Correlation between the Pressure Pain Threshold and Sonography and Spontaneous Electrical Activity in Myofascial Trigger Points

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Purpose: This study was designed to investigate possibilities for quantitative analysis using the electromyography and sonography. For better understanding, we evaluated the correlation between the pressure pain threshold and sonography, spontaneous electrical activity in trigger points located in the upper trapezius muscle.

Methods: Thirty three active subjects volunteered to participate in this study (n=33). They had a palpable taut band, exquisite spot tenderness of a nodule in a taut band, spontaneous pain, referred pain, jump sign, local twitch response, and a painful limit to full stretch range of motion. We measured Pressure pain threshold, density, white area index, root mean square, and reaction. Pearson's correlation coefficient was calculated to estimate the relationship between the pressure pain threshold and other variables including density, white area index, root mean square, and reaction time.

Results: There were significant correlations between pressure pain threshold and density ($r=-0.75$, $p<0.01$), and between pressure pain threshold and white area index ($r=-0.74$, $p<0.01$). A significant correlations between pressure pain threshold and root mean square ($r=-0.59$, $p<0.01$). The significant correlation was found between pressure pain threshold and reaction time ($r=-0.64$, $p<0.01$).

Conclusion: These should indicate whether quantitative analysis can be done using the characteristics of electromyography and sonography

Keywords: Myofascial trigger points, Upper trapezius, Pressure pain threshold, Electromyography, Sonography, Spontaneous electrical activity

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I. Introduction

Myofascial pain syndrome (MPS) is described as a regional, painful and prevalent condition in any skeletal muscle of the body. Myofascial trigger points (TrPs) are characterized by the development of local tenderness when active and which refer chronic pain.[1] TrPs are divided into two classifications. First, latent TrPs mean specific pain upon palpation or when injected. Second, active TrPs are always tender, painful, and symptomatic.[2,3] Pain is occurred at rest, and with muscular activity, and upon direct palpation. Postural muscles are the most common involving sites of TrPs, for instance, 33% of TrPs were observed around the upper trapezius muscles.[3,4]

A number of investigators have undertaken to establish the pathophysiology of TrPs in several medical fields and explore an appropriate confirmatory test for detecting TrPs. These have consisted of histological analysis, pressure algometer, and electromyographic (EMG) research.[5,6]

Pressure algometer is a diagnostic instrument used for measurement of the abnormal tenderness and to estimate the sensitivity of myofascial TrPs.[7] This instrument quantifies the subjects pressure pain threshold (PPT) which is characterized as the minimum pressure (force) that provokes pain or throbbing.[5]

EMG has been used to prove TrPs through the measurement

of spontaneous electrical activity (SEA) in the muscle and to explore the pathophysiologic mechanisms of TrPs.[6,8] SEA of activity was postulated to represent stimulation of intrafusal muscle spindle fibers, which are innervated by the sympathetic nervous system.[6] In a resting muscle, SEA is distinguished as low amplitude background noise (50 μV), with superimposed high amplitude spike activity (100～700 μV).[6]

Additionally, diagnostic ultrasound was regarded as the diagnostic imaging modality which is able to determine a pathologic condition in soft tissues, muscles, tendons and fascia in their surrounding areas.[9] Ultrasound can be used as a screening technique in outpatient clinics, for follow-up studies to evaluate the possible effects of treatment.[10]

This study is aim to conduct the possibilities for quantitative analysis using the character of EMG and sonography. To better understand the characteristics, we analyzed correlation between the PPT and sonography, SEA in TrPs placed in the upper trapezius muscle.

II. Methods

1. Subjects

Active thirty three subjects were enrolled and volunteered to participate in this study. Subjects signed in the experiment agreement in this study (Table 1). For eligibility in this study, they should have palpable taut band, exquisite spot tenderness of a nodule in a taut band, pain pattern recognition by patient, referred pain, jump sign, local twitch response, and painful limit to full stretch ROM.

2. Measurement of PPT on upper trapezius

The 1 cm rubber disc of the pressure meter was placed perpendicular to the skin's surface on the point of maximal tenderness. The patient was asked to indicate the point at which pain was first perceived by saying "yes". They were requested to remember this level of pain and to apply the same criterion for the next measurement.[11] At this point the pressure was stopped and the reading was noted. Three repetitive readings were taken by two physical therapists, and an average of these readings was used for data analysis of PPT measurement.[12]

3. Measurement of sonography on upper trapezius

Transverse and longitudinal ultrasound images were taken using by ultrasound imaging system (Sonography) (SONOACE 6000, Medison Co., Korea). Sonography was recorded using a B-mode ultrasound scanner with Modulation frequency range 6～8.5 MHz, gain range was G20-80.[13] The subjects were seated comfortably in a chair. Image analysis was performed using integrated software, image pro plus 4.1 (Media Cybernetics, USA) after resizing the collected images to 332×310 pixels through photoshop CS (Adobe, USA). Using this software, the density of the muscles was averaged at the transverse and longitudinal section including TrPs.[10]

1) Echodensity

To quantify muscle aspect properties, care was taken not to select fascia or muscle-tendon transitions. To quantify muscle echogenicity, the average pixel value (density) of the selection was determined. If this value is 0, the selection is pure black; if this value is 255, the selection is pure white.[10]

2) White area index (WAI)

The WAI (a fraction between 0 and 1) was calculated as the white area in the selection divided by the total area of the selection.[10]

4. Needle EMG on upper trapezius

Intramuscular electrical activity was recorded using 37 mm TECA disposable monopolar needle electrodes (VIASYS, USA). The EMG unit was set with the following parameters: high pass filter 10 Hz, low pass filter 500 Hz, sample rate 1000 Hz. These levels were selected in order to improve baseline stability and reduce baseline noise level. The gain was generally set at 1000 μV per division. The needle electrode was connected to the preamplifier. Reference and ground electrodes were placed to adjacent tissues. The needle insertion was done at an extremely slow rate to avoid and local twitch response.[14]

Table1. General characteristics of the subjects

	Age (years)	Height (cm)	Weight (kg)
Mean±SD	22.9±3.6	166.4±7.1	58.2±8.1

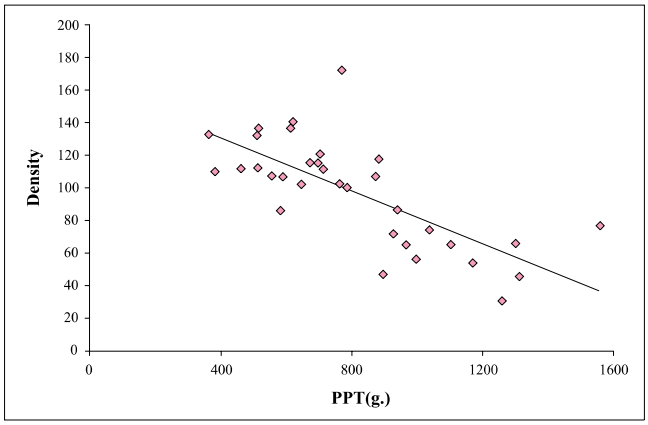

Figure 1. Scatter plot of correlation between PPT and density. PPT and density showed significantly negative correlation (r=-0.75, p<0.01).

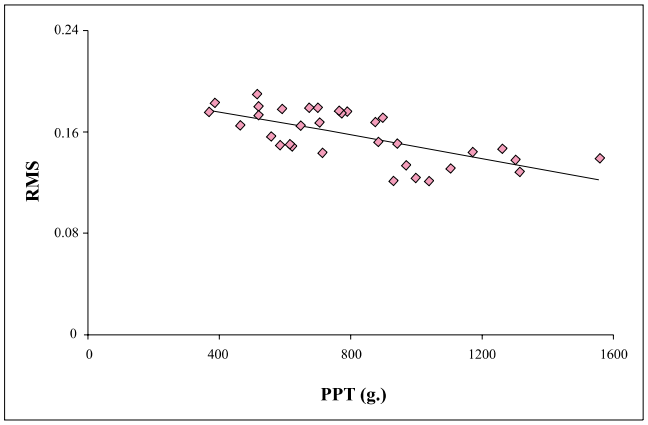

Figure 3. Scatter plot of correlation between PPT and RMS. PPT and RMS showed significantly negative correlation (r=-0.59, p<0.01).

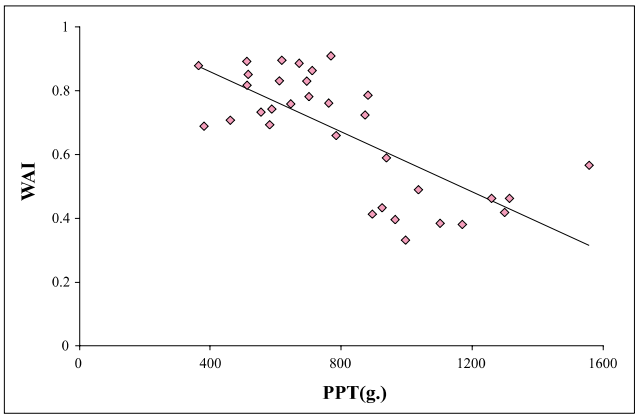

Figure 2. Scatter plot of correlation between PPT and WAI. PPT and WAI showed significantly negative correlation (r=-0.74, p<0.01).

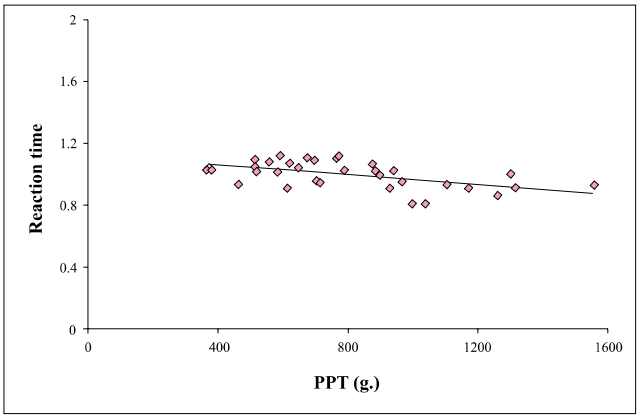

Figure 4. Scatter plot of correlation between PPT and reaction time. PPT and reaction time showed significantly negative correlation (r=-0.64, p<0.01).

1) Analysis of amplitude of SEA

Rectified SEA from needle EMG used for analysis of root mean square (RMS). We used moving window of analysis of variable with window length 0.125 sec, window overlap 0.0625 sec for RMS.

2) Analysis of time of SEA

Rectified SEA from needle EMG used for analysis of reaction time. Reaction time was from induced SEA to maximum maintain time.

5. Statistical analysis

The Pearsons correlation coefficient was used to estimate the correlation between the PPT and density, WAI, RMS, reaction time. All analyses were carried out using SPSS v. 12.0 with the level of significance set to 0.05.

III. Results

Figure 1 and 2 shows the relationship between PPT and the sonography measures. There were significant correlations between PPT and density (r=-0.75, p<0.01)(Figure 1), the PPT and WAI (r=-0.74, p<0.01)(Figure 2).

The correlations were found in PPT and needle EMG measurements in active TrPs (Figure 3, 4). There was a significant correlation between PPT and RMS (r=-0.59, p<0.01)(Figure 3). The significant correlation was demonstrated between PPT and

reaction time show in a figure 4 ($r=-0.64$, $p<0.01$).

IV. Discussion

In the view of general practitioners, palpation is regarding a common method to detect myofascial TrPs in the musculoskeletal system. Unfortunately, this method has been constantly revealed as unreliable appliance. Needling of a myofascial TrPs is possible to evoke a twitch response in soft tissues and cause regional and referred pain.[15]

Although we know the clinical importance of myofascial TrPs, the reliability of their diagnostic criteria has been comparatively deficiency of concurrence.[16] Ultrasound diagnostic imaging give us the ability of visualization of skeletal muscles using a noninvasive, secure and reasonable examination procedure. It can be very beneficial in identifying neuromuscular disorders, specifically, if the respective planes of reference values are ready for use.[17]

With direct palpation, TrPs known as 'active' are characterized as tenderness and may be painful in the lack of applied pressure, and are more likely to evoke a jump sign when stimulated enough.[16]

Based on appearance by the computerized ultrasonic B-scan texture analysis, the anatomical composition and organization of each muscle are shown as its own particular image characterized by the grey-scale intensity and structure of the muscle. Such quantitative ultrasound is also a possible testing technique to find potential alternations linked to use, age, and pathology in whole muscles where invasive biopsy method is not appropriate, and for screening objectives or complementary diagnostic procedures.[18]

Using EMG, researchers were capable of obtaining SEA exhibition in both long-term myofascial symptomatic disorders and asymptomatic disorders with diagnosed TrPs.[19] The patients have hada tendency to avoidance of the action of needling into muscles when EMG activity is used for record in research.[6] However, it was useful that SEA was recorded from an active place in the vicinity of the myofascial TrPs and has been sensitive enough to evaluate the myofascial TrPs.[20] Reduction in SEA in trigger spots after dry needling has been illustrated when compared to a control area in rabbit muscle.[19,20] Investigators are able to observe persistently SEA in TrPs of the upper trapezius muscle in human as well as in trigger spots found in rabbit biceps femoris muscle.[6,21] Moreover, the surprising correspondence of SEA found in both human muscle and rabbit muscle to recordings of motor end-plate potentials proposes that a symptom of TrPs is placed in the region of dysfunctional end-plates closely located to sensitively reacted nociceptors.[21,22] As an additional diagnosis technique specifying activity of a TrPs, the employment of EMG and the quantification of SEA suggested a physiological correlation to pain sensation, presenting highly related validity to the results of this study. The indicators triangulate and meet prove each other by accomplishing congruence outcomes applying subjective (pain perception) and objective (SEA) examinations. Furthermore, degrees of SEA could advocate whether a TrPs is still active or has been impeded with suitable intervention.[14]

Quantitative analysis is indicated to be more sensitive and objective assessment than visual or palpable evaluation and also shown upgrading accuracy although Bargfrede et al.[23] observed no distinction.[17]

V. Conclusion

This research was purposed to analysis correlation between the PPT and sonography, EMG in subjects with TrPs. There were negative correlations between PPT and density, WAI, RMS, reaction time.

The evaluation of PPT differs from case by case depending on clinical symptoms. However, we investigated that quantitative analysis using the character of EMG and sonography suggested sensitive and accurate assessment.

Author Contributions

Research design: Kim HJ, Kim TY
Acquisition of data: Kim HJ, Kim SH, Oh S
Analysis and interpretation of data: Kim HJ, Kim MH
Drafting of the manuscript: Kim HJ
Administrative, technical, and material support: Oh S, Kim SH, Choi JH
Research supervision: Kim TY, Kim MH

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