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Characteristics of electrical activity in trapezius muscles with myofascial pain

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Abstract

Objective: To study the reliability and validity of resting electrical activity from tender areas in muscle.
Methods: In seven subjects with tender areas in their trapezius muscles, electromyographic (EMG) signals were obtained from monopolar needles at various depths over the tender area and at the same depths over the control area, and from surface electrodes. At selected depths, multiple epochs were recorded.
Results: Increased electrical activity occurred from the electrode inserted toward the tender area in all seven subjects (to a mean of 47.6 μV), but not from control areas. The depths of the maximal EMG amplitudes advancing and withdrawing the needle were usually within 3 mm. The EMG amplitude from the first of multiple epochs (38.4 μV) did not differ from the average (40.0 μV) of subsequent epochs (paired-t test, 6 df, $0.2 < p < 0.3$).
Conclusions: We suggest that the electrical activity arises from a localized zone and is stable over time.
Significance: Our data provide evidence for the reliability and validity of the electrical activity from myofascial tender areas.

Keywords: Electromyography; Pain; Trapezius muscle; Human; Monopolar needle

1. Introduction

Myofascial pain syndrome is a regional myogenous pain condition which occurs in about 55% of head and neck pain patients (Fricton et al., 1985) and about 30% of general pain patients (Skootsky et al., 1989), and is characterized by tender areas within the muscle.

The "integrated hypothesis" (Simons et al., 1999a; Simons et al., 2002) for the mechanism of myofascial pain postulates a chain of events beginning with abnormally high release of acetylcholine at the neuromuscular junction, causing muscle action potentials, with their sequelae of contraction, blood vessel compression, release of algesic substances, and pain. One can test the second step in this chain, the muscle action potentials, with EMG.

Resting electrical activity from muscle under tender areas has been reported (Hubbard and Berkoff, 1993; McNulty et al., 1994; Couppe et al., 2001; Simons et al., 2002), but the results have often been described in general terms and have been poorly replicated. For example, the range of depths over which the activity can be recorded, the waveform characteristics of the resting electrical activity itself, and the persistence or pattern of the spikes over time have not been thoroughly documented. Moreover, both negative (Kraft et al., 1968; Zidar et al., 1990; Durette et al., 1991) and positive (Hubbard and Berkoff, 1993; McNulty et al., 1994; Couppe et al., 2001; Chung et al., 2004) results emerge from studies using ostensibly comparable methods. In studies where the existence of electrical phenomena from tender areas were not observed, the investigators had failed to describe how the search proceeded using the recording needle whereas in the positive reports the investigators specifically described a careful approach (i.e., small increments) for advancing a monopolar needle. Thus, the needle

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advance protocol may determine the adequacy of sampling within muscle once the location for the needle insertion has been determined based on customary clinical criteria for palpating the tender area. We are not aware of any other reviews of the existing literature having noted this seemingly critical methodological issue involving the electrical activity of tender areas. These details are important if the putative physiological phenomenon believed to underlie the myofascial pain syndrome is to have any validity.

Based on the contradictory published literature regarding electrical phenomena associated with myofascial tender areas, we believe a careful, systematic analysis is needed in order to be more confident regarding the validity of these phenomena. A more systematic approach is given in Section 2.

The aim of this study was to provide such data by recording electromyographic activity from tender trapezius muscles at various depths for extended times with monopolar needles. The ultimate goal is to understand the EMG activity in tender areas and to determine the mechanisms giving rise to palpation-evoked pain that is the common feature of myofascial pain syndrome.

2. Materials and methods

2.1. Strategy

Based on the contradictory published literature regarding electrical phenomena associated with myofascial tender areas, we believe a careful, systematic analysis is needed in order to be more confident regarding the validity of these phenomena. A more systematic approach includes all of the following elements: (1) Document the existence of the tender area in two ways: First, identify the tender area by clinical palpation using the usual characteristics of a nodule and a taut band and, second, confirm that location by pressure pain threshold measurement. Thus, the clinical observation is validated using psychophysical data. (2) Record amplitudes of electromyographic (EMG) activity from the tender area at various needle depths in order to provide a careful sampling of the target area. If successful, this method would document the range of depths over which the electrical activity can be observed and perhaps explain failure to find the phenomenon when less exacting methods have been used. (3) Record at the same depths from nearby control sites in the same and different muscle sites in order to reveal whether any electrical activity is local or widespread. This method, if successful, might also explain the failures of prior studies in not finding the putative source of on-going electrical activity. And (4), having established a reliable method for locating and sampling the phenomenon, identify its characteristics over time in order to determine whether the phenomenon is relatively transient and if the contradictions in the prior literature are related to the sampling methods used in the negative studies. The characteristics over time can be obtained by recording over an extended time period without changing the needle depth in order to quantitatively reveal the stability of the electrical activity.

2.2. Subjects

Seven subjects (Table 1) with myofascial pain in their trapezius muscles, confirmed by the process described below, were recruited from the local community. Subjects were between 22 and 38 years (32.6 ± 4.7 years) old. The study was approved by an Institutional Review Board and informed consent was obtained from each subject.

2.3. Equipment

Pressure pain thresholds (PPTs) were measured with an algometer (Pain Diagnostics and Thermography, Inc., Great Neck, NY 11021). Two EMG signals were recorded with 50 mm monopolar TECA disposable EMG needles (Model 902-DMG-50, Oxford Instruments, Hawthorne, NY 10532). These needles are 26 gauge and insulated except for a 0.34 mm^2 bare recording area at the tip. In order to have bipolar recordings each needle was used with a surface reference electrode (Model E5S, Silver Cup Electrode, 1 cm diameter, Grass Instrument, Quincy, MA 02169). A third EMG signal was recorded with a pair of surface electrodes. All three EMG signals were amplified with Model 7P511 amplifiers (Grass Instrument) with bandwidth from 30 to 3 kHz, digitized at 10 kHz and 12 bits for 1.6 s (specifically, 16,384 data points, a power of 2), stored, and processed by programs written in TestPoint (Keithley Instruments, Cleveland OH, 44139; Ver. 3.3).

2.4. Protocol

Each subject was seated in a comfortable chair with armrests. The tender area, as stated by the subject, in the superior band of the trapezius was located by manual

Table 1
Characteristics of subjects

Subject	Sex	Duration of MFP (years)	Recording side	Weight (kg)	Height (m)	BMI
1	M	10	Left	77	1.7	26.6
2	F	10	Right	55	1.55	22.9
3	F	2	Right	61	1.55	25.4
4	M	5	Left	60	1.7	20.8
5	F	3	Left	62	1.55	25.8
6	M	8	Right	73	1.73	24.4
7	M	3	Left	70	1.78	22.1