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Relationship between Pain, Function, and Pressure Algometry in College Students with Chronic Mechanical Neck Pain

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ABSTRACT

Backgrounds: Chronic Mechanical Neck Pain (CMNP) is a common musculoskeletal disorder. The "new normal" during the Corona Virus Disease-2019 (COVID-19) lockdown has forced schools to shift to online classes as a mitigation strategy.
Objectives: This study aimed to correlate pain, function, and pain pressure threshold (PPT) in college students with chronic mechanical neck pain.
Patients and Methods: Thirty-three college students with a mean age of 21.33 ± 0.98 who were diagnosed with CMNP. They were using online learning for more than three months during the COVID-19 lockdown. These students were recruited from outpatient settings. The investigators measured their pain intensity using the visual analogue scale (VAS), functional disability using the neck disability index (NDI), and PPT using a pressure algometer (PA). A correlation analysis was conducted between these outcome measures using Pearson's correlation coefficient.
Results: There was a direct significant relationship between VAS and NDI scores ($p < 0.05$), while there was no significant correlation between pain pressure threshold, VAS, and NDI scores ($p > 0.05$). Also, there was a significant difference between males and females in NDI scores with a mean score of 23.0 ± 1.41 in males versus 32.6 ± 4.69 in females ($p < 0.01$). While there was no significant difference between both gender in the scores of VAS and pain pressure threshold ($p > 0.05$).
Conclusion: The presence of pain in the neck significantly correlates with decreased function. While the presence of tight muscles and/or trigger points may not correlate with pain intensity or functional disability in college students with chronic mechanical neck pain.
Keywords: Neck pain, Outcome measures, Data correlation.

INTRODUCTION

It was reported that the prevalence of chronic neck pain is about 70% worldwide and about 20% of the population could experience chronic neck pain at one point in their lives [(1)].

Quantifying patients' findings is important in the realm of musculoskeletal physical therapy and the use of validated outcome measures helps to accurately document such findings. Most of the self-reported outcome measures have been extensively studied in literature and their psychometric properties have been established. It is important to note, however, that discrepancies exist in the reported psychometric properties given the fact that the studied variables and/or the research design and the studied population are different [(2)].

The neck disability index (NDI) is used extensively in the literature and its psychometric properties have been well established. It has been translated and cross-culturally adapted to many languages [(3)]. The index has 10 neck-related functional activities scored on a 0-5 likert scale for each item and a total raw score of 50.

The higher the score, the greater the disability. It is reliable, valid, and responsive in patients with cervical radiculopathy treated non-operatively [(4)]. NDI and visual analogue scale (VAS) have been strongly recommended to be used in patients with cervical radiculopathy 11 [(5)]. The original developer of the NDI [(6)] and a systematic review concluded that the NDI has sufficient published data to support its usefulness as the most commonly used outcome measure in patients with neck pain [(1)].

Since the NDI has been cross-culturally adapted to many languages, the original and the translated versions have a plethora of published psychometric properties. The minimal detectable change (MDC) of the NDI was reported to be 10.5 in patients with neck pain [(7)], internal consistency with a high Cronbach alpha between 0.70- 0.96 [(8-11)], high correlation (more than 0.70) with other similar indices [(12-15)].

Quantifying pain can be a challenging issue considering the vague nature of pain in many disorders. Studies have found that, however, self-reported pain status by the patient is the most representative way of reporting what a patient experiences with different health disorders. Pain questionnaires and surveys can be unidimensional, multidimensional, disease-specific, or region-specific. Most of the used pain outcome measures are easy to use for a layperson to accurately report what they feel [(16)].

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The visual analogue scale (VAS) is considered a generic unidimensional pain scale to document pain intensity and has been ubiquitously available in physical therapy literature as a simple and fast subjective reporting of pain. It is a horizontal or vertical line 100 mm in length. The line is anchored by two simple representations of pain intensity at its ends where 0 represents no pain, and 10 represents the worst experienced pain. Some variation exists in the highest pain score's description. For example, some literature used "worst imaginable pain", "pain as bad as it could be", or "worst pain ever". The original VAS is not numbered other than at the two ends (0 and 10) [16, 17].

For VAS scoring, the subject is asked to place a mark on the VAS line, which best represents his/her pain intensity. A ruler will be then used to measure the distance in millimeters from zero and the score is rounded to the closest integer. For example, a score of 58 mm is rounded up to 60 mm (6 cm). A higher score indicates greater pain intensity. Another proposed way of grading the VAS is available. This includes the following scores with corresponding representations: no pain (0-4 mm), mild pain (5-44 mm), moderate pain (45-74 mm), and severe pain (75-100 mm). Considering the subjective nature of the scale, normative data is unavailable. The criterion validity of the VAS could not be established yet since there is no gold standard for pain measurement. A correlation between the VAS and the numeric pain rating scale has been found to range from 0.62 to 0.91. The correlation between the horizontal and vertical versions of the VAS is 0.99. The minimal clinical important difference (MCID) for the VAS is 1.37 cm for patients with rotator cuff disease [16, 17].

The minimal amount of pressure perceived by the patient that causes pain is known as the pressure pain threshold (PPT). Manual examination of soft tissues is subjective and cannot quantify the amount of tenderness the patient feels.

Therefore, quantifying the tenderness with a pressure algometer (PA) objectifies what the patient feels and is considered a good way to assess the response to treatment. Although helpful, repeated testing with PA may sensitize the patient and result in false positive or negative findings, which is probably why the Intraclass Correlation Coefficient (ICC) of test-retest reliability has a wide range (0.43 to 0.94) and is slightly better in the healthy population. To improve this testing effect, an author recommended using the healthy side as a reference in unilateral painful disorders and not depending on the repeated measures of the same tender spots pre- and post-treatment [18].

Since patients with neck pain may have altered function and may develop trigger points in their neck muscles, it is important to study the relationships between these variables. COVID-19 lockdown has forced college students to study for long hours in sitting position and they can develop chronic symptoms due to improper study positions. No study has investigated such a correlation in college students living in the COVID-19 world to the authors' knowledge. It is expected that the result of this study will guide clinicians in designing their treatment program considering the COVID-19 consequences such as patients who are "long haulers". Living in the COVID-19 world brings about changes in physical health that should be investigated. It may also help researchers to build up on the result to find a deeper correlation between the studied variables.

Most importantly, it may help college students with CMNP find out why the pain they feel is related or not to other factors and choose the right treatment accordingly. Therefore, the purpose of this study was to study the relationship between pain, function, and PPT in college students with chronic mechanical neck pain.

PATIENTS AND METHODS

Study design and setting

Data were obtained for pain, function, and PPT from thirty-three physical therapy college students diagnosed with chronic mechanical neck pain (CMNP). The design for this study was cross-sectional and observational analysis. The study ran between September 2021 and February 2022. after obtaining consent approval at the Outpatient Clinic of the Faculty of Physical Therapy, Misr University for Science and Technology (MUST).

Participants

Data were obtained from 33 college students involved in distance learning as a result of Corona Virus disease 2019 (COVID-19) restriction with the resultant shifting of most education to be online.

Participants were between 18-25 years old, had a diagnosis from their primary care physicians of CMNP localized to the cervical and periscapular regions and have at least one trigger point in the upper trapezius and/or levator scapula muscles as identified by a pressure algometer. They used a computer for at least three months as the primary way of education during COVID-19 lockdown. CMNP was defined as having vague, dull, achy pain in the neck for more than three months with an intensity of at least 30 mm on a 100 mm visual analogue scale (VAS) line.

Exclusion criteria:

Subjects with non-mechanical neck pain, cervical instability, systemic diseases affecting the cervical spine e.g. rheumatoid arthritis, having any red flags signs, or any other finding not included in the inclusion criteria were excluded from participation. Subjects with active COVID-19 disease and those who were required to

quarantine were not tested until after they had clearance from their physicians to resume normal life after being tested negative for COVID-19 virus on two separate occasions performed on two consecutive days. Also, subjects had to wear facial masks during testing and use hand sanitizers several times during testing. The researcher who performed the test had to wear a face mask and disposable medical gloves all the time.

The required sample size was calculated based on the NDI as the primary outcome measure using a previous similar study [19].

A sample of convenience was used based on the subject's availability to participate. An advertisement was pinned in the school bulletin and circulated online to invite students to participate. It was hypothesized that there will be no statistically significant correlation between variables, and it was assumed that participants will not receive any treatment for their neck pain at least one month before data collection.

Assessment procedure

After explaining the purpose of the study and obtaining the participants' signatures for the consent form, we measured the pain using the VAS scale, neck functional disability using the NDI, and the PPT using a PA. For pain assessment, the patients were asked to place a mark on the VAS line to indicate pain intensity.

A ruler was then used to measure the distance from zero, and the recorded number was rounded to the nearest number, for example, a measure of 5.7 cm was rounded to 6 cm. For the NDI, the subjects were asked to choose the best answer for each of the items in the NDI and the total score was then calculated.

We used a digital pressure algometer (PA) for PPT assessment (model: FPX 50, S/N: 2010600173, JTECH Medical, Midvale, Utah, USA) (figure 1-A).

The PA was applied perpendicularly and slowly on the trigger point (figure 1-B) until the patient reported the first feeling of pain and the value on the screen was recorded. The average of three readings with an interval of 1 minute between the trials was recorded [19, 20].

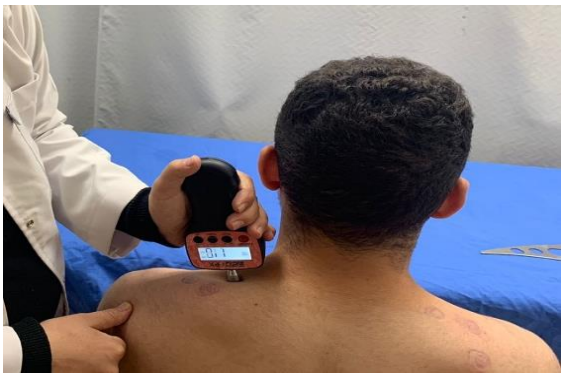

Figure (1): The pressure algometer used in the study (A), was applied perpendicular to the trigger point (B).

Ethical consideration:

The study was approved by the Institutional Review Board (IRB) of the Faculty of Physical Therapy, Cairo University (approval number: PT.REC/012/003381). The experiments reported in the manuscript were performed following the ethical standards of Helsinki Declaration 1975 for studies involving human subjects.

Statistical analysis

Data were analyzed using the statistical package for social sciences (SPSS) computer program version 27 software for Windows (IBM SPSS Inc., Chicago, IL, USA). Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequency distribution (%) for categorical variables. The normality of the data was examined using the Kolmogorov-Smirnov statistical test. A correlation between the studied variables was performed using Pearson's correlation coefficient. Pearson's correlation coefficient values were estimated as follows: 0-0.19 very weak, 0.2-0.39 weak, 0.4-0.69 Moderate, 0.7-0.89 strong, and 0.9-1.00 very strong correlation [23]. The alpha level was set at p= 0.05. An independent sample t-test was used to examine the difference between males and females across the measured variables.

RESULTS

Our sample included 29 females (88%) and 4 males (12%). Their mean age was 21.33 ± 0.98 (years), mean body mass index (BMI) was 26.39 ± 5.78 kg/m^2, mean weight was 69.98 ± 16.29 (kg), and mean height of 161.98 ± 5.88 (cm).

Pearson correlation coefficient showed an inverse significant correlation between VAS and NDI. There was a direct significant relationship between BMI and VAS scores on the left side of the neck, and NDI ($p \leq 0.05$). On the other hand, there was no significant correlation

between pain pressure threshold and other variables, between NDI, age, and VAS scores ($p > 0.05$) (Table 1).

Table (1): Pearson's correlation coefficient (r) between the studied variables

Variables	VAS right	VAS left	Pain pressure right	Pain pressure left	NDI
Age	-.35	.23	-.01	-.17	.1
BMI	.24	**.66***	.34	.46	**.58***
VAS- right		**.77****	.03	.05	.3
VAS- left			.65	.58	.42
Pain pressure-right				**.76****	.43
Pain pressure-left					.3

*Correlation is significant at p-value ≤ 0.05 (2-tailed)
**Correlation is significant at p-value ≤ 0.01 (2-tailed),

There was a statistically significant difference between males and females in NDI scores with a mean score of 23.0 ± 1.41 for males versus 32.6 ± 4.69 for females ($p < 0.01$), while there was no statistically significant difference between both genders in the scores of VAS and pain pressure threshold ($p > 0.05$) (table 2).

Table 2. Difference between measurements of males and females

Data	Males		Females		t-test	p-value
	Mean	SD	Mean	SD		
Vas right	2.5	2.1	3.3	1.3	1.2	0.22
Vas left	4.0	1.4	3.61	1.3	0.79	0.43
Pain pressure right	3.25	0.63	2.92	0.62	1.01	0.31
Pain pressure left	3.0	0.01	2.76	0.58	0.8	0.42
NDI	23.0	1.41	32.6	7.8	4.69	0.0001*

*Significant at p-value<0.05

DISCUSSION

The study shed some light on the correlation between clinical variables in college students using distance learning due to COVID-19 lockdown and diagnosed with CMNP. It was important to the investigators to find out if there were relationships between outcome measures. This can serve as a step toward understanding the relationship between clinical outcome measures in different musculoskeletal conditions experiencing what is known as "a new normal" because of the COVID-19 pandemic.

Although this was a heterogenous, small, predominately female sample, males showed lower NDI scores as compared to females. Although the primary aim of this study was to correlate the studied variables, we conducted a comparison between gender in the studied variables since gender was a discrete variable. One possible explanation is that the sample was predominately females and had only four males. It is possible that the number of male subjects was not large enough to cause a shift in the NDI scores. Previous studies also found gender differences in functional limitation in a population of subjects with low back pain [21, 22].

Pain pressure threshold did not correlate with any of the variables including pain although VAS and PA technically measure a similar quality of the same outcome variable, which is pain. While, VAS subjectively documents how much pain the patient feels and the PA documents the level of tenderness, it was predicted that these two variables could be somehow correlated. A possible explanation for the lack of correlation is the small sample size which might not have been enough to show a correlation. Another explanation is that the testing effect of the PPT caused the patient to be sensitized and did not change the scores with repeated measurements. Although, we followed previously published protocols to avoid this testing effect and allowed a one-minute resting period between subsequent PPT measurements [19, 20], we still could not completely avoid the negative effect of the repeated measurement effect. This also means that VAS and PPT scores were not reflected in the NDI scores as there was no correlation between the three of them. One would expect to find a relationship between pain and function since the presence of pain would logically decrease function scores and vice versa. The same may be true for the scores of functions as indicated by the NDI and PPT. This was not the case in this study. However, this may be because pain and functions are not static variables and either one can change due to other variables over time. Again, the small sample size and an observational analysis can also explain the lack of this relationship. It is important to note that the construct of these outcome measures is different; the higher the scores in NDI and VAS indicate greater disability, while the higher the scores in the digital PA indicate that the patient has better tolerance for pressure and hence a better outcome [23]. Finally, a small sample size like ours cannot be used to generalize the results of this study.

A similar study design [24] found a positive correlation between patients who excessively use smartphones and the development of degenerative changes of their cervical spine, cervical spine discs, and the development of neck pain. Although there is a large discrepancy in the sample size and the age difference between the current study and theirs, spending more time

studying or using smartphones in improper postures may yield similar negative outcomes on physical health.

Data collection during and early after the effect of COVID-19 disease was not easy since the researchers faced limitations of COVID-19 consequences. Data collection for a similar study design could have been performed over a shorter period, but the circumstances of this study were different. Given the fact that we had to wait for subjects to recover if they have an illness or are being quarantined or wait for their healthcare givers to give them clearance to resume normal life, this study took longer than expected. Also, safety measures had to be maintained all the time to help mitigate the spread of the disease. This all explained the challenges the researchers faced while collecting the data.

Since we cannot draw cause-and-effect conclusions from a cross-sectional and observational analysis, we recommend further studies to investigate the effect of different treatments on the outcome measures studied in this study and to increase the sample size to better study the correlation between the clinical variables.

CONCLUSION

College students with chronic mechanical neck pain may be faced with consequences of the Corona Virus Disease 2019 affecting their cervical spine while studying during the lockdown. The presence of pain in the neck significantly correlates with decreased function. While the presence of tight muscles and trigger points may not be correlated with pain intensity or functional disability.

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