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ROLE OF DIFFERENT H REFLEX PARAMETERS IN DIAGNOSIS OF LUMBOSACRAL RADICULOPATHY ALONG WITH THEIR CORRELATION WITH MRI

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Abstract:
Objective:
To observe the changes of H reflex and it's different parameters in patients of chronic low back pain (clinically diagnosed as radiculopthy.) and to correlate the findings with MRI.
Method:
It was an observational cross-sectional study on 51 patients with clinical diagnosis of lumbosacral radiculopathy. First H-reflex study was done . Then findings were statistically analysed and correlated with their radiological counterpart.
Result:
Abnormal H-Reflex has the maximum percent prevalence (92%) followed by H amplitude (88%); even more than percent prevalence of abnormal MRI (65%).
 Regarding the correlation with MRI, unilaterally absent H reflex showed extremely statistically significant correlation (P=0.0004).
 Apart from it, H reflex as a whole, H amplitude, H latency, bilaterally absent H reflex had statistically significant correlation with MRI (P<0.05).
Conclusion:
Nerve conduction studies, specially H reflex with its individual parameters can be used as efficient diagnostic tool for lumbosacral radiculopathy. It is evidenced by high percent prevalence of abnormal results of the above parameters as well as significant correlation (by P value) and agreement (by Kappa coefficient) studies.

Keywords: H-reflex, MRI, Radiculopathy

Introduction:

back pain ranks second only to upper respiratory tract illness as a symptomatic reason for office visit to physicians. Its overall lifetime prevalence is 60-90%, but only 5% of patients develop persistent symptoms developing into chronic low back pain.(1)

But unfortunately 85% patients can't be given a definitive diagnosis because of weak association among symptoms, pathological changes & imaging studies. The diagnostic evaluation is difficult because its primary causes are different affecting intervertebral discs, ligaments, facets, joints, muscles etc.

The dominant medical factors associated with the development of disability in patients with low back pain are the presence of severe leg pain and a history of prior episodes of low back pain. [2,3] In patients presenting with leg pain greater than low back pain, lumbar radiculopathy and lumbar canal stenosis are described as the most common etiologies.[2,3]

Lumbosacral radiculopathy was first described by Mixter & Barr in 1934. It refers to a pathologic process involving the lumbar nerve roots causing radicular symptoms into a lower extremity. The nerve root pathology arises primarily from direct neural compression irrespective of whether the etiology is an acute herniated or displaced disc, bony spurs, foraminal stenosis, central stenosis, or hypermobility of a vertebral segment.(4) Less commonly other compressive lesions like tumor and cysts may cause radiculopathy.

Apart from these, there may be some noncompressive or non-structural etiologies like 'chemical radiculitis' (5) or systemic diseases like diabetes or malignancies. The prevalence of lumbar radiculopathy varies from about 2.2% to 8% and the incidence ranges from 0.7% to 9.6%. (6)

Despite the large number of nerve roots subject to potential compromise in the lumbosacral region, approximately 76.1% of lumbar radiculopathies involve the L5 and S1 nerve roots.

MRI is exquisitely sensitive in detecting these anatomical changes. However MRI often shows disc disease and other degenerative diseases in asymptomatic people. Lumbar disc protrusion can be seen in as high as 67% of asymptomatic people, older than 60 years of age & 20% of them have lumbar canal stenosis.(1) Therefore MRI is very sensitive in detecting these anatomical changes but does not give any information about nerve function or whether these anatomical changes could be a source of symptoms.

Regarding nerve conduction studies there are limited data about their importance in diagnosis of radiculopathies. There are studies showing significant relationship between L5-S1 radiculopathy & CMAP amplitude of peroneal & tibial nerve respectively, when there was at least 3 months period of involvement. Soleus H –reflex study though is considered as sensitive marker of root dysfunction, information about its role in diagnosing radiculopathy is quite insufficient. There are studies showing strong correlation between pathological changes in H-reflex parameters & clinical findings in different segmental lesions.(7)

In our study focus was made to evaluate the potential H-reflex along with its all parameters, for diagnosis of radiculopathies along with its comparison with imaging (MRI) and clinical examination. Patients with complaints of low back pain for more than 3 months were evaluated clinically, radiologically & neurophysiologically. Thereafter, a comparative study will be done amongst these three types of findings, especially to evaluate the role of H-reflex in diagnosis of radiculopathy.

Aims & objectives

0bjectives:

A) General:

To observe the changes of H reflex and it's different parameters in patients of chronic low back pain (clinically diagnosed as radiculopthy.) and to correlate the findings with MRI.

B) Specific:

a) To compare the H reflex results with MRI findings

b) To determine if there is any association between radiculopathy and H-reflex parameter change. c) To find out the diagnostic potential of H-reflex in patients of chronic low back pain in evaluation of radiculopathy.

d) To review the correlation between clinical and electrophysiological findings.

e) Effort to locate the specific site of pathology. f) To correlate between advancement of disease & electrophysiological changes.

Materials and methods

Ethical consideration: The study proposal with other relevant documents was submitted to the concerned ethical committee for review and approval. The study was commenced only after such approval .

Study area:

Department of Medicine of a tertiary care centre

Study population:

30-70 years patients of both sexes presenting to OPD with complaints of low back pain for more than 3 months.

Inclusion criteria:

a) Age: 30-70 years
b) Complaints of low back pain for at least 3 months or more
c) Clinical features of radiculopathy as evidenced by clinical examinations(table stated below)
d) Physically capable of undergoing required test (NCS) & visit OPD
e) Patients who will sign informed consent

Exclusion criteria:

a)Complaints of duration for less than 3 months.
b) Patients aged more than 70 years
c) Patients with other causes of polyneuropathy including diabetes mellitus.
d) Patients physically unable to undergo the test
e) Patients with major medical illness
f) Patients who are unwilling to give consent.

Study period: One year

Sample size: Sample size will be calculated by multi stage sampling method (First stage – simple random sampling Second stage – purposive sampling)

Fifty one (51) patients with complaints of low back pain and satisfying the inclusion criteria will undergo the study.

Study design:

It is an observational cross-sectional study.

Study parameters:

a) Detail history:

A detail account of low back pain was recorded to elaborate its nature, its duration, intensity, radiation to lower limbs, sensory changes if any, level of impairments in daily pursuits due to it.

b) Height and weight: of each patient was recorded

c) Clinical examination:

Systemic examination was done as per the following table.

Power of the following muscles	Normal	Impaired
Gluteus maximus (L4-L5)		
Hamstrings (L4,5-S1,2)		
Quadriceps (L3-L4)		
Tibialis anterior (L4-L5)		
Tibialis posterior (L4)		
Gastrosoleus(S1)		
Extensor Hallucis Longus(L5-S1)		
Sensory Examination (L2 – S1)		
Straight Leg Rising test		
Femoral stretch test		

Table 1: Clinical examination chart

d) Magnetic resonance imaging (MRI) of L-S spine:
Then these clinically diagnosed cases of L-S radiculopathy had undergone MRI study of lumbosacral spine in the department of radiology. The reports of MRI scan was collected from them and recorded accordingly. The significant anomalies suggestive of causing radiculopathy are disc herniation and subsequent nerve root compression, lumbar canal stenosis, degenerative disc disease etc. These are recorded in the following form:

Normal	Disc herniation and root compression	Lumbar canal stenosis	Degenerative changes	Others like lumbar spondylosis

Table 2: MRI parameters

e) H-reflex study:
H reflex, a monosynaptic reflex elicited by submaximal stimulation of tibial nerve and was recorded from soleus muscle. Patients were instructed to lie in a prone position comfortably with legs and thighs supported. Appropriate exposure was ensured. The active electrode was placed at the distal edge of calf muscle and the reference electrode was placed on Achilles tendon.
A square wave pulse of 1 ms duration was used for preferential stimulation of large sensory fibers. The cathode was kept proximal to anode to avoid anodal block. Care was taken to ascertain that stimulus frequency does not exceed 1 in 5 ms to exclude any effect of prior stimulus. The latency of H reflex was measured from the stimulus artefact to the first deflection from the baseline. The H amplitude was measured base to peak of the negative phase. The study was done at room temperature confirming the body temperature of the subject remaining between 34-38 degree Celsius.

❖ **Normal H reflex parameters:**

H reflex latency(ms)	**30.3±1.7**
H reflex amplitude(mV)	9.8±6.1
M wave amplitude(mV)	24.6±6.6
HM ratio	0.4±0.2

Table 3: H-reflex parameters

f)Blood sugar report :
In the form of fasting, post-prandial blood sugar and HBA1C was collected to exclude the patients with diabetes in the view of possible pre-existent neuropathy.
Study Technique:
Patients satisfying the inclusion criteria were explained about the purpose of the study. Prior informed consent was taken from them. Proper history was taken and clinical examination done as per the scheduled protocol. Reports of MRI scan and diabetes profile were collected and reviewed. Then steps of Nerve Conduction Study was performed and documented.
Data analysis:
After collection of relevant data from the proposed study, appropriate statistical analysis will be done by latest version of SPSS software.
Result and analysis:
We have compared each of the H-reflex parameters with corresponding MRI findings one by one. Collected data were analysed by latest version of SPSS programme and statistical tests including Fisher's exact test, Chi square test and Kappa coefficient.
MRI and H-reflex:
If we compare MRI with H-reflex, we can see that as many as 92% of patients had abnormal H-reflex (by one or more H-reflex parameters) whereas MRI abnormalities suggestive of lumbosacral

radiculopathy were detected in about 65% of cases. Only 8% of patient had normal H-reflex whereas 35% of patients had normal MRI.

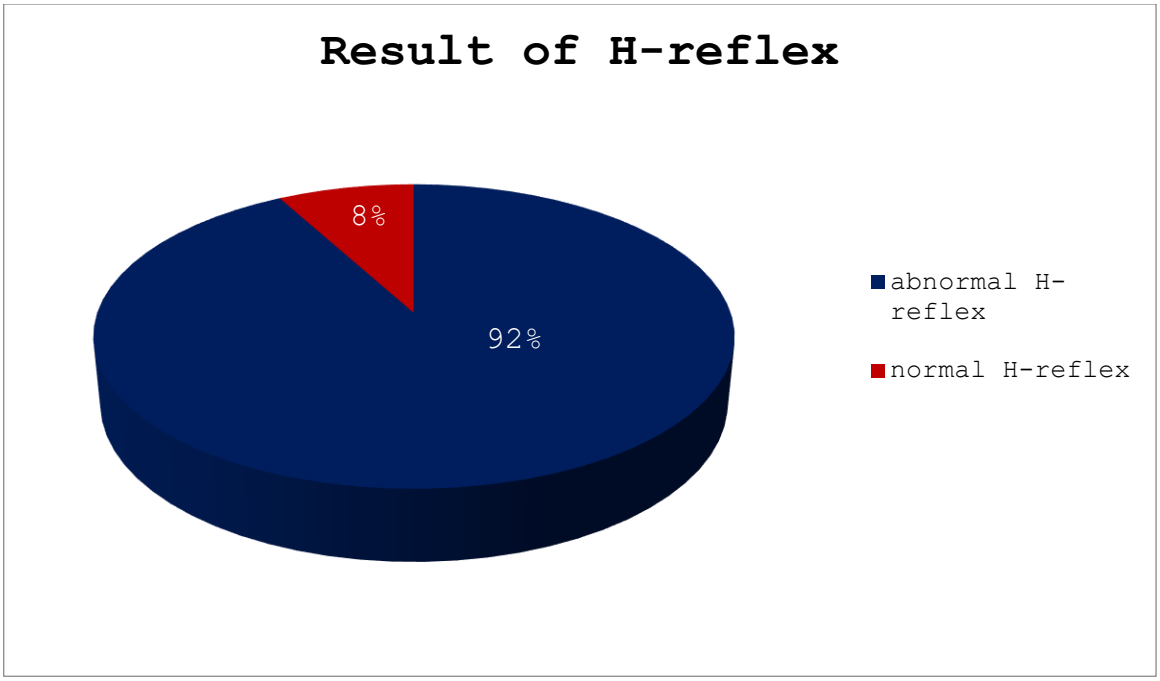


Figure 4: Result of H-reflex study

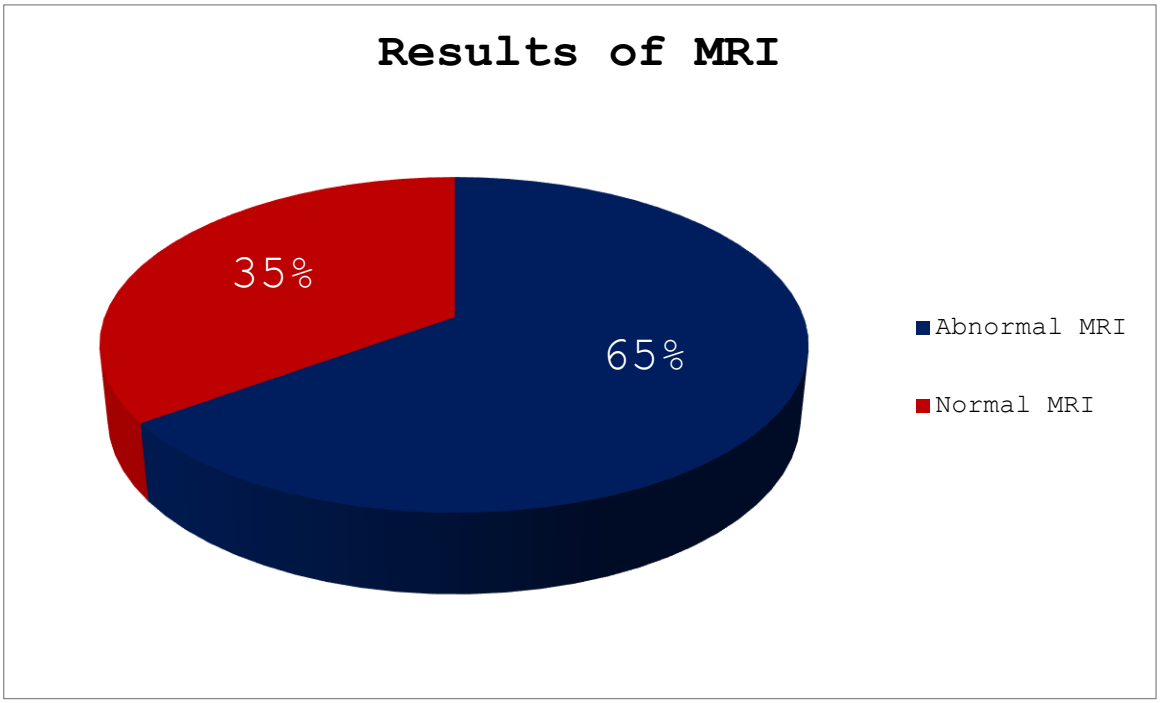


Figure 5: Result of MRI SCAN

Now, the association between these two tests was assessed by estimation of P value and Kappa coefficient. The P value estimated by Fisher's exact test was 0.012 suggesting statistically significant correlation between these two. The estimated Kappa coefficient was 0.270 which suggests a "fair" strength of agreement between these two (table-3). The standard error of Kappa was 0.114 and 95% confidence interval was 0.047 to 0.493.

Table 4 : Proportional agreement between H-reflex and MRI in the evaluated patients P=0.012, Kappa= 0.270

H-reflex MRI	Normal	Abnormal	Total
Normal	22% 4 100%	78% 14 30%	100% 18 35%
Abnormal	0% 0 0%	100% 33 70%	100% 33 65%
Total	8% 4 100%	92% 47 100%	100% 51 100%

Thereafter, individual H-reflex parameters like H-latency, H-amplitude, unilateral or bilateral absence of H-reflex etc were compared with MRI results. The results obtained was as following- □ MRI and H-amplitude: Reduced H amplitude was observed in more than 88% of patients who had bilateral H-reflex still present. In comparison MRI was abnormal in about 62% of them. It suggests that about 38% of patients who had bilateral H-reflex, showed normal MRI study. As per association is concerned between these two, the estimated P value was 0.046 which was statistically significant. The Kappa coefficient assessed was 0.345 which indicates "fair" strength of agreement between these two. The standard error of kappa was 0.160 and 95% confidence interval was 0.032 to 0.659.

Table 5 : Proportional agreement between H-amplitude and MRI in the evaluated patients P=0.046, Kappa= 0.345

H-amplitude MRI	Normal	Abnormal	Total
Normal	30% 3 100%	70% 7 44%	100% 10 38%
Abnormal	0% 0 0%	100% 16 66%	100% 16 62%
Total	12% 3 100%	88% 23 100%	100% 51 100%

MRI and H latency :

H latency was abnormally prolonged in about 67% patients whereas MRI study was abnormal in 63% of patients. The P value estimated was 0.015 which denotes a statistically significant correlation between these two. According to the Kappa coefficient study the estimated Kappa coefficient was 0.488 which indicates a "moderate" strength of agreement between these two tests (table 5). The standard error of Kappa was 0.167 and 95% confidence interval was 0.161 to 0.814.

Table 6: Proportional agreement between H-amplitude and MRI in the evaluated patients P=0.046, Kappa= 0.345

H-amplitude MRI	Normal	Abnormal	Total
Normal	30%	70%	100%

	3 100%	7 44%	10 38%
Abnormal	0% 0 0%	100% 16 66%	100% 16 62%
Total	12% 3 100%	88% 23 100%	100% 51 100%

MRI and unilaterally absent H reflex:
55% of patients had unilaterally absent H reflex whereas MRI was abnormal in about 65% of patients. In this case MRI shows more abnormal result than an H-reflex parameter. But as per the correlation is concerned, it shows an estimated P value of 0.0004, which indicates an extremely statistically significant correlation between these two (table 6). Kappa coefficient assessed was 0.668, which denotes a "good" strength of agreement between these two. Standard error of kappa was 0.133 and 95% confidence interval was 0.407 to 0.929.

Table 7: Proportional agreement between unilaterally absent H-reflex and MRI in the evaluated patients P=0.015, Kappa=0.488

H-reflex	**Bilateral**	**Unilateral**	**Total**
MRI			
Normal	91% 10 71%	9% 1 6%	100% 11 35%
Abnormal	20% 4 29%	80% 16 94%	100% 20 65%
Total	45% 14 100%	55% 17 100%	100% 31 100%

✓ **MRI and bilaterally absent H-reflex:**
55% patients had bilaterally absent H reflex and the same percentage of patients showed abnormalities in their MRI scan. Regarding association, the estimated P value was 0.038 which signifies statistically significant correlation between these two (table 7). The Kappa coefficient assessed was 0.389 indicating "fair" strength of agreement between them. Standard error of kappa was 0.161 and 95% confidence interval was 0.073 to 0.704.

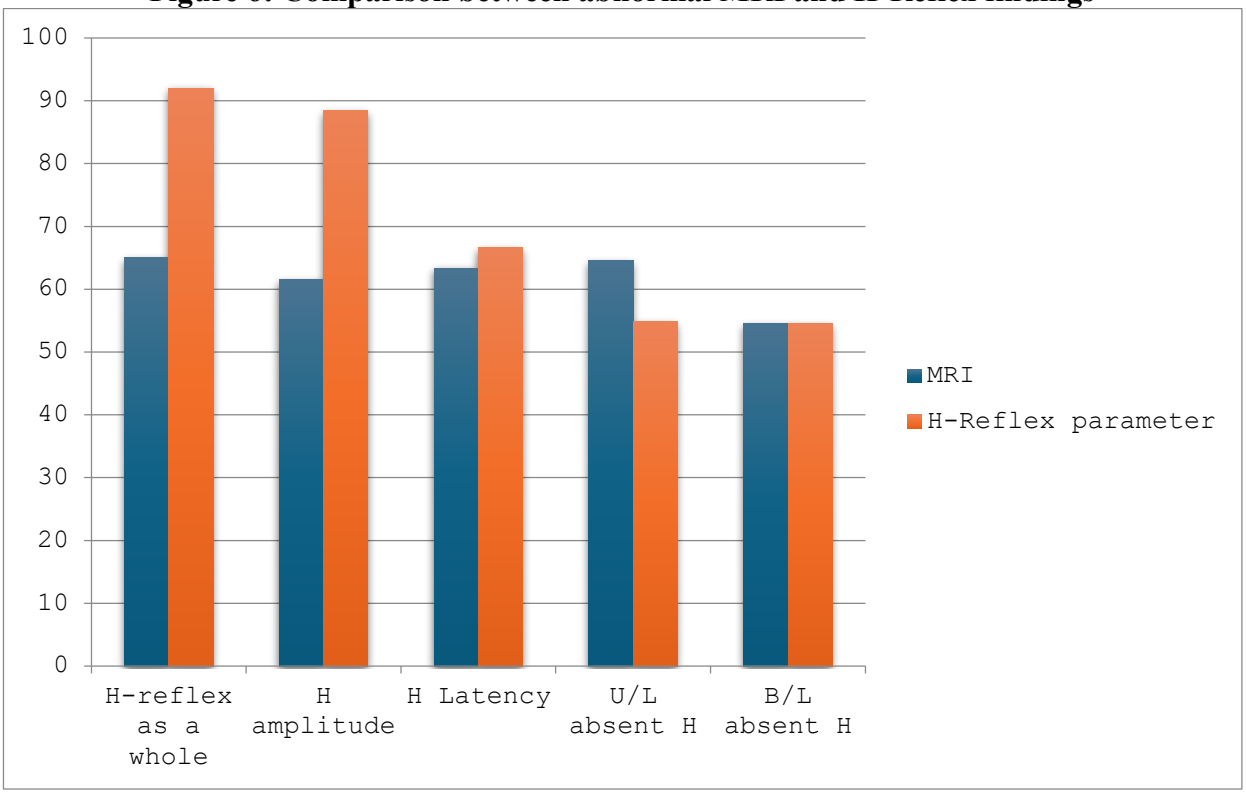
Table 8 : Proportional agreement between bilaterally absent H-reflex and MRI in the evaluated patients P=0.038, Kappa= 0.389

H-reflex	**Bilateral**	**Unilateral**	**Total**
MRI			
Normal	67% 10 67%	33% 5 28%	100% 15 45%
Abnormal	28% 5 33%	72% 13 72%	100% 18 55%

Total	45% 15 100%	55% 18 100%	100% 30 100%

So, finally if we compare the various H-reflex parameters with MRI the picture will be like following (figure 5)-

Figure 6: Comparison between abnormal MRI and H-Reflex findings



So, finally if we summarise the result it will be like following:

Table 9 : Summary of resuts

NCS parameters	% prevalence of abnormality	% prevalence of MRI abnormality in corresponding group	P value	Kappa coefficient
H-reflex as a whole	92	65	0.012	0.270
H amplitude	88	62	0.046	0.345
H latency	67	63	0.015	0.488
Unilaterally absent H	55	65	0.0004	0.668
Bilaterally absent H	55	55	0.038	0.389

From above table we can see that

- H-Reflex has the maximum percent prevalence (92%) followed by H amplitude (88%); even more than percent prevalence of abnormal MRI (65%).
- Regarding the correlation with MRI, unilaterally absent H reflex showed extremely statistically significant correlation (P=0.0004); followed by reduced peroneal amplitude (P=0.003).
- Apart from the above two; H reflex as a whole, H amplitude, H latency, bilaterally absent H reflex had statistically significant correlation with MRI (P<0.05).
- Regarding Kappa coefficient study the unilaterally absent H reflex showed “good” strength of agreement with MRI (Kappa=0.668)
- H reflex as a whole, Reduced H amplitude, bilaterally absent H showed “fair” strength of agreement with MRI.

 Prolonged H latency showed “moderate” strength of agreement with MRI.
 It is interesting to see that although unilaterally absent H and peroneal NCS had less percent prevalence than MRI; they had statistically significant correlation with MRI. Strength of agreement of these parameters was moderate to good.
 Another striking point to note was that 35% of patients who were clinically diagnosed cases of lumbosacral radiculopathy ; had normal MRI. But, 78% of this normal MRI group had abnormal H-reflex. On the contrary, only 8% of patients had normal H-reflex and none of them had normal MRI.

Discussion

In 1990, Sabbahi MA, Khalil M had performed a study where The H-reflex was recorded from the flexor carpi radialis, vastus medialis, and soleus muscles in patients with radiculopathy at C7, L4, and S1 roots. Reflex parameters were compared to normal standards and correlated with other electrophysiologic (eg, electromyography) and clinical evaluations, as well as magnetic resonance imaging scan reports. The H-reflex had significantly smaller peak-to-peak amplitude and longer latency. The stimulus threshold for eliciting the reflexes was substantially higher than normal standards. A strong correlation was recorded between the pathologic changes in reflex parameters and electrophysiologic and clinical findings of different segmental lesions. Magnetic resonance imaging reports showed moderate correlation with the Hreflex changes. A test of specificity showed that soleus and vastus medialis Hreflexes were 100% specific for lumbosacral segments; flexor carpi radialis was 90% specific for cervical spinal segments. These results indicate that flexor carpi radialis, vastus medialis, and soleus H-reflexes are useful and valid methods for testing C7, L4, and S1 radiculopathy. (8)

In previous works Mazzochio R, Scarfo GB, Cartolari R et al. studied with 26 patients with chronic low back pain of mechanical origin were examined the only abnormality detected was significant increase in Hreflex threshold with normal routine nerve conductions and other parameters of H-reflex study. (9) Ayse Lee Robinson and Aaron Taylor Lee had performed 70 patients with chronic low back pain. They showed precisely 27% of patients with lumbosacral radiculopathy had co-existent polyneuropathy of lower limbs. They also suggested that correlation of the abnormal lumbar MRI, clinical symptoms and signs, and findings from electrodiagnostic studies is ideal in the diagnosis of lumbar radiculopathy and polyneuropathy. (10)

Ghugare BW, Singh RK, Patond KR, Joshi MU had conducted a study to establish most common electrophysiological predictors of Lumbosacral Radiculopathy in MRI diagnosed L5S1 neural foramina compression subjects. Fifty subjects, with definite L5S1 neural foramina compression underwent electrophysiological evaluation and the data was analyzed using established electrodiagnostic criteria. Reduced H/M ratio in combination with absent H response was evident in 74 nerves. H-reflex study was abnormal in 88% subjects. Study concluded that, H/M ratio if used with other H-reflex study variables may be most common predictor of Lumbosacral Radiculopathy. (11)

In an article published in Neurol. Clinic 25 (2007) journal, Bryan Tsao showed that electrodiagnostic examination provides and important correlate to clinical diagnosis of lumbosacral radiculopathy . These electrodiagnostic examination can confirm the presence and severity of axon loss, localize which nerve root is affected and rule out other neuromuscular disorder that may be present . (12) In 2009 Balaji Ghugare, Piyali Das et. al. had performed a study on assessment of NCS in evaluation of radiculopthy among chronic low back pain patients. They observed that routine NCS showed no significant difference whereas all the H-reflex parameters including Hthreshold , H-amplitude , H-latency and H/M ratio were significantly different ($p< 0.0001$) , when compared with controls. They concluded that patients had not only partial conduction block but also secondary axonal loss due to nerve root compression. They further suggested that soleus H-reflex study should be included in evaluation of radiculopathy.(1) In 2013 Shahriar naffissi, Shahram Nikuam et. Al. of department of neurology of Tehran university had undertaken a crosssectional study with 97 patients with the clinical diagnosis of lumbosacral radiculopathy . Abnormal electrophysiological finding was recorded in 82%

of patients compared to 64% positive MRI findings. In patients with pretibial muscle weakness CMAP amplitude abnormality of common peroneal nerve was significant. (7)

Summary and Conclusion:

We have performed an observational cross-sectional study on 51 patients of clinically diagnosed lumbosacral radiculopathy. Our objective was to compare the electrophysiological study (H-reflex) and imaging study (MRI) of these patients. At the same time we tried to find out the diagnostic potential of different H reflex parameters for detection of L-S radiculopathy.

We can conclude from our present study-

Nerve conduction studies, specially H reflex with its individual parameters can be used as efficient diagnostic tool for lumbosacral radiculopathy. It is evidenced by high percent prevalence of abnormal results of the above parameters as well as significant correlation (by P value) and agreement (by Kappa coefficient) studies.

Among the individual H reflex parameters H amplitude and unilaterally absent H reflex were the best. Reduced H amplitude has the highest percent prevalence whereas unilaterally absent H reflex has most significant statistical association and "strongest" agreement with MRI abnormalities.

Another interesting outcome of our study was that, a normal MRI cannot rule out lumbosacral radiculopathy. Here, a significant proportion of patients with normal MRI showed abnormal H reflex. Clinical features were already noted in favour of radiculopathy. Thus, this group of patients were "false negative" in view of MRI. So, it can be suggested that before marking a patient to be not having radiculopathy solely on the basis of MRI one must undergo nerve conduction studies. Thus, NCS specially H reflex should be included in the diagnostic protocol of lumbosacral radiculopathy.

However, the study population was small and further studies with large sample size and multicentric design are required for confirmation.

Disclosure:

- It was a self-funded study
- There was no conflict of interest.

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