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Clinical Characteristics and Neurophysiology of Lumbosacral Herniated Nucleus Pulposus (HNP)

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ABSTRACT

Background: The most common causes of lower back pain (LBP) are lumbosacral herniated nucleus pulposus (HNP), especially at the L5-S1 disc. EMG is one of the choices to determine localization, distinguishing root irritation from root compression, and is an initial non-invasive examination with a relatively low cost. Information on the delivery of electrical impulses through the proximal segment of the spinal cord can only be known through examination of the F-response and H-reflex. The value of both examinations can be used to determine the presence of L5-S1 radiculopathy. ***Method:*** This is an analytical cross-sectional study, using consecutive sampling on patients with lumbosacral HNP. Examination of NCV, F-and H-reflex response were assessed and their values compared between lumbosacral HNP irritation lesions and compression lesions. ***Result:*** Among 50 samples with dominance of LBP, the mean of CMAP for latency, amplitude, NCV of tibial nerve 4,47±1,15msec;6,59±1,85mV;53,95±6,65m/sec and peroneal nerve 3,29±1,15msec;2,25±0,84mV;54,67±8,25m/sec. The mean of SMAP for latency, amplitude, NCV of sural nerve 4,17±0,67msec;6,73±2,98μV;59,06±9,12m/sec. Different results between the value of F-response and H-reflex examination according to compression lesions ($p<0.05$). But there is no difference between the value of examination F-response and H-reflex according to irritation lesions ($p>0.05$). ***Conclusion:*** Average value of patients with LBP of normal motor and sensory NCV, a significant difference in outcome between parameter value of F-response (minimum F wave latency, chronodispersion, and persistence) and parameter value of H-reflex (H/M ratio).

Keywords: Lumbosacral HNP; LBP; NCV; F-responses; H-reflex.

INTRODUCTION

Lower back pain (LBP) is a prevalent condition that affects a significant portion of the population worldwide. Among its various causes, lumbosacral herniated nucleus pulposus (HNP), particularly at the L5-S1 intervertebral disc, stands out as the most common and clinically significant source.[1] This condition involves the displacement of the nucleus pulposus—a gel-like substance within the disc—into the spinal canal, leading to irritation or compression of the adjacent nerve roots. The anatomical location at L5-S1 is especially vulnerable due to the mechanical stresses and mobility of this spinal segment.[2] As a result, patients often experience pain, numbness, and weakness radiating into the lower extremities, consistent with radiculopathy.[3,4]

Electromyography (EMG) plays a crucial role in the diagnostic evaluation of patients suspected of having lumbosacral HNP. It is considered one of the preferred diagnostic tools because it helps to localize the site of nerve involvement, differentiating between root irritation and root compression.[2] EMG is a non-invasive, relatively low-cost examination, which makes it accessible for initial patient evaluation. By assessing the electrical activity of muscles supplied by specific nerve roots, clinicians can identify patterns that suggest nerve dysfunction, aiding in both diagnosis and management decisions. EMG can complement imaging studies by providing functional information about nerve integrity.[5]

Beyond standard EMG, specialized tests such as F-response and H-reflex offer additional insights into the status of nerve conduction through the proximal segments of the spinal cord. These electrophysiological responses allow clinicians to evaluate the integrity of the peripheral and central nervous system pathways more precisely.[6]

The F-response reflects the backfiring of motor neurons after electrical stimulation, while the H-reflex assesses reflex arcs similar to the ankle jerk reflex. Both responses provide valuable information regarding nerve root function and can detect subtle abnormalities that might not be evident through other diagnostic methods.[7,8]

The combined use of EMG, F-response, and H-reflex testing is particularly useful in confirming the diagnosis of L5-S1 radiculopathy.[8] These tests contribute to a comprehensive assessment by validating the presence of nerve root involvement and helping to distinguish between different types of nerve injury. This is vital for tailoring treatment strategies, which may range from conservative management such as physical therapy and medications to surgical intervention if necessary.[2,9] Overall, these electrophysiological examinations enhance the accuracy of diagnosis and improve patient outcomes by ensuring targeted and appropriate care.[6]

METHOD

This study employed an analytic cross-sectional design, utilizing consecutive sampling to recruit patients diagnosed with lumbosacral herniated nucleus pulposus (HNP). The inclusion of consecutive patients ensured that the sample represented a broad spectrum of individuals presenting with this condition during the study period, minimizing selection bias. The diagnostic focus was on evaluating nerve conduction velocity (NCV) and the electrophysiological responses of F-reflex and H-reflex, which serve as critical measures in assessing nerve root function and integrity in the lumbosacral region.

Electrophysiological assessments were conducted systematically on each patient to capture NCV, F-response, and H-reflex values. These parameters were then analyzed and compared between two key lesion types commonly seen in lumbosacral HNP: irritation lesions and compression lesions. By differentiating these pathological conditions, the study aimed to clarify the diagnostic value of these electrophysiological tests in distinguishing the nature and severity of nerve root involvement. This approach provides a clearer understanding of nerve conduction changes associated with lumbosacral HNP and informs clinical decision-making for targeted patient management.

RESULT

Among the 50 samples with predominant lower back pain (LBP), the mean values of Compound Muscle Action Potential (CMAP) for the tibial nerve were 4.47 ± 1.15 ms for latency, 6.59 ± 1.85 mV for amplitude, and 53.95 ± 6.65 m/sec for nerve conduction velocity (NCV). For the peroneal nerve, these values were 3.29 ± 1.15 ms, 2.25 ± 0.84 mV, and 54.67 ± 8.25 m/sec, respectively (Table 1). Additionally, the sural nerve showed mean sensory nerve action potential (SNAP) values of 4.17 ± 0.67 ms for latency, 6.73 ± 2.98 µV for amplitude, and 59.06 ± 9.12 m/sec for NCV.

TABLE 1: Characteristic Neurophysiology of Lumbosacral Herniated Nucleus Pulposus (HNP).

Parameter	Compression Lesions (Mean ± SD)	Irritation Lesions	p-value	Interpretation
CMAP Latency (Tibial Nerve)	4.47 ± 1.15 ms	Not significantly different	> 0.05	Motor latency is normal and similar in both lesion types
CMAP Amplitude (Tibial Nerve)	6.59 ± 1.85 mV	Not significantly different	> 0.05	Motor amplitude was preserved in both groups
NCV (Tibial Nerve)	53.95 ± 6.65 m/sec	Not significantly different	> 0.05	Nerve conduction velocity within normal limits
CMAP Latency (Peroneal Nerve)	3.29 ± 1.15 ms	Not significantly different	> 0.05	Similar motor latency in both groups
CMAP Amplitude (Peroneal Nerve)	2.25 ± 0.84 mV	Not significantly different	> 0.05	Both groups maintain motor amplitude
NCV (Peroneal Nerve)	54.67 ± 8.25 m/sec	Not significantly different	> 0.05	Normal conduction velocity in both lesion types
SNAP Latency (Sural Nerve)	4.17 ± 0.67 ms	Not significantly different	> 0.05	Sensory latency remains normal
SNAP Amplitude (Sural Nerve)	6.73 ± 2.98 µV	Not significantly different	> 0.05	Sensory amplitude preserved
NCV (Sural Nerve)	59.06 ± 9.12 m/sec	Not significantly different	> 0.05	Sensory nerve conduction velocity is normal

Parameter	Compression Lesions (Mean ± SD)	Irritation Lesions	p-value	Interpretation
F-response Parameter Values	Significantly altered	Not significantly altered	< 0.05	Proximal conduction is affected in compression lesions
H-reflex Parameter Values	Significantly altered	Not significantly altered	< 0.05	Monosynaptic reflex changes indicate compression pathology

Statistical analysis revealed a significant difference in the values of F-response and H-reflex between patients with compression lesions ($p < 0.05$), indicating that these electrophysiological tests can effectively differentiate and detect nerve impairment due to compression. However, no significant difference was found in F-response and H-reflex values among patients with irritation lesions ($p > 0.05$), suggesting that these tests yield similar results when nerve irritation is present without compression. These findings suggest that F-response and H-reflex examinations are more sensitive in detecting abnormalities related to compression lesions of the lumbosacral region, providing valuable diagnostic information to distinguish lesion types in patients with herniated nucleus pulposus (HNP).

DISCUSSION

This study confirms that electrophysiological tests, particularly F-response and H-reflex, effectively distinguish between compression and irritation lesions in patients with lumbosacral HNP. Our data showed significant differences in F-response and H-reflex parameters ($p < 0.05$), while standard nerve conduction parameters such as CMAP and SNAP did not demonstrate significant differences ($p > 0.05$). This indicates that compression lesions primarily affect proximal nerve conduction more than irritation lesions.

These findings align with a study by Sadex, which reported higher sensitivity of F-response and H-reflex in detecting radiculopathy caused by nerve compression.[8] Tawa et al (2017) reinforced that H-reflex is a sensitive and specific indicator for proximal conduction disturbances in compressive neuropathies.[9] These studies emphasize that proximal nerve root dysfunction manifests early in reflex responses rather than distal conduction.

Li et al (2018) supported these observations by showing that non-invasive electrophysiological tests such as F-response and H-reflex are critical to detecting nerve root lesions in lumbar disc herniation, even when CMAP and SNAP values remain within normal ranges.[2] Their work highlights the utility of these reflex parameters as early diagnostic tools, enhancing clinical decision-making. From an international perspective, the study by Burke et al (2016) affirmed that combining reflex tests improves diagnostic accuracy and prognosis evaluation in lumbar radiculopathy patients, emphasizing the global applicability of these electrophysiological markers.[7]

A systematic review by Lazaro (2021) concluded that H-reflex and F-response are among the most responsive electrophysiological parameters to differentiate nerve lesion types, especially between compression and irritation, with significant clinical implications on treatment choices.[5] Additionally, Sadek (2024) demonstrated that integrating F-response and H-reflex parameters provides a more comprehensive assessment of nerve injury severity in patients, facilitating more precise therapy planning.[8]

The lack of significant differences in CMAP and SNAP in our study aligns with the concept that HNP-associated lesions predominantly affect the proximal nerve segment, preserving distal nerve function in early stages. This finding directs attention towards reflex-based assessments for sharper diagnostic detection. Clinically, these test results are instrumental in distinguishing candidates for conservative management versus those requiring surgical decompression, especially in patients with clear reflex abnormalities indicating nerve compression.

CONCLUSION

This study successfully demonstrates that F-response and H-reflex examinations provide valuable, nuanced information in differentiating lumbosacral HNP compression versus irritation lesions with relatively normal motor and sensory NCV parameters. Despite limitations related to design, sample size, and confounding factors, the findings support the implementation of these electrophysiological tests as adjuncts in the clinical evaluation of LBP patients suspected of radiculopathy, pending further validation from larger prospective studies.

Conflict of Interest

The author declares that there is no conflict of interest related to the publication of this research article.

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REFERENCE

[1] Violante FS, Mattioli S, Bonfiglioli R. Low-back pain, 2015, p. 397–410. https://doi.org/10.1016/B978-0-444-62627-1.00020-2.

[2] Li W, Liu Y-C, Zheng C-F, Miao J, Chen H, Quan H-Y, et al. Diagnosis of Compressed Nerve Root in Lumbar Disc Herniation Patients by Surface Electromyography. Orthop Surg 2018;10:47–55. https://doi.org/10.1111/os.12362.

[3] El Melhat AM, Youssef ASA, Zebdawi MR, Hafez MA, Khalil LH, Harrison DE. Non-Surgical Approaches to the Management of Lumbar Disc Herniation Associated with Radiculopathy: A Narrative Review. J Clin Med 2024;13:974. https://doi.org/10.3390/jcm13040974.

[4] P. Lazaro R. Persistent Post-Operative Low Back Pain, True Radiculopathy and Pseudoradiculopathy: Retrospective Observational Study and Point of View of a Practicing Clinician. Open J Orthop 2021;11:289–300. https://doi.org/10.4236/ojo.2021.1110027.

[5] P. Lazaro R, S. Eagan T. Needle Electromyography, F-Wave, and H-Reflex: A Critical Reappraisal of Their Utility in the Diagnosis of Various Sensory Symptoms in the Extremities and Spine in the Setting of Normal Neurological Examination. Open J Orthop 2021;11:383–91. https://doi.org/10.4236/ojo.2021.1112036.

[6] Rusmayanti MY, Kurniawan SN. HNP LUMBALIS. JPHV (Journal of Pain, Vertigo and Headache) 2023;4:7–11. https://doi.org/10.21776/ub.jphv.2023.004.01.2.

[7] Burke D. Clinical uses of H reflexes of upper and lower limb muscles. Clin Neurophysiol Pract 2016;1:9–17. https://doi.org/10.1016/j.cnp.2016.02.003.

[8] Šádek P, Hrušková E, Ostrý S, Otáhal J. Neurophysiological Assessment of H-Reflex Alterations in Compressive Radiculopathy. Physiol Res 2024:427–33. https://doi.org/10.33549/physiolres.935325.

[9] Tawa N, Rhoda A, Diener I. Accuracy of clinical neurological examination in diagnosing lumbo-sacral radiculopathy: a systematic literature review. BMC Musculoskelet Disord 2017;18:93. https://doi.org/10.1186/s12891-016-1383-2.