Turkish Journal of Family Medicine and Primary Care

Original Research / Orijinal Araştırma

Effect of Neural Therapy on Cervical Discopathy-Related Chronic Neck Pain

Nöral Terapinin Servikal Diskopatiye Bağlı Kronik Boyun Ağrısına Etkisi

İbrahim Başhan[1], Gülşah Yaşa Öztürk[2]

Abstract

Introduction: To investigate how 1% procaine injection therapy, one of the neural therapeutic agents, affects neck disability and pain intensity in patients who have cervical discopathies that are causing chronic neck pain and/or functional limitations Methods: The records of 58 patients diagnosed with cervical discopathy were examined. The Range of Motion values, Neck Disability Questionnaire and Visual Analog Scale scores were compared at baseline and one month after neural therapy. The results of cervical magnetic resonance imaging were analyzed, and the mean scores were compared between the protrusion and bulging. P values of <0.05 were considered statistically significant. Results: A statistically significant increase was observed in Range of Motion values after NT in all movements of the neck and the decrease in the mean Visual Analog Scale and Neck Disability Index scores after neural therapy were found to be statistically significant in both the protrusion and bulging groups. Conclusion: This is the first study providing evidence of the effects of neural therapy on neck pain severity and neck disability in adult patients with cervical discopathies (protrusion and bulging) presenting with chronic neck pain resistant to medical treatment, who had not yet made a surgical decision.

Key words: Neural therapy, procaine, cervical discopathy, neck pain

Özet

Giriş: Bu çalışmanın amacı, servikal diskopatisiye bağlı kronik boyun ağrısı ve/veya fonksiyon kaybı olan hastalarda uygulanan, nöral terapötik ajanlardan biri olan %1'lik prokain enjeksiyon tedavisinin, ağrı ve boyun disfonksiyonu üzerine etkisini araştırmaktır. Yöntem: Servikal diskopati tanısı alan 58 hastanın kayıtları incelendi. Hareket Açıklığı değerleri, Boyun Özürlülük Anketi ve Vizüel Analog Skala skorları başlangıçta ve nöral terapiden bir ay sonra karşılaştırıldı. p<0,05 değerleri istatistiksel olarak anlamlı kabul edildi. Bulgular: Nöral Terapi sonrası Hareket Açıklığı değerlerinde boynun tüm hareketlerinde istatistiksel olarak anlamlı bir artış gözlendi ve Vizüel Analog Skala ve Boyun Özürlülük İndeksi puan ortalamalarındaki azalma hem protrüzyon hem de bulging gruplarında istatistiksel olarak anlamlı bulundu. Sonuç: Bu çalışma, cerrahi kararı alınmamış medikal tedaviye dirençli kronik boyun ağrısı olan servikal diskopatili (protrüzyon ve bulging) erişkin hastalarda nöral terapi uygulamasının sonuçlarını gösteren ilk çalışmadır.

Anahtar kelimeler: Nöral terapi, prokain, servikal diskopati, boyun ağrısı

Geliş tarihi / Received: 19.05.2022   Kabul tarihi / Accepted: 11.10.2022

[1]Mersin Üniversitesi Tıp Fakültesi Tıp Eğitimi Anabilim Dalı / Türkiye
[2]Sağlık Bilimleri Üniversitesi Adana Şehir Sağlık Uygulama ve Araştırma Merkezi / Türkiye

Address for Correspondence / Yazışma Adresi: İbrahim Başhan, Mersin Üniversitesi Tıp Fakültesi Tıp Eğitimi Anabilim Dalı, Türkiye
ibashan@yahoo.com

Bashan I, Yasa Ozturk G. Effect of Neural Therapy on Cervical Discopathy-Related Chronic Neck Pain. TJFMPC,2022;16(4): 779-785

DOI: 10.21763/tjfmpc.1118848

Introduction

Neural therapy (NT) was first defined by two German physicians, Ferdinand and Walter Huneke, in the early 1900s, and while it is widely used in central Europe, especially in Germany and England, it remains unknown in most of the remaining countries across the world.[1,2] NT is a simple and effective treatment method applied by injecting local anesthetics into the most common symptom trigger points or alternatively into autonomic ganglia, scars, and other tissues to alleviate the severity of chronic pain.[3]

The definition of a relationship between the autonomic nervous system and inflammation and pain, as well as the effect of local anesthetics used in NT stimulating the membrane potential of the nerve cell of the symptomatic region and the autonomic nervous system, has once again attracted researchers' attention to this system.[4,5] Instead of obtaining local anesthesia, the major aim of NT is to selectively eliminate other unpleasant stimuli by activating the parasympathetic nervous system in the needle-targeted areas. By influencing both the way the nervous system is organized and tissue perfusion, the aim is to break the cycle of pain.[6,7] NT is used in the treatment of acute and chronic musculoskeletal diseases (MD), inflammatory diseases, and functional conditions. As in many studies on pain, successful results have been reported regarding the effectiveness of NT in treatment-resistant MD.[8-11] With the use of NT in MD, treatment costs decrease and there is an increase patient satisfaction with the treatment and therapist.[12] The most important reasons for the use of 0.5-1% procaine as one of the first-choice local anesthetic agents in NT are its short duration of action, not causing allergic reactions or inflammation at the application site, its role in cell regulation by regulating endothelial function with its metabolites, and not containing sympathomimetic substances.[13]

Neck pain is the second most common after low back pain and creates a high economic burden. One of the most important causes of neck pain is cervical intervertebral disc diseases (CD).[14,15] There is no strong evidence suggesting that intervertebral discs (via degenerative or other changes) are a discogenic source of pain.[16] However, cervical disc degeneration is known to cause inflammation (or vice versa), and inflammation triggers the migration of immunocyte cells and the secretion of inflammatory cytokines from disc cells.[17] These cytokines increase the production of nerve growth factor, which may lead to the release of calcitonin gene-related peptide and substance P from the dorsal root ganglia, resulting in cervical discogenic pain.[18,19]

This study aimed to investigate the effect of neural therapy on neck pain and function limitation in patients resistant to medical treatment.

Methods

Study design and data collection

The patients who presented to the physical therapy and rehabilitation outpatient clinic of the City Hospital between March 2020 and March 2021 with complaints of neck pain were analyzed in this cross-sectional study. After a physical examination, cervical magnetic resonance imaging (c-MRI) was performed, and according to the results, 58 patients with persistent neck pain for longer than three months, who were diagnosed with CD (protrusion and/or bulging) and determined to be resistant to medical treatment (previously used local, intramuscular, or oral analgesic, anti-inflammatory and antimuscarinic agents) were included in the study.

The exclusion criteria

Patients that were scheduled for surgery due to CD, those with a history of surgery due to CD, fracture of the cervical vertebra, inflammatory diseases in the neck area, malignancy or coagulation disorders, patients under the age of 18 years, and pregnant or breastfeeding women were excluded from the study.

Treatment protocol

The patients underwent a total of three physical therapy sessions at one-week intervals. In the first session, 1% procaine was injected into the skin to form a lentil-sized papule into the painful points on the neck and trapezius area with palpation. In addition, quaddel method was applied, and approximately 0.5 cc of 1% procaine was injected into deep segmental trigger points (into fibrocystic nodules) detected by palpation. In the second session, the treatment protocol followed in the first session was repeated. In addition, 1% procaine was injected into the area of the first and seven cervical paravertebral segments to form a lentil-sized papule into the skin. In the last session, the second session protocol was repeated.[20] All treatment sessions were performed by a physical therapy specialist with a certificate of neural therapy application. The range of motion (ROM) was measured based on the guidelines of Kendall et al.; cervical flexion, extension, rotation and lateral flexion ROM measurements were made actively, each measurement was repeated three times and average values were calculated.[21] The Neck Disability Index (NDI) scores were obtained for the evaluation of the effect of neck pain on daily life function, and the Visual Analog Scale (VAS) was administered to determine the patients' pain level both at the beginning of the treatment and at one month after the third treatment session.[22,23]

Written informed consent was received from all the patients and approval was obtained from the Ethics Committee of the University of Health Sciences, City Training and Research Hospital (date 08.04.2021 and number 78-1365).

Statistical Analysis

The data obtained and additional c-MRI results were analyzed using SPSS v. 21 software package. The normality of continuous variables was evaluated using the Kolmogorov-Smirnov test. The paired t-test was used for the comparison of variables before and after treatment for normally distributed data, and the Wilcoxon test was conducted for those that did not conform to a normal distribution. The changes were found to be significant and effect sizes were calculated accordingly. Spearman's Rho coefficient was calculated to determine the linear relationship of the difference between pre- and post-treatment VAS scores with age and body mass index (BMI), as well as the relationship of the difference in pre- and post-treatment NDI with these variables. According to the c-MRI results, the homogeneity analysis of the variances in the scores was performed with the Levene test. For the NDI scores Student's t-test, and for the VAS scores the Mann-Whitney U test was performed. Descriptive statistics were given as mean or median values with 95% confidence intervals. In addition, Student's t-test was also used to compare the averages by gender. Statistical significance was accepted as $p < 0.05$.

Results

Of the 58 patients participating in the study, 41 (70.7%) were female. The demographic characteristics of the patients and the c-MRI results of the patients are presented in Tables 1 and 2, respectively.

Table 1. Demographic characteristics of the patients

	Mean ± SD	Median (IQR)	Min-Max
Age (year)	51.02 ± 10.77	51 (47-57)	19-75
Weight (kg)	77.38 ± 10.28	76.5 (70-85)	50-98
Height (cm)	164.97 ± 8.2	163.5 (158-172)	150-182
BMI (kg/m^2)	28.45 ± 3.32	28.67 (26.28-30.21)	19.29-35.16

SD: Standard deviation, IQR: Inter Quantile Range, BMI: Body Mass Index

Table 2. Distribution of the c-MRI results of the patients according to the cervical region

Cervical region	Normal n (%)	Protrusion n (%)	Bulging n (%)
C3-4	17 (29.3)	22 (37.9)	19 (32.8)
C4-5	14 (24.1)	29 (51.7)	15 (24.1)
C5-6	7 (12.1)	34 (58.6)	17 (29.3)
C6-7	8 (13.8)	35 (60.3)	15 (25.9)

c-MRI: Cervical magnetic resonance imaging

A statistically significant increase was observed in ROM values evaluating cervical ROM after NT in all movements (flexion, extension, rotation, and lateral flexion) compared to the baseline data ($p < 0.001$) (Table 3).

Table 3. Comparison of the baseline and post-NT VAS and NDI scores

	Mean ± SD	Median (IQR)	Min-Max	95% CI	
Baseline VAS	8.10 ± 1.12	8 (7-9)	6-10	8.00-8.00	**p1** < 0.001
Post-NT VAS	2.67 ± 1.22	3 (2-3.25)	1-6	2.00-3.00	**effect size:** 0.974
Difference in VAS	5.43 ± 0.9	5 (5-6)	3-8	5.00-6.00	
Baseline NDI	29.59 ± 7.44	29.5 (22-36.25)	16-42	27.63-31.54	**p2** < 0.001
Post-NT NDI	9.84 ± 6.13	9.5 (6-14)	0-28	8.23-11.46	**effect size:** 0.961
Difference in NDI	19.74 ± 4.00	20 (17-23)	9-26	18.69-20.79	

p1: Wilcoxon test, p2: Paired t- test, IQR: Inter Quantile Range, VAS: Visual Analog Scale, SD: standard deviation, NT: neural therapy, CI: confidence interval, NDI: Neck Disability Index

When the mean VAS and NDI scores of the patients were compared between the baseline and post-NT evaluations, statistically significant decreases were found ($p < 0.001$) (Table 4). In addition, there was a positive linear correlation between the VAS and NDI mean scores at baseline and after NT ($r = 0.274$; $p = 0.037$). The decrease in the VAS and NDI values after NT did not show a significant difference according to gender (Data not shown).

Table 4. Distribution of the VAS and NDI scores according to the c-MRI results

	Bulging			Protrusion			
	Mean ± SD	**Median (IQR)**	**Min-Max**	**Mean ± SD**	**Median (IQR)**	**Min-Max**	p_{group1}
Baseline NDI	27.84 ± 7.4	27 (22-34)	16-41	31.59 ± 7.09	33 (24-37)	20-42	0.055
Post-NT NDI	8.1 ± 5.48	8 (3-12)	0-19	11.85 ± 6.31	11 (9-16)	1-28	0.019
Difference in NDI	19.74 ± 3.22	19 (17-23)	13-25	19.74 ± 4.81	21 (17-24)	9-26	0.999
p_{time1}	p < 0.001; Effect size: 0.975			p < 0.001; Effect size: 0.946			
	Mean ± SD	**Median (IQR)**	**Min-Max**	**Mean ± SD**	**Median (IQR)**	**Min-Max**	p_{group2}
Baseline VAS	7.87 ± 1.09	8 (7-9)	6-10	8.37 ± 1.11	8 (8-9)	6-10	0.100
Post-NT VAS	2.52 ± 1.26	2 (1-3)	1-5	2.85 ± 1.17	3 (2-4)	1-6	0.261
Difference in VAS	5.35 ± 0.8	5 (5-6)	4-7	5.52 ± 1.01	6 (5-6)	3-8	0.453
p_{time2}	p<0.001; Effect size:0.979			p<0.001; Effect size:0.969			

p_{group1}: Student's t-test, p_{group2}: Mann-Whitney U test, p_{time1}: Paired t-test, p_{time2}: Wilcoxon test
IQR: Inter Quantile Range, VAS: Visual Analog Scale, SD: standard deviation, NT: neural therapy, NDI: Neck Disability Index, c-MRI: Cervical magnetic resonance imaging
Bulging: Patients with discopathy with no protrusion according to c-MRI. Protrusion: Patients with at least one protrusion according to c-MRI

Table 5 shows the differences in the NDI and VAS score averages between the baseline and post-NT evaluations in the bulging and protrusion groups. In both groups, the decrease in the mean NDI and VAS scores was statistically significant ($p < 0.001$). When the bulging and protrusion groups were compared, although the baseline NDI values were numerically higher in the protrusion group, there was no statistically significant difference between the groups ($p = 0.055$). After NT, the decrease in the mean NDI scores ($p = 0.999$) and the decrease in the median VAS scores were similar in the bulging and protrusion groups ($p = 0.999$ and 0.453, respectively). No significant difference was observed in terms of the median VAS scores of the bulging and protrusion groups before and after NT ($p = 0.100$ and 0.261, respectively).

Table 5. Comparison of the baseline and post-NT (after four weeks) ROM scores

	Mean ± SD	Median (IQR)	Min-Max	95% CI for Mean	
ROM Flexion					
Baseline	34.83±7.89	35 (30-40)	20-50	32.75-36.9	**p** < 0.001 **effect size:** 0.646
Post NT	46.55±3.27	45 (45-50)	40-50	45.69-47.41	
Difference to baseline	-11.72±8.76	-12.5 (-20--5)	-30-10	-14.03--9.42	
ROM Right Rotation					
Baseline	50.69±6.65	50 (45-55)	40-65	48,94-52,44	**p** < 0.001 **effect size:** 0.925
Post NT	74.05±4.54	75 (70-76.25)	65-80	72,86-75,24	
Difference to baseline	-23.36±6.71	-25 (-30--20)	-35--5	-25,13--21,6	
ROM Left Rotation					
Baseline	49.31±8,71	50 (45-55)	30-65	47.02-51.6	**p** < 0.001 **effect size:** 0.941
Post NT	74.14±4.7	75 (70-80)	65-80	72.9-75.37	
Difference to baseline	-24.83±6.28	-25 (-30--20)	-40--15	-26.48--23.18	
ROM Extension					
Baseline	38.1±6.74	40 (35-45)	25-50	36.33-39.88	**p** < 0.001 **effect size:** 0.921
Post NT	56.03±3.83	55 (55-60)	50-60	55.03-57.04	
Difference to baseline	-17.93±5.3	-15 (-25--15)	-25--10	-19,33--16,54	
ROM Right Lateral Flexion					
Baseline	31.21±8.07	30 (25-36)	20-45	29.55-33.56	**p** < 0.001 **effect size:** 0.757
Post NT	43.62±2.25	45 (40-45)	40-45	43.03-44.21	
Difference to baseline	-12.41±7.09	-15 (-16.25--8.75)	-25-0	-14.28--10.55	
ROM Left Lateral Flexion					
Baseline	31.55±7.62	30 (25-35)	20-45	29.08-33.33	**p** < 0.001 **effect size:** 0.741
Post NT	43.62±2.25	45 (40-45)	40-45	43.03-44.21	
Difference to baseline	-12.07±7.02	-12.5 (-15--8.75)	-25-0	-13.96--10.18	

p: Wilcoxon test, IQR: interquartile range, ROM: range of motion, SD: standard deviation, NT: neural therapy, CI: confidence interval.

Discussion

In this study, neural therapy was shown to have positive effects on neck pain and functional disability in patients with CD. The aim of neural therapy practice is to increase the perfusion of unregulated tissues, organs, or systems and to remove destruction products by taking advantage of the effects of local anesthetics on anti-inflammatory, analgesic, sympatholytic, and cell membrane activation potential. This provides both analgesic efficiency and healthy functioning (regulation) of the organism.[24,25] NT is known to be particularly effective on the autonomic nervous system. In addition to maintaining vital functions, the autonomic nervous system has the task of establishing a connection between the cells in the body. Abnormal electrical signals created by scar tissues are transmitted to other parts of the body via the autonomic nervous system. The term 'interference field', which refers to disturbances and pain in another part of the body with the dissemination of abnormal electrical activity, was first defined by Huneke in 1940. It is considered that these areas can develop as a result of physical trauma, and the application of local anesthetic corrects bioelectrical disorders and associated functional impairment.[3,8,12] In the current literature, there are neural therapy studies on treatment-resistant chronic pain conditions (fibromyalgia, lumbar degenerative diseases, cervical myofascial pain syndrome, and degenerative diseases of the knee joint, etc.), which have reported successful results.[10] Atalay et al. compared physical therapy over five sessions of neural therapy using lidocaine in the treatment of chronic low back pain and reported that both methods were effective in reducing this pain.[9] In another study, 280 patients with chronic pain were evaluated, and it was reported that neural therapy was an effective method in the treatment of chronic pain, significantly increased patient satisfaction, and significantly reduced treatment costs.[6] In a case report, Ugurlu et al. described a patient with persistent low back and leg pain due to lumbar disc herniation and piriformis muscle spasm, who was successfully treated with neural therapy techniques.[26]

Our sample consisted of patients with chronic neck pain and functional disability due to cervical discopathies, who were resistant to medical therapy and had not yet taken a surgical decision. To our knowledge, the literature contains no study investigating the efficacy of neural therapy on this patient population. Among the cervical spinal movement segments, the thickest disc and the most mobile segment of the spine is C5-C6, and cervical discopathies are most common in this region.[27] In this study, according to the C-MRI results, discopathy (bulging and protrusion) was found to be most common in the cervical C5-6 and C6-7 segments. Bulging refers to the penetration of the nucleus pulposus into the multiple annular tears and the overflow of the disc, and the protrusion is defined as localized disc bulging. A natural increase is expected in neck pain and dysfunction caused by bulging toward protrusion, extrusion, and hernia.[28] In our study, the mean baseline NDI scores were found to be higher in the protrusion group compared to the bulging group, although this was not statistically significant.

ROM value is directly related to functionality and activities of daily routine, and the significant increase in cervical ROM values after NT allowed the study to be evaluated objectively.[29] Since pain is a subjective concept based on the patient's complaint, it is very difficult to ensure objectivity in its evaluation. Despite the subjective evaluation of VAS, it is a frequently preferred pain scale due to its ease of application. Neck pain due to cervical discopathy negatively affects neck functions and quality of life. To evaluate the level of disability in patients with neck pain, the NDI questionnaire has been accepted and widely used.[24,25] In the current study, we determined a positive linear correlation between the differences in the VAS and NDI scores between the baseline and post-NT evaluations, which can reduce the subjectivity of such assessments.

Conclusion

NT is a treatment method widely used in daily clinical practice. It has the advantages of effective treatment, cost-effectiveness, and patient satisfaction. It is considered that neural therapy decreases the cost of treatment and can contribute to the national economy in patients with diseases that do not respond to treatment for years.

Limitations

The main limitations of this study are the limited number of patients and the lack of output regarding the long-term results of neural therapy.

References

1. Brobyn TL, Chung MK, LaRiccia PJ. Neural Therapy: An Overlooked Game Changer for Patients Suffering Chronic Pain? J Pain Relief. 2015;4:184. https://doi.org/10.4172/2167-0846.1000184.
2. Harris GR. Effective treatment of chronic pain by the integration of neural therapy and prolotherapy. Journal of Prolotherapy. 2010;2:377–386. Available from: https://www.journalofprolotherapy.com/pdfs/issue_06/issue_06_07_neural_therapy.pdf
3. Frank BL. Neural therapy. Phys Med Rehabil Clin N Am. 1999;10(3);573-82. viii. PMID: 10516978.
4. Altınbilek T, Terzi R, Başaran A, Tolu S, Küçüksaraç S. Evaluation of the effects of neural therapy in patients diagnosed with fibromyalgia. Turk J Phys Med Rehabil. 2019;65(1):1-8. https://doi.org/10.5606/tftrd.2019.1931.
5. Koopman FA, Stoof SP, Straub RH, Van Maanen MA, Vervoordeldonk MJ, Tak PP. Restoring the balance of the autonomic nervous system as an innovative approach to the treatment of rheumatoid arthritis. Mol Med. 2011;17(9-10):937-48. https://doi.org/10.2119/molmed.2011.00065.
6. Egli S, Pfister M, Ludin SM, Puente de la Vega K, Busato A, Fisceher L Long-term results of therapeutic local anesthesia (neural therapy) in 280 referred refractory chronic pain patients. BMC Complement Altern Med. 2015;15(1):1-9. https://doi.org/10.1186/s12906-015-0735-z.
7. Sillevis R, Shamus E. The Effects of Neural Therapy Using 1% Procaine Injections on Pain and Autonomic Nervous System in Patients with Neck Pain. J Rehab Pract Res. 2020;1(2):111. https://doi.org/10.33790/jrpr1100111.
8. Weinschenk S. Neural therapy a review of the therapeutic use of local anesthetics. Acupuncture and Related Therapies.

2012;1:5–9. https://doi.org/:10.1016/j.arthe.2012.12.004.
9. Atalay NS, Sahin F, Atalay A, Akkaya N. Comparison of efficacy of neural therapy and physical therapy in chronic low back pain. Afr J Tradit Complement Altern Med. 2013;10:431–5. https://doi.org/:10.4314/ajtcam.v10i3.8.
10. Özkan N. The Efficiency of Neural Therapy in Resistive Musculoskeletal Disorders. Journal of Complementary Medicine, Regulation and Neural Therapy. 2014;8(2),14-18. Available from: https://dergipark.org.tr/tr/download/article-file/621082
11. Cleland JA, Childs JD, McRae M, Palmer JA, Stowell T. Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. Man Ther. 2005;10(2):127-35. https://doi.org/10.1016/j.math.2004.08.005.
12. Mermod J, Fischer L, Staub L, Busato A. Patient satisfaction of primary care for musculoskeletal diseases: a comparison between Neural Therapy and conventional medicine. BMC Complement Altern Med. 2008;8:33. https://doi.org/10.1186/1472-6882-8-33.
13. Subasi V, Kucuk MO. Neural Therapy Protocols in Musculoskeletal Disorders: Review. Turk J Osteoporos. 2018;24:1-4. https://doi.org/10.4274/tod.64935.
14. Carroll LJ, Hurwitz EL, Côté P, Côté P, Hogg-Johnson S, Carragee EJ, Nordin M, et al. Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Research priorities and methodological implications: The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine. 2008;15;33(4 Suppl): S214-20. https://doi.org/10.1097/BRS.0b013e318164462c.
15. Yang L, Yang C, Pang X, Li D, Yang H, Zhang X, et al. Mechanoreceptors in Diseased Cervical Intervertebral Disc and Vertigo. Spine. 2017;42(8):540–546. https://doi.org/10.1097/BRS.0000000000001801.
16. Evans G. Identifying and treating the causes of neck pain. Med Clin North Am. 2014;98(3):645–661. https://doi.org/10.1016/j.mcna.2014.01.015.
17. Navone SE, Marfia G, Giannoni A, Beretta M, Guarnaccia L, Gualtierotti R, et al. Inflammatory mediators and signalling pathways controlling intervertebral disc degeneration. Histol Histopathol. 2017;32(6):523–542. https://doi.org/10.14670/HH-11-846.
18. Risbud MV, Shapiro IM. Role of cytokines in intervertebral disc degeneration: pain and disc content. Nat Rev Rheumatol. 2014;10(1):44–56. https://doi.org/10.1038/nrrheum.2013.160.
19. Peng B, DePalma MJ. Cervical disc degeneration and neck pain. J Pain Res. 2018;11:2853-2857. https://doi.org/10.2147/JPR.S180018.
20. Bashan I, Yasa Ozturk G. (2022). Effect of Neural Therapy on shoulder dysfunction and pain in supraspinatus tendinopathy. PJMS. 2022; 38(3). https://doi.org/10.12669/pjms.38.3.482321.
21. Robertson JA, Kendall FP, McCreary EK. 'Muscles, Testing and Function' (Third Edition). Br J Sports Med. 1984;18(1):25. PMCID: PMC1858872.
22. Kesiktas, N, Ozcan, E, Vernon H. Clinimetric properties of the Turkish translation of a modified neck disability index. BMC Musculoskelet Disord. 2012;3-25. https://doi.org/10.1186/1471-2474-13-25.
23. Freyd M. The graphic rating scale. Journal of Educational Psychology. 1923;14:83-102. https://doi.org/10.1037/h0074329.
24. Cassuto D, Sinclair R, Bonderovic M. Anti-inflammatory properties of local anesthetics and their present and potential clinical implications. Acta Anaesthesiol Scand. 2006;50:265–282. https://doi.org/10.1111/j.1399-6576.2006.00936.x.
25. Watkins LR, Hutchinson MR, Milligan ED, Maier SF. 'Listening' and 'talking' to neurons: Implications of immune activation for pain control and increasing the efficacy of opioids. Brain Res Rev. 2007;56:148-169. https://doi.org/10.1016/j.brainresrev.2007.06.006.
26. Uğurlu FG. Coexistance of Piriformis Syndrome and Lumbar Disc Herniation Treated with Neural Therapy. Journal of Complementary Medicine Regulation and Neural Therapy. 2017;11:28-30. https://doi.org/10.1111/j.1533-2500.2008.00177.x.
27. Nishizawa S, Yokoyama T, Yokota N, Kaneko M. High cervical disc lesiones in elderly patients-presentation and surgical approach. Acta Neurochir. 1999;141:119–126. https://doi.org/10.1007/s007010050275.
28. Arana E, Martí-Bonmatí L, Mollá E, Costa S. Upper thoracic-spine disc degeneration in patients with cervical pain. Skeletal Radiol. 2004;33(1):29-33. https://doi.org/10.1007/s00256-003-0699-9.
29. Johnson AJ, Godges JJ, Zimmerman GJ, Ounanian LL. The effect of anterior versus posterior glide joint mobilization on external rotation range of motion in patients with shoulder adhesive capsulitis. J Orthop Sports Phys Ther. 2007;37(3):88-99. https://doi.org/10.2519/jospt.2007.2307.