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Incidence of Neuropathic Pain in Patients with Thoracic Disc Pathologies Presenting with Chronic Upper Back Pain and Correlation of Herniation Grade with Pain Severity

Emine DUNDAR AHI[1], Asli GOKTAN[2]

[1]Kocaeli Health and Technology University, Private Medar Hospital, Department of Physical Medicine and Rehabilitation, Kocaeli, Turkey
[2]Private Medar Hospital, Department of Radiology, Kocaeli, Turkey

Corresponding author: Emine DUNDAR AHI ✉ eminedundarahi@gmail.com

ABSTRACT

AIM: To determine the incidence of neuropathic pain (NP) in patients with thoracic disc herniation (TDH) and to determine whether there is any correlation between pain severity and herniation grade.

MATERIAL and METHODS: A total of 110 patients diagnosed with TDH with chronic non-specific thoracic spine pain were included in our cross-sectional observational study. Data including magnetic resonance imaging findings, bulging, protrusion, extrusion and sequestration were retrospectively analysed. We determined the incidence of NP in patients by administering the self report form Douleur Neuropathique 4 (DN4) questionnaire. Pain severity was assessed using Numeric Rating Scale scores.

RESULTS: In our study, 79.1% of TDHs were located below the T7-8 level. The patients were divided into two subgroups on the basis of the results of the DN4 questionnaire: NP subgroup, 43 (39.1%), and non-NP subgroup, 67 (60.9%). Although there was no statistically significant association between presence of NP and herniation grade bulging, protrusion or sequestration ($p>0.05$), the rate of herniation in the extrusion grade was statistically significantly higher in patients with NP than in those without NP ($p=0.004$). The pain severity of the patients with herniation grade extrusion was statistically higher than that of patients with other non-extrusion grades ($p=0.035$).

CONCLUSION: TDH should be considered in patients with neuropathic chronic back, chest and abdominal pain. If the patient's pain characteristics indicate NP, a diagnosis of TDH becomes more likely, considering that nearly 4 out of 10 patients with TDH have NP.

KEYWORDS: Neuropathic pain, Thoracic back pain, Thoracic disc degeneration, Thoracic disc herniation, Upper back pain

ABBREVIATIONS: NP: Neuropathic pain, **TDH:** Thoracic disc herniation, **DN4:** Douleur Neuropathique 4, **NRS:** Numeric Rating Scale, **MRI:** Magnetic Resonance Imaging, **CTBP:** Chronic thoracic back pain, **PMR:** Physical Medicine and Rehabilitation

INTRODUCTION

Chronic thoracic back pain (CTBP) is the pain experienced in the area of the upper back or middle back between the T1 and T12 vertebrae across the posterior aspect of the trunk that continues for >3 months. Upper back pain has not been studied as often as neck and low back pain; thus, the available data are limited (10,14). Thoracic disc herniations (TDHs) are one of the causes of CTBP and are a rare cause of spinal cord compression; they account for only 0.25%–1% of all disc herniations. In the literature, TDHs have been most frequently reported in patients between the third and fifth decades of life, with 60% of the patients being male. In 75% of patients, TDH is located below the T7-T8 discs (13,17). Generally, patients with TDHs present with upper back pain or pain radiating in a dermatome (12,13). If a disc herniation

Emine DUNDAR AHI : 0000-0001-6417-5406 Asli GOKTAN : 0000-0002-5627-0857

exerts pressure on a thoracic spinal nerve as the nerve passes through the foramen, pain or numbness may spread around the rib cage from posterior to the anterior part of the chest or to the upper abdomen. In patients with a large TDH, compression of the spinal cord within the spinal canal may occur, causing numbness and weakness in the legs and possibly bowel and bladder dysfunctions, as seen in cauda equina syndrome (13). In such cases, conditions related to gastrointestinal, genitourinary and heart diseases are considered, and unnecessary tests are required to ruled out these conditions (18,19,23). Magnetic resonance imaging (MRI) is the preferred imaging modality because it is noninvasive and more sensitive for showing soft-tissue pathologies and multiple planes (15). Surgery is recommended for patients with progressive neurological dysfunction. In the literature, there are insufficient resources on the efficacy of conservative treatment.

The definition of neuropathic pain (NP) was revised by the International Association for the Study of Pain Special Interest Group on Neuropathic Pain in 2008 and is still accepted as 'pain arising as a direct consequence of a lesion or disease affecting the somatosensory system'. The lack of a gold standard method to diagnose NP may also cause difficulties in diagnosis. Consequently, the first step in the evaluation is to differentiate NP from other types of pain, and questionnaire tests have been developed for this purpose (2,3,7).

In this study, we used the Douleur Neuropathique 4 (DN4) questionnaire that is always reliable and valid (2). NP must be correctly diagnosed for optimal treatment.

Although there are some studies on the incidence of NP in patients with cervical and lumbar disc herniations (5,8,20), there has been no similar study on TDHs. The aim of this study was to determine the incidence of NP and to determine whether there is any correlation between pain severity and herniation grade in patients with TDH detected because of CTBP.

MATERIAL and METHODS

Study Design

This was a cross-sectional observational study approved by the Medical Research Ethics Committee of Derince Training and Research Hospital (27/26/2019-49). All participants provided written informed consent. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The power analysis performed before the study to estimate the NP rate with a maximum 15% error indicated that ≥90 individuals with 80% power and 5% error levels had to be included in the study.

A total of 161 patients presented with chronic non-specific thoracic spine pain and were diagnosed with TDH between February 2016 and February 2020 were identified from Physical Medicine and Rehabilitation (PMR) outpatient clinic. The inclusion criteria were male and female patients aged 18–65 years who were diagnosed with TDH.

The exclusion criteria were age <18 and >65 years; other diseases that can cause NP in the upper back (such as myofascial pain syndrome and radicular pain), a history of cervical or lumbar spine surgery and presence of vertebral fractures, developmental deformities of the spine, spinal infections, tumours or other spinal disorders (such as syringomyelia or hydromyelia), mental disorders or impairment of cognitive function, conditions or treatments that might be a potential cause of polyneuropathy (e.g., diabetes mellitus), severe comorbid conditions (e.g., malignancy), diffuse widespread pain (e.g., fibromyalgia) and patients using pregabalin and gabapentin. Figure 1 summarises the subject recruitment process.

Since there are 12 discs in the thoracic region, they were evaluated as the upper (herniations on T1-2, T2-3, T3-4, T4-5, T5-6 and T6-7 discs) and lower (herniations on T7-8, T8-9,T9-10, T10-11, T11-12 and T12-L1 discs) thoracic region

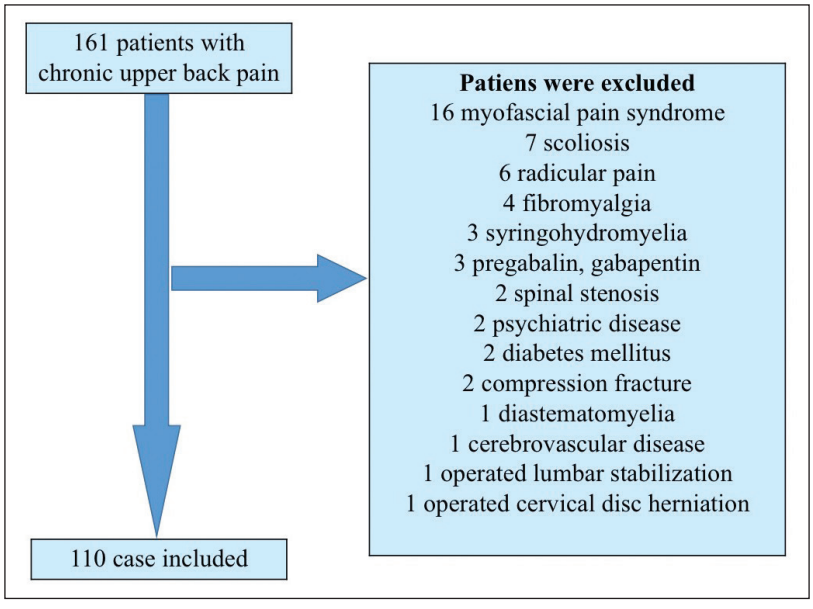

Figure 1: Study flowchart shows participant recruitment.

for ease of evaluation in our study. If there were herniations in both upper and lower regions in the same patient, it was indicated as 'both upper and lower' in Tables I and II. Because we wanted to understand the relationship between the grade of herniation and NP, we did not record the number of herniations in a patient. If a patient had two or more TDH, we recorded it as different grades of herniations.

Pain Assessment

Demographic data of the patients were recorded and body mass index was calculated. All patients underwent a detailed neurological examination. The characteristics, duration, distribution and intensity of the pain and whether the patient took medication for pain were also recorded. From

Table I: Demographic and Clinical Features of the Cases According to Groups with and without Neuropathic Pain

	No neuropathic pain (n=67)	There is neuropathic pain (n=43)	p
Age (years), median (min-max)	38 (18-65)	34 (20-59)	0.305¶
Gender			0.664‡
Male	46 (68.7%)	32 (74.4%)	
Female	21 (31.3%)	11 (25.6%)	
BMI (kg/m²)	25.6±4.5	25.7±4.3	0.941†
Thoracic herniation location			0.353¶
Lower (T7-8, T12-L1)	25 (37.3%)	19 (44.2%)	
Upper (T1-2,T6-7)	17 (25.4%)	6 (13.9%)	
Both Upper-Lower (T1-2,T12-L1)	25 (37.3%)	18 (41.9%)	
Herniation grade			
Bulging	23 (34.3%)	8 (18.6%)	0.116‡
Protrusion	54 (80.6%)	39 (90.7%)	0.246‡
Extrusion	5 (7.5%)	13 (30.2%)	**0.004**‡
Sequesteration	1 (1.5%)	0 (0.0%)	NA
Pain intensity (NRS)	4.0 (3.0-5.0)	4.0 (3.0-5.0)	0.876$

¶ Mann Whitney U test, † Student's t test, ‡ Continuity corrected χ2 test, † Pearson's χ2 test, ***NA:*** *Not available,* ***BMI:*** *Body mass index,* ***NRS:*** *Numeric rating scale.*

Table II: Distribution of Patients in Terms of Thoracic Herniation Level and Grade according to Groups with and without Neuropathic Pain

	No neuropathic pain (n=67)	There is neuropathic pain (n=43)	p
Thoracic herniation location			0.353†
Lower (T7-8, T12-L1)	25 (37.3%)	19 (44.2%)	
Upper (T1-2,T6-7)	17 (25.4%)	6 (13.9%)	
Both Upper-Lower	25 (37.3%)	18 (41.9%)	
Herniation grade			
Bulging	23 (34.3%)	8 (18.6%)	0.116‡
Protrusion	54 (80.6%)	39 (90.7%)	0.246‡
Extrusion	5 (7.5%)	13 (30.2%)	**0.004**‡
Sequesteration	1 (1.5%)	0 (0.0%)	NA
Pain intensity (NRS)	4.0 (3.0-5.0)	4.0 (3.0-5.0)	0.876¶

† Pearson's χ2 test, ‡ Continuity corrected χ2 test, ¶ Mann Whitney U test, ***NA:*** *Not available,* ***NRS:*** *Numeric rating scale.*

the registration information of the participants, pain status assessed using Numeric Rating Scale (NRS) scores was recorded. On a scale of 1 to 10, 0 indicates no pain and 10 indicates the most severe pain (9).

The presence of NP was assessed by administering the self report form DN4 questionnaire, which has been proposed as an appropriate questionnaire for screening NP, including that due to spinal disorders (2,7). A DN4 score ≥ 3 means that NP is likely (maximum score = 7).

MRI of the Thoracic Spine

T1-weighted (T1W) and T2-weighted (T2W) sagittal and T2W axial images of 110 patients were obtained on a 1.5T Magneto Essenza MRI system (Siemens) at our hospital. In all cases, T1W [repetition time (TR): 590; echo time (TE): 11; field of view (FOV): 320], T2W sagittal (TR: 2970; TE: 104; FOV: 320) and T2W axial (TR: 5940; TE: 88; FOV: 230) sequences were obtained on MRI. Each participant laid in a supine position during the examination for approximately 30 min. All MR images were assessed by a trained radiologist blinded to the patients' clinical data. Disc pathologies were classified based on the updated Lumbar disc nomenclature version 2.0 (6,22). The patients were evaluated regarding the presence of the following disc pathologies: bulging, protrusion, extrusion and sequestration.

Statistical Analysis

Analysis of the data was done in IBM SPSS Statistics 17.0 (IBM Corporation, Armonk, NY, USA) package programme. Kolmogorov-Smirnov test was used to determine whether the distribution of continuous numerical variables was close to normal or not and Levene test was used to investigate whether the assumption of homogeneity of variances was met. Descriptive statistics: mean variables were expressed as mean ± standard deviation for continuous numerical variables, whereas the sortable variables were shown as median (1^{st} quarter–3^{rd} quarter) and categorical variables as number of cases and percentages. The significance of the difference between the groups with and without NP in terms of mean values was evaluated using Student's t test. Categorical variables were analysed using Pearson's $\chi 2$ or Continuity corrected $\chi 2$ test. The presence of NP and whether there was a statistically significant change in pain intensity according to the herniation grade were investigated using the Mann Whitney U test. Results for $p<0.05$ were considered statistically significant.

RESULTS

Demographic and clinical features of the cases according to groups with and without NP included in the study are presented in Table I.

Table II depicts the comparisons made in terms of thoracic herniation level and grades of the cases according to the groups with and without NP.

The total number of patients with herniation grades over 110 (because some of the patients had more than one herniation) are presented in Tables I and II.

Table III: Pain Intensity of the Cases According to the Grade of Herniation

	n	Pain intensity (Numeric Rating Scale)	p†
Bulging			0.312
No	79	4.0 (3.0-5.0)	
Yes	31	5.0 (3.0-5.0)	
Protrusion			0.358
No	17	4.0 (2.5-5.0)	
Yes	93	4.0 (3.0-5.0)	
Extrusion			**0.035**
No	92	4.0 (3.0-5.0)	
Yes	18	5.0 (3.75-6.0)	

Descriptive statistics; shown as median (1^{st} quarter - 3^{rd} quarter), † Mann Whitney U test.

There was no statistically significant difference between the group with NP and the group without NP in terms of thoracic herniation distribution (p=0.353). Pain scores were similar between groups with and without NP (p=0.876).

Although there was no statistically significant association between the presence of NP and herniation grade bulging, protrusion or sequestration ($p>0.05$), the rate of herniation in the extrusion grade was significantly higher in patients with NP than in those without neuropathic pain (p=0.004).

Table III shows whether there were statistically significant changes in the pain intensity of the cases according to their herniation grades.

There was no significant difference in terms of pain severity between cases with bulging and other herniation grades (p=0.312). Moreover, there was no significant difference in terms of pain severity between cases with protrusion and those with other herniation grades (p=0.358). The pain severity of the patients with herniation grade extrusion was significantly higher than that in patients with bulging, protrusion and sequestration (p=0.035).

DISCUSSION

This study determined the incidence of NP in patients with CTBP caused by thoracic disc pathologies, which occurred most frequently in the lower segments from T7-8 to T11-12. In a study of 195 patients, the most commonly affected site was T7-8, followed by T8-9 and T11-12 (17). We also achieved similar results and determined that 79.1% of TDHs are located below the T7-8 level. These findings can be attributed to the anatomical differences between the ribs and their attachments (21). The 8^{th}–10^{th} ribs are connected to the sternum by uniting with each other via a cartilage, the ventral ends of the 11^{th} and 12^{th} ribs are free. Therefore, these levels are more flexible than other high levels (13). The greater degree of flexion allowable

at these levels is predictive of a high incidence of nucleus pulposus herniation.

In the literature, a majority of TDHs are seen in patients between the third and fifth decades of their life, with 60% of the patients being male (12). In our study, we obtained the similar results; the mean patient age was 38.1 years. Although our results regarding age were consistent with those in the literature, we obtained a different sex distribution: 78% patients were male and 22% female. These results can be explained by the fact that our hospital is located in an area where the number of factories is high; thus, our patient population has a high percentage of factory workers who are mostly male.

In the new definitions of NP, the inclusion of significant neuroanatomical distribution of pain, being a condition affecting the somatosensory system, as well as neuroanatomical distribution and diseases affecting the somatosensory system shown by at least one test has increased the importance of discopathies among the causes of NP. Causes of NP-related spinal disorders include radiculopathy due to disc herniation, spinal stenosis and spinal cord injury (1). We excluded patients with other causes of NP except TDHs (Figure 1).

In our study, the incidence of NP in patients with TDH was 39.1%. Interestingly, we reached nearly the same conclusion (39.4%) as that of a study conducted in Turkey in 2015 in which the prevalence of NP was investigated in patients with chronic low back pain. In that study, which included 190 patients, unlike us, the authors determined the presence of NP using the Leeds Assessment of Neuropathic Symptoms and Signs questionnaire (5). In an unselected cohort of patients with chronic low back pain, 37% were found to predominantly have NP. In another study, the incidence of NP in 717 patients with low back pain was reported to be 33.5% and chronic lumbar radicular pain was considered to be the most common NP syndrome (1,18).

Although there was no significant association between presence of NP and herniation grade bulging, protrusion or sequestration ($p>0.05$), the rate of herniation in the extrusion grade was significantly higher in patients with NP than in those without NP ($p=0.004$). Similarly, the pain severity of the patients with herniation grade extrusion was significantly higher than that of patients with other non-extrusion grades ($p=0.035$). In fact, as the number of patients with sequestrated disc herniation was only one, it may be incorrect to include it in this evaluation. The reason for NP incidence and pain severity being significantly higher in patients with extruded pain may be due to the spread of more inflammatory mediators to the spinal canal because inflammatory mediators released due to the dispersion of the nucleus pulposus into the annulus in disc disorders stimulate nociceptors present in the disc and cause nociceptive or discogenic pain (4,11). Protrusion is focal herniation that has a wider base than the body, whereas extrusion has a narrower base than the body (16).

The present study has some limitations. First, our hospital is located in an industrial zone; therefore, the majority of our patient population comprised male workers. The second limitation is that there was only one patient with sequestrated disc herniation. The last limitation is that the relationship among the other components of thoracic disc degeneration, such as Schmorl nodes, endplate degeneration, disc height loss, presence of NP, and its relationship with pain severity have not been investigated. The strength of this study is that it reports a comprehensive clinical examination and detailed MRI examination of the thoracic spine of patients with TDH presenting with NP.

CONCLUSION

Although pain radiating from the neck to the shoulder–arm or from the low back to the hips–legs can easily suggest the presence of cervical or lumbar disc herniations, usually the initial assumption is that pain radiating from the thoracic spine to the upper back or abdominal region indicates visceral organ pathologies. Patients cannot be diagnosed with TDH unless these visceral organ pathologies are excluded. Although it is very important for vital organs, it sometimes leads to detailed, prolonged and expensive examinations. After obtaining a good history and performing examination, if the patient is found to have dermatomal pain, TDH should be considered earlier. If the patient's pain characteristics indicate NP, a diagnosis of TDH becomes more likely, considering that nearly 4 out of 10 patients with TDH have NP. MRI is very important for diagnosis and severe pain may indicate that the herniation is in an advanced grade.

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