of the most common forms of stretching the pectoralis major is a position very similar to the maximal neural tension of the median nerve [9-13]. This raises the doubt about the specificity of this stretch on muscle tissue and on the possible provocation of stress on the neural tissue during its realization. To answer this question, in the present study it was proposed to perform the SD manoeuvre in the stretching position, since it has been shown to be a specific manoeuvre to move the nervous system independently to the muscle at certain positions [9,10,12,20,23,24]. Specifically, with the upper extremity in shoulder abduction and elbow extension, the contralateral neck side bending has been shown to selectively increase the tension in the median nerve rather than in adjacent muscle structures [21].

In this study, it was observed that more than half of the cases (54.8%) reported a change in the tension during stretching after the SD man oeuvre. This suggests that the perceived tension in these cases could come from neural rather than muscular structures. On the other hand, in a high percentage on the cases (69.59%), subjects reported the feeling of tension in other regions than the location of pectoralis major muscle, such as the arm, forearm or wrist. This could also support the idea that this tension originated at the median nerve, since all of them are areas in which the neural tension during the NDT of the median nerve appears [9-12]. It is noteworthy that only 30.41% of the cases reported to feel tension in the pectoral area.

Although it is already known the risk of putting the joint passive

Table 2: Tension predominance regions during the stretching divided by gender.

	Wrist volar aspect	Forearm ventral aspect	Elbow ventral aspect	Arm ventral aspect	Shoulder ventral aspect	Neck	Pectoralis
Men	0.58%	1.75%	4.68%	28.65%	7.02%	0%	19.88%
Women	0%	1.17%	0.58%	11.70%	12.28%	1.17%	10.53%
Total	0.58%	2.92%	5.26%	40.35%	19.30%	1.17%	30.41%

stabilization structures into tension, there are few studies including the effect on the nervous system, and in those, the results are reduced to its action on the proprioceptive neuromuscular system (neuromuscular spindles and Golgi tendon organs) [25]. In the case of the nervous system, it is well known that tension maintained on the neural structures can produce, both short and long term, alterations in its function. Several studies have shown that increased stress on the nerve produces a decrease in intraneural blood flow [26,27]. If this ischemia is maintained over time, nerve conduction is reduced and exponentially increases the likelihood of adverse effects.

In addition to the potential damage to neural structures, if stress occurs in neural tissue means that the stress is being directed to an inadequate structure and stretching is not meeting its initial goal, which is to increase muscle length. According to the anatomy of the pectoralis major muscle, to achieve its stretching it is not necessary to use the elbow or wrist joints. Some authors have proposed the use of more analytical stretches that only move the shoulder and the thorax in order to separate the insertions of the muscle, avoiding the tensioning of the neural tissue [6,7]. On the other hand, limiting the area where the subjects should feel tension during the stretching, to the region where the muscle is located, could be useful in order to increase its specificity and minimize the possible effect on neural structures.

Finally, taking into account the results obtained, the authors of this study propose to add the SD procedure to the pectoralis major self-stretching techniques, in order to help determine both the indication of the stretching, when it is verified that tension comes from the muscular tissue, as its contraindication, when the tension is of neural origin. In this way, generating stress and damage in other structures can be avoided [21,28].

Limitations of the Study

The study has several limitations. The first could be related to the type of sample which was analysed. Although subjects were recruited in sports centres, a selection of subjects with muscle shortening was not performed. Maybe, in subjects with muscular restriction, the results would have been different, obtaining a greater number of muscular responses during the stretching of the pectoralis major.

On the other hand, although SD has been shown to be a specific manoeuvre to selectively move the nerve without moving adjacent structures [18], in this study an imaging tool, such as ultrasound imaging, was used to visually confirm the selective effect of the SD.

Conclusions

The results obtained in this study suggest that the stretching of the pectoralis major could produce tension in the median nerve and not in the muscle in half of the analyzed subjects.

The addition of SD into the stretching of the pectoralis major could provide greater insight into the structure that receives tension during the stretching. Its use may increase the specificity of stretching and reduce the risk of injury by discarding those techniques that produce tension in neural tissues.

Ethical Statements

This study was approved by the Ethics Committee of Clinical Research of Aragon.

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