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Investigation of the relationship between pain threshold and joint position sense in the cervical region

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Abstract

This study was performed to investigate whether there is a relationship between cervical region pain threshold and joint position sense (JPS) in healthy subjects. The subjects were 38 healthy volunteers in the Hacettepe University, Faculty of Health Sciences, Physiotherapy and Rehabilitation Department. Pain thresholds in the right and left cervical paravertebral regions of participants were assessed with a digital algometer (Wagner Instruments, Greenwich, USA). The JPS of the cervical region was assessed with the Cervical Range of Motion 3 (CROM 3) device. While the pain thresholds in the left and right cervical paravertebral regions increased, the JPS error levels in the cervical region of the extension direction decreased (right and left cervical paravertebral region $p = 0.003$ and $r = -0.475$, $p = 0.020$ and $r = -0.377$, respectively). At the end of this study, the position sense error was higher in the participants with a low pain threshold. In participants in which the pain threshold is lower, prematurely stimulated pain receptors can decrease JPS by causing suppression of proprioceptive receptors. JPS should be assessed in individuals who define pain in the neck region. According to the result of this study, it is necessary to improve JPS in patients with neck pain, or healthy individuals who have lower pain threshold may be able to avoid neck pain when they receive appropriate proprioceptive training to improve their JPS. In conclusion, when healthy individuals were included in proprioceptive training, it was observed that neck pain could be prevented in the early period.

Keywords: Joint position sense, pain threshold, cervical region

Introduction

Individuals develop a variety of strategies to protect themselves from trauma coming from their surroundings. An internal pain that gives a warning to the individual and the postural awareness that the individual possesses are of crucial importance for use of these strategies [1,2].

Pain is defined by the International Association for the Study of Pain as "an unpleasant sensory and emotional feeling which starts from any part of body, originates from an organic or non-organic cause and is associated with the past experiences of the person". Pain has also been defined as the unconscious awareness of tissue damage. It has also been shown that pain causes panic and avoidance behaviors in the person. Many studies have emphasized that the proprioceptive system deteriorated with the emergence of pain. As a result of reduced proprioception, deteriorations may occur in the reaction time, postural control and stability of the person. However, the reasons for this situation have not been fully explained [3-5].

Since proprioception regulates joint position, motion perception and the sensitivity of the force exerted by muscles, it is an important part of neural control [6]. Emphasizing the importance of neural control strategies in preventing injuries, Quint et al [7] reinforced the presence of an association between proprioception and injuries.

Pain is always subjective, it varies according to the person's perception and it is expressed in parallel to the extent of the pain threshold. Pain threshold is defined as the minimum stimulus value that produces the pain sensation. The past experiences, socio-cultural status and gender of the person may influence pain threshold. While causes such as central and peripheral dysfunctions, inflammatory changes, loss of descending inhibitory system and central sensitization in the pain transmission pathways decrease pain threshold value, nonsteroidal anti-inflammatory

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drug and opioid analgesic use, electric stimulation, and local physical therapy methods such as warm and cold application may temporarily increase the pain threshold [8].

Pain threshold measurement is an objective pain level assessment method which indicates the moment of pain emergence and which is measured by applying stimulus via algometers [9]. For painful stimulation, the methods of heat, pressure, electrostimulation and creating muscle ischemia may be used [8]. In individuals with low pain thresholds, the pain sensation activated early may depress the proprioceptive system and the individual may become vulnerable to injury. On the other hand, because pain is a perceptual sensation, it may occur earlier in individuals with proprioceptive disorders [9].

There are studies which examine the relationship between pain and proprioception in the literature. Gill et al compared proprioception sensation between individuals with and without lumbar pain. At the end of their studies, it was indicated that proprioception was low in the individuals with lumbar pain and this was considered to be caused by degenerative changes in the muscle and joints of the individuals with lumbar pain [10]. O'Sullivan et al found that the proprioceptive sensation of patients with lumbar pain was less than that of normal individuals and they reported that this may occur through a positive feedback mechanism between inappropriate posture and decreased proprioception [11]. Reid et al demonstrated that proprioceptive sensation was lower in patients with neck pain compared to asymptomatic individuals, but they did not provide any clarification related to the cause [12]. These studies attempted to define the association between pain and proprioception by expressing decreased proprioceptive sensation in the presence of pain. These studies are valuable with respect to the idea that pain may cause decreased proprioceptive sensation. Although there are studies regarding the association between pain severity and proprioception in the literature, to the best of our knowledge no study has been conducted on the association between pain threshold and proprioception. The present study examines the perception of pain that individuals may experience at an early stage with impaired proprioceptive sense. If individuals face pain at an earlier stage as a consequence of low pain thresholds, functional disorders occur earlier due to proprioceptive disorders.

Material and Methods

Study Design

Fifty-two male individuals who had not suffered from neck pain for the previous six months [those who marked a point of less than 10 mm on the Visual Analogue Scale (VAS)] and who were aged 18-30 years (mean age 22 ± 2 years) were contacted about participation in the study between December 2015 and September 2016. Ethical approval of the work was obtained by Hacettepe University Non-Interventional Ethics Committee on November 18, 2015 (Decision NO:GO 15/716-04). As a result of the assessments, nine participants were not eligible to participate in the study. Five of the participants were excluded due to various reasons during the evaluation phase. Thus, a total of 38 participants were included in the study (Figure 1). The study was conducted in the Hacettepe University, Faculty of Health Sciences, Physiotherapy and Rehabilitation Department. The demographic characteristics of the individuals were collected by using a questionnaire. The individuals were asked whether they had hypertension, diabetes, or a rheumatologic disease diagnose previously. Their family history, medications and educational status were noted. Individuals who have had neck pain, sensory perception, or rheumatologic problems in the past, or who have received analgesic medication within the past ten days were not included in the study. Furthermore, informed consent form was signed before the start of the study by the voluntary participants.

The participants underwent two assessments. In the first assessment, pain threshold was measured with a digital algometer, while in the second, the joint position sense (JPS) of the cervical region was measured with the Cervical Range of Motion 3 (CROM 3) device.

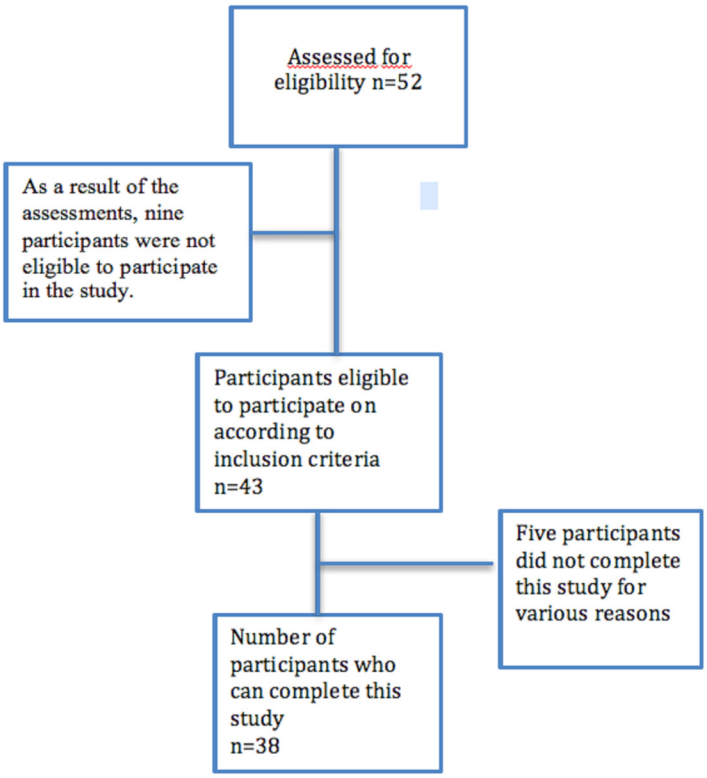

Figure 1. Flow chart of participants

Assessments

Pressure Pain Threshold

Pain threshold was measured bilaterally with a digital algometer (JTech Medical Industries, ZEVEX Company) in the healthy individuals. The reliability of the digital algometer was confirmed by Chung et al. The tip of the device was placed vertically in the paravertebral muscles at the level of seventh cervical (C7) vertebra. The applied pressure was 0.5 kg/cm2 for per second. The mean value of three measurements taken at 30-second intervals was calculated and recorded [13].

Joint Position Sense Error

Clinical assessment of proprioception should employ tests for measuring JPS, kinesthesia, or force sense [6]. The researchers have used the CROM 3 device to measure cervical active JPS and found it as a reliable and valid method [14,15]. Errors greater than 4.5 are considered to indicate abnormal cervical active JPS.

The error of the cervical region's JPS was evaluated in the directions of flexion, extension, right and left lateral flexion and

right and left rotation. The JPS measurements were performed by using the CROM 3 device. When the participant started to the test, he was asked to look across while sitting upright in a relaxed position with his arms at his sides. The head of the participant was brought up slowly and passively to the target point (determined previously by the physiotherapist], which was up to 65 percent of the maximum joint range of motion. The aim of moving the head slowly was to minimize the effects of varying vestibular functions with age in individuals. The participant was told to keep his head in a passive position and to feel his position. Afterwards, the head of the participant was brought back to the neutral position. Then the participant was asked to recall it and bring his head to the point that it had been brought to passively. The error degree between the point reached by the participant using the joint position feeling and the predetermined reference point was recorded. This process was repeated three times and the mean value was calculated [14, 16] (Figure 2).

Figure 2. Determination of cervical region joint position sense error

Statistical Analysis

Statistical analysis was performed by using SPSS 18.0. Whether the data were normally distributed or not was measured by the Kolmogorov-Smirnov test. Since the data are not normally distributed, Spearman's correlation test that was used to identify the correlation between two parameters. The statistical significance value was set at 0.05 with 95% confidence interval and the result was considered significant when the p-value was less than 0.05 (p<0,05).

Results

At the end of the study, it was determined that the movement with the largest JPS error was right rotation, while that with the smallest error was left lateral flexion. The error values of JPS were measured in flexion, extension, right lateral flexion, left lateral flexion right rotation and left rotation directions. The participants' pain threshold was measured in the paravertebral muscles at the C7 vertebral level (Table 1).

Correlation analysis showed there was a weak or moderate correlation between JPS error and pain threshold in all measured directions and the pain threshold was lower if the JPS error was greater. The negative correlation detected between the direction of extension and right / left paravertebral cervical muscles was moderate (p=0.003 and r=-0.475, p=0.020 and r=-0.377, respectively), while the negative correlation in other positions was weak (Table 2)

Table 1. Pain threshold and joint position sense error

	Mean Value ± Standard Deviation
Movement	**(degree)**
Flexion	3.72 ±1.53
Extension	3.90 ± 1.66
Lateral Flexion	
Right	3.16 ± 1.36
Left	2.90 ± 1.21
Rotation	
Right	4.00 ± 1.38
Left	3.91 ± 1.57
Pain Threshold	**(kg/cm²)**
C7 Paravertebral Muscle	
Right	2.66 ± 0.86
Left	2.62 ± 0.79

Table 2. Relationship between pain threshold and joint position sense error levels in the neck region of individuals

n=38	**Right Region PT**		**Left Region PT**	
Movement	**ICC**	**p**	**ICC**	**p**
Flexion	-0.362	**0.025***	-0.296	0.071
Extension	-0.475	**0.003***	-0.377	**0.020***
Lateral Flexion				
Right	-0.367	**0.024***	-0.188	0.258
Left	-0.336	**0.036***	-0.366	**0.024***
Rotation				
Right	-0.201	0.227	-0.010	0.953
Left	-0.201	0.137	-0.050	0.763

ICC: Intraclass Correlation Coefficient, p: Spearman rank correlation
PT: Pain Threshold *p<0.05

Discussion

The aim of this study was to determine whether there is a relationship between pain thresholds and proprioception senses in individuals who have not yet had neck pain and to emphasize that proprioceptive training applied to healthy individuals may prevent neck problems in individuals when there is a relationship between these two senses.

At the end of this study, a weak or moderate correlation was seen between JPS error and pain threshold and the pain threshold was lower when the JPS error was higher. The pain threshold levels of the male subjects with a mean age of 22 ± 2 years were approximately 2.6 kg/cm2. This result was similar to those of other studies in healthy young individuals that were used to measure the pain threshold of the neck region. Sacramento et al [2] found a mean pain threshold of 2.1 kg/cm2 in individuals with a mean age of 23 years. It was reported to be 2.1 kg/cm2 in individuals with a mean age of 21 years by Fernandez-de-las-Penas et al [17], 2.7 kg/cm2 in individuals with a mean age of 20 years by Oliviera-

Campelo et al [18] and 2.3 kg/cm2 in individuals with a mean age of 32 years by de Camargo et al [19]. According to these results, the level of pain threshold in our study is slightly higher compared to that in many studies. Previous studies indicated that females had a pain threshold 1.2 kg/cm2 lower than that in males [20, 21]. This difference between the studies may be regarded as normal since the data of our study were obtained exclusively from male individuals.

In our study, when the JPS error size in individuals was higher, the pain threshold was lower. There has been no study in the literature examining the relationship between pain threshold and JPS, there are studies describing the relationship between pain and JPS. JPS error was higher in individuals who were suffering from neck pain as a result of whiplash injury according to Loudon et al [22] and this contributed to the decreased kinesthetic awareness secondary to muscle injury and the pain which developed due to the whiplash injury. Revel et al [23] found that JPS error was significantly higher in individuals with neck pain compared to healthy individuals, and suggested that this was due to functional changes in muscle proprioceptors due to nociceptive pain impulses.

In our study, the level of JPS error decreased in individuals with a high pain threshold and thus JPS was also high. The possible inhibition mechanisms that cause this result may be explained by the gate control theory [24]. According to this theory, the stimulation of a low-threshold, large-diameter mechanoreceptor which is responsible for position sense suppresses the pain fibres in that region and may increase the pain threshold in this way [25].

Based on the results, the JPS error levels were 3-4 degrees. According to Wibault et al, in healthy individuals with a mean age of 25 years, the average JPS error was 2 degrees for individuals with a Neck Disability Index score of 20 or less [14]. Reddy et al reported that JPS errors were 3-4 degrees in healthy individuals between 18 and 30 years of age [16], while Asha et al reported JPS errors of 3-12 degrees in healthy individuals between 20 and 40 years of age [26]. Wibault et al [14] found a JPS error lower of than that of our study. This may have been because they selected healthy individuals by a more discriminative method using the Neck Disability Index assessment, which evaluates neck symptoms in a more detailed way and which is a reliable method for differentiating healthy individuals. VAS assessment is a more practical but superficial method than assessing Neck Disability Index to evaluate pain. The mean JPS errors in the study by Asha et al [26] were higher compared to those in our study, especially in the rotation components. The reason for this difference may be that the universal goniometer is inadequate, especially in evaluating the rotational components, compared to the CROM 3 device.

Based on our results, the correlation coefficient in the direction of cervical extension was higher than in the other directions. The reason for this may be that the suboccipital muscles are in the direction of the extension, which is the area of the proprioceptors concentrated most [27, 28].

All of these studies in the literature have identified the relationship between pain and JPS in the post-pain phase. However, unlike other studies, it was concluded that individuals without neck pain but with lower joint positions may experience neck pain earlier than individuals with higher joint positions, although they are still healthy. This result suggests that healthy individuals who do not have neck pain but who experience any loss of proprioceptive may encounter neck pain earlier, which is a very important finding for preventive rehabilitation approaches. In this study, it was observed that healthy individuals without neck pain could experience pain at an earlier stage due to impaired proprioceptive sensations.

Including only male individuals to study can be considered as a limitation because this results do not cover the entire population. In addition, a relatively small number of cases included in the study were considered another limitation of study because negatively impacted the power of the study.

Conclusion

In conclusion, when healthy individuals were included in proprioceptive evaluation and training, it was observed that neck pain could be prevented in the early period. In individuals with neck pain, the development of proprioception sense may increase pain thresholds and thus may prevent neck pain. More detailed work on these issues will bring new perspectives to both the treatment of patients and the studies to be done to protect public health.

Competing interests
The authors declare that they have no competing interest

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Ethical approval
Before the study, permissions were obtained from local ethical committee.

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