Correlation between lumbosacral radiculopathy and knee pain in patients with unilateral knee pain

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Abstract:

Background: Knee pain is a major disorder of all ages.There are different causes of such pain; one of them may have a neural origin. Lumbosacral radiculopathy occursdue to compression of a nerve root by surrounding structures. H-reflex is a good tool for assessing nerve root function .We aimed to know the relation between lumbosacral radiculopathy and pain in patients with unilateral knee painand the relationship between knee pain and changes of H- reflex.**Methods:**Twenty patients (male and female) suffered from unilateral non-traumatic knee pain; age ranged from 25 to 45years with body mass index less than 30kg\m^2 and knee pain persisted for 3 months or more with or without low back pain.Knee pain evaluated by the numerical pain rating scale and nerve root function assessed by electromyography (H-reflex).**Results:**the relation between lumbosacral radiculopathy and pain in patients with unilateral knee painwas 50% with decreasedamplitude of H-reflex at affected side relative to H-reflex amplitude at the non-affected side (H\H ratio)and 20% of them with an increased latency difference.There was a significant positive correlation between knee pain and H/H ratio (ρ = 0.37, p= 0.05), a non-significant negative correlation between knee pain and latency difference when p-value <.05. **Conclusion:** Therewas high relation between lumbosacral radiculopathy and pain in patients with unilateral knee pain .There was a significant correlation between knee pain and H/H ratio, a non-significant correlation between knee pain and latency difference.

Keywords:H-reflex,knee pain, lumbosacral radiculopathy.

Introduction

Knee pain isa major disorder of all ages instead of thisthe annual health care cost is in billions of dollars **[1]**.The exact underlying cause of knee pain is difficult to determine because of the extensive differential diagnosis **[2].** According to **(Dutton, 2014)[3],**the knee joint is one of the most commonly injured joints in the body. The types of knee injuries seen clinically could be generalized into the following categories:Unspecified sprains or strains, and other minor injuries, including overuse injuries, contusions,meniscal or ligamentous injuries. In the older population, it is claimed to be the result of degenerative osteoarthritis (OA) while in sports, it is probably due to injuries of some intra-articular structures **[1].**

These injuries might result in common symptoms in the knee include stiffness, aching pain, locking, swelling, limping and difficult fully straightening or bending the knee **[4]**. Damage, strain or sprain to the structures of the knee could give rise to these symptoms. Improper mechanics of patella and tibiofemoral joint in relation to other joints were significant. This pathomechanicslead to arthritic changes in the knee. (Musculoskeletal etiologies) **[2].**

In young adults when the degenerative disorders were not common and they suffered from this persistent pain could be for another cause might be explained by the cartilage is insensitive to pain with few noxious nerve fibres causing such pain. In addition to that cartilage was stimulated daily for so many years without pain provocation **[5].**

Most knee pain unrelated to structural impairment treated by non-operative treatment. After the exclusion of musculoskeletal etiologies, the pain persisted after a reasonable time frame of three to six months mostly confined for a neural origin. **[6]**.

This pain might results from direct damage to the cutaneous nerves of the knee, such as a neuroma of the infrapatellar branch of the saphenous nerve, or whether the pain is coming from an injury to one of the nerves arising within the knee joint structures themselves. A further source of knee pain due to nerve injury is an injury to a nerve far away from the knee, like the lateral femoral cutaneous nerve **[6].**

Badghish et al.,(2015b)[5] added another cause for such pain that resulted from a neural origin as the nerve root dysfunction might be the cause for such pain and testing nerve root function/dysfunction could reveal such proposition through using electrodiagnostic measures(such as H- reflex).

Lumbosacral radiculopathy (LSR) is one of the most common disorders of the spine which comprises 62% to 90% of all radiculopathies **[7]**. Itis caused by compression of nerve roots from pathology in the intervertebral disc or associated structures **[8]**. Patients with radiculopathy and stenosis usually present with low back pain and unilateral more than bilateral leg pains, numbness, and weakness. Physical examination most commonly reveals reduced lumbar range of motion, lumbar paraspinal muscle spasm and lower extremity muscle weakness, sensory loss, and reflex changes associated with L4, L5 or S1 radicular pattern**[9].**

Our correlation based on Hilton's law whichis one of most powerful springboards for understanding articular anatomy and pathophysiology illustrate that any nerve supplying muscles that act across a joint must also supply sensory fibres to that joint**[10]**. For example; the sciatic nerve (L5 & S1) supplying the hamstrings also sent sensory branches posteriorly to the knee. So any healthy nerve if touched it would cause pain, numbness or sensory symptoms distal to the stimulation site**[1].**

Electrodiagnosis has an important role in diagnosing lumbosacral radiculopathy secondary to spinal nerve involvement for making an accurate diagnosis, proper treatment plan and a good evaluation of the prognosis **[11].**H-reflex considered as of the most reliable tests for differential diagnosis as the amplitude of H-reflex in the soleus-gastrocnemius complex is a diagnostic criterion with high specificity for patients with lumbosacral radiculopathy**[12].**

The H-reflex considered the electrical equivalent of the monosynaptic phasic myotatic (deep tendon reflex) which involves a stimulus moving through sensory fibres (afferent) then the response would travel in motor fibres (efferent). Afferent and efferent synapsed at alpha motor neuron (MN) and efferent part of reflex generated at alpha MN which travelled through motor fibres till neuromuscular junction and produce twitch response in EMG unit **[13].**

H-reflex has two parameters, amplitude and latency. The amplitude is used to monitor spinal activity and integrity of nerve roots (sensory and motor) along the reflex arc. The normal value for the H-reflex amplitude ranges from 2 to 12 Mv. The latency of reflex usually assessed sensory and motor conductivity. The normal latency value in healthy adults ranges from 25-32 milliseconds **[13].**

H-reflex amplitude is a great indicator for electrophysiological changes that occurred earlier in nerve root involvement while increased or prolonged latency reported in chronic and long-standing cases of lumbar radiculopathy **[14].**

The recommended H-reflex diagnostic criteria are prolonged latency on the affected side **[15]**, side-to-side latency differences, and H-reflex amplitude reduction on the affected side **[16].**H-reflex latency prolongation or side-to-side differences in patients with radiculopathy probably indicate neural demyelination with significant damage of large diameter nerve axons **[17].** Absent or reduced amplitude on the affected side is probably indicative of nerve conduction block in absence of extensive demyelination **[18]**.

Previous researches finds that an H/H ratio smaller than 0.67, in the absence of latency differences, indicates S1 neural involvement **[14].** It reduced to 0.5 when the latency difference more than 1ms as reported by **[16]** or latency difference between both limbs is more than 1msalso diagnostic for LSR **[19]**.

H-reflex is affected by changes in stresses on the spine when measured in lying, standing, loading and unloading.H-reflex amplitude is inhibited during standing, loading and unloading when compared by prone lying position. There is no significant change in reflex latency when compared in four conditions. From observation, it finds that both lower extremities had a similar pattern of change in H-reflex **[17].**

The inhibition of H-reflex amplitude is probably due to the relative increase in vertical compressive forces on the lumbosacral spine and roots during standing which such mechanical compressions were distributed equally on both sides of the vertebral spine, the H-reflex suppression should presumably be comparable in both lower extremities **[17].**

The flexor carpi radialis, vastus medialis and soleus H-reflexes are proven to be useful, valid **[16],** reliable **[20]** and sensitive **[21]** methods for testing neurophysiological changes in C7, L4 andS1 roots respectively. A test of specificity showed that soleus and vastus medialis H-reflexes were 100% specific for lumbosacral segments **[20]**.Abnormal soleus H-reflex showsa good correlation with S1 sensory impairment and equally useful in acute or chronic S1 radiculopathy **[22]**

The percentage of patients with a primary complaint of knee pain, which classified as Spinal Derangements, had no complaint of low back pain (LBP) was unknown**[23].**So we aimed to identify patients with knee pain caused by nerve root dysfunction using soleus H- reflex.

Material and methods

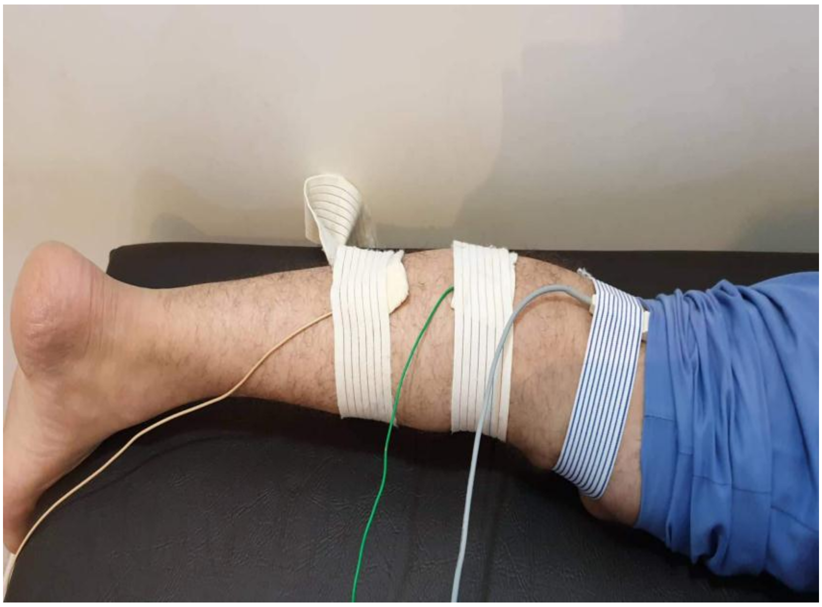
Study design: a cross-sectional study was conducted at the outpatient orthopaedic clinic, Faculty of Physical Therapy, Cairo University for 10 months from February 2018 till December 2018.Once patients agreed to participate in this work, informed consent was provided and signed prior to participation

Participants:Twenty patients (male and female) suffered from unilateral non-traumatic knee pain, age ranged from 25 to 45years (means=29.7, SD=±5.3), BMI kg\m^2 (mean=24.0400, SD=±2.87995).Knee pain persisted for 3 months or more included in the study.Patients with a history of surgical intervention for the spine or knee, patients with knee pain following trauma, including a fracture or ligament injury, and patients with an infection of the knee or spine were not considered eligible.

Measurement procedure:The History included personal data, medical history, and present history was collected. Weight and height of patients collected for measuring the body mass index(BMI).Evaluation of knee pain through the numerical pain rating scale(NPRS).Patients asked to circle the number which represented the level of pain between 0 and 10 that fits best to their pain intensity. Zero usually represents ‘no pain at all’ whereas the upper limit (10) represented the worst pain ever possible.

EMG unit(neuro soft MEP Micro version 2009) set at a gain of 1000× to 5000× (1-5 mv./div.) and filter bandpass of 10 Hz- 10 kHz elicited soleus H-reflex by a percutaneous electrical stimulus of 1 ms square-wave pulses were delivered at frequency of 0.2 pps to the tibial nerve to elicit the maximum H-reflex. Five repetitive H-maximum traces were recorded in the affected side then non affected one to calculate H\H ratio and latency difference of H-reflex.

The silver-silver chloride surface stimulating bar electrode was applied longitudinally on the tibial nerve in the popliteal fossa midline with the cathode proximal to the anode to avoid the anodal block**.**



The recording bar electrode was placed longitudinally over the soleus, with the active electrode 3 cm distal to the bifurcation of the gastrocnemius and on a line with the Achilles tendon and the reference electrode 2 cm distally. As a ground, a metal electrode 2 cm in diameter was applied between the stimulating and the recording electrodes on the skin of the calf.

H-reflex stimulating and recording:The skin was prepared for stimulation and recording and cleaned with alcohol. Electrodes with conductive gel were then applied to the appropriate locations and secured in placed with adhesive tape and straps for the duration of the recording session.After placement of electrodes, each participant's Soleus reflex recruitment curves were recorded during prone lying and standing postures fig(1, 2).

In the prone lying position, the participant was asked to lie in a prone position while maintaining the ankle in a neutral (90 degrees of the foot to shank angle)**.**In the standing position, each participant was asked to stand upright relaxed (ankle in the neutral position, 90 degrees of the foot to shank angle).

Fig.(1): Recording H-reflex in unloading position

Data analysis: Descriptive statistics, including means and standard deviations for age, height, weight, side-to-side H/H ratios, and side-to-side latency differences of all participants were calculated.Prevalence of lumbosacral radiculopathy in patients with unilateral knee pain was measured. The Spearman's correlation coefficient would be used to detect the relation between knee pain and H\H Ratio of H-reflex andthe relation between knee pain and the latency difference of H-reflex. All statistical analyses were done with SPSS 21.0 for Windows (IBM incorporation, IL, USA) with the p-value level set at 0.05.

Results

Demographic data:

The study included 20 knee pain patients with means and standard deviations of their ages, heights, weights and BMI were 29.7(5.3) years, 171.6(7.86) cm, 71.35(10.64) kg, and 24(2.88) kg/cm^2, as shown in the table (1).

Table (1): Descriptive Statistics

	N	Mean	Std. Deviation
Pain	20	4.6500	.81273
Age (years)	20	29.7000	5.32225
Height (cm)	20	171.6000	7.85661
Weight (kg)	20	71.3500	10.63893
BMI (kg/ cm2)	20	24.0400	2.87995

Prevalence of lumbosacral radiculopathy in patients with unilateral knee pain:

Prevalence of lumbosacral radiculopathy in patients with unilateral knee pain was 70% with 95% confidence that the prevalence of lumbosacral radiculopathy or abnormal H/H ratio lies between 48.6% and 91.4%. In addition to that, 50% (or 71.4% of total patients in nerve root dysfunction class) of knee pain patients had decreased H\H ratio and 20% (or 28.6% of total patients in nerve root dysfunction class) of them had increased latency difference, as shown in table (2), and fig. (3, 4).

Table (2): Prevalence of lumbosacral radiculopathy among unilateral knee pain patients

Class	Frequency	Percentage

Nerve root dysfunction	decreased H/H ratio	10	50%
	Increased Latency difference	4	20%
	total	14	70%
Normal nerve root function	6		30%
Total	20		100%
prevalence of lumbosacral radiculopathy in unilateral knee pain patients was 70%			
A confidence interval of 95%	Lies between 48.6% and 91.4%		

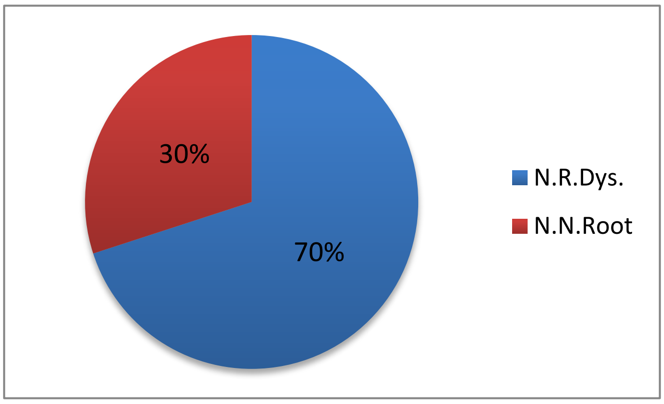


Fig (3): Pie chart prevalence (in percentage) of lumbar radiculopathy among unilateral knee pain patients ((N.N.R: normal nerve root= 30%), (N.R.Dys.: nerve root dysfunction= 70%) of total sample =20)

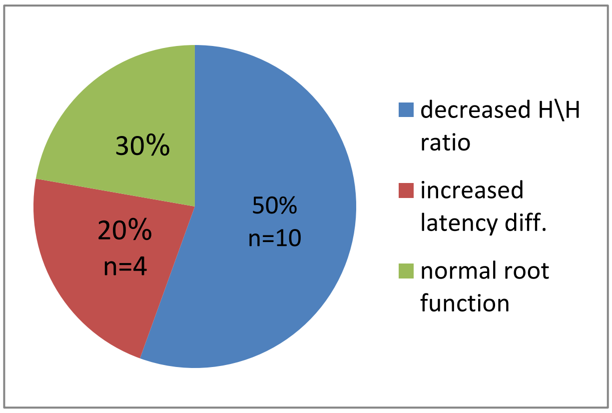


Fig (4): Pie chart showing Prevalence of decreased H\H ratio, increased latency difference of H-reflex among unilateral knee pain patients with lumbar radiculopathy n = 14)

Correlation between the Knee pain and H/H ratio:

As presented at the table (3) the correlations between Knee pain and H/H ratio (mean=.7212, SD =±.45354) was studied through the Spearman product moment correlation coefficient. It revealed that there was a significant positive correlation between knee pain and H/H ratio (ρ = 0.37, p= 0.05), as shown in figure (5).

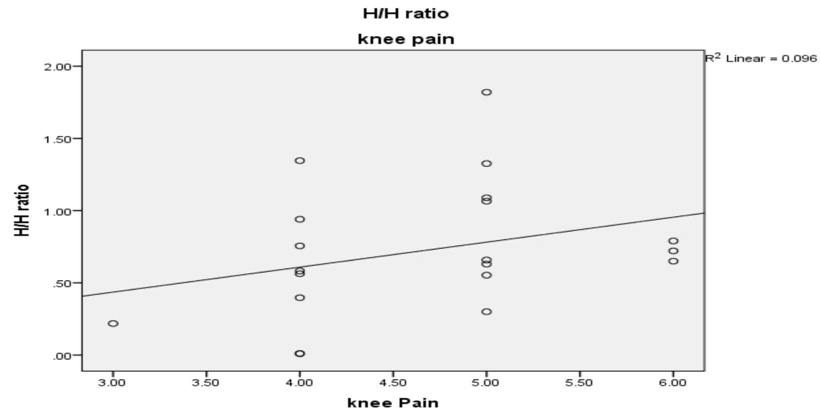


Fig. (5): Scatter plot of correlation between the knee pain and H/H ratio

Correlation between the Knee pain and Latency difference

As presented at the table (5) the correlations between Knee pain and latency difference (mean=2.25, SD=± 0.5) was studied through the Spearman product moment correlation coefficient. It revealed that there was a non-significant negative correlation between knee pain and latency difference (ρ = - 0.54, p= 0.23), as shown in figure (6)).

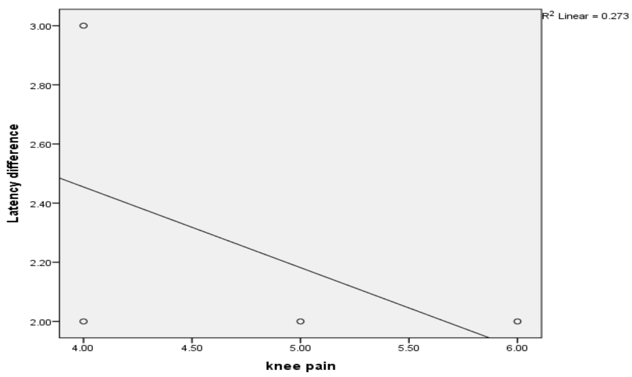


Fig. (6): Scatter plot showing the correlation between knee pain and latency difference

Discussion:

Our study investigated prevalence of lumbosacral radiculopathy in patients with unilateral knee pain and the relationship between knee pain and changes of H-reflex. The patient who complained of non-traumatic unilateral knee pain for more than 3 months included in our study. NPRS used to evaluate the intensity of their pain and EMG unit used to measure the soleus H-reflex which reflected if there was nerve root dysfunction or not.

Our findings were a high prevalence of lumbosacral radiculopathy among patients with unilateral knee pain, there was a significant positive correlation between knee pain and H\H ratio and a non-significant negative correlation between knee pain and latency difference so Knee pain might originate from the lumbar spine even in patients with no lower back pain.

(Hashimoto et.al, 2018)[23] Concluded that 44.6% of 101 patients with primary complaints of non-acute knee pain were classified with the concluding mechanical diagnosis and therapy (MDT) classification of Spinal Derangement. Further, the percentage of Spinal Derangements was greater in individuals with LBP than those without LBP and in individuals with negligible pathologic findings on knee imaging than those with apparent pathologic findings on images.

Four sessions were required to obtain a concluding MDT classification in more than 80% of patients with non-acute knee pain and only the MDT concluding classification was a useful predictor of the reduction of knee pain at the 1- month follow-up **[23]**.

In a study for **Badghish et al.,(2015a)[1],** they showed that a decreased H-reflex was recorded on the ipsilateral side of the knee pain. They found increased reflex asymmetry especially in loading position more than unloading one. So this was a strong correlation between knee pain and changes of H-reflex.

There were two case studies applied to show the relation between knee pain and lumbosacral radiculopathy using H-reflex. The first one revealed that after 12 sessions of back treatment, there was a significant decrease in knee pain from 8 to 3 on the visual analogue scale but no significant increase in H-amplitude **[5].**

The second case study which supports our study concluded that knee pain was significantly improved which disappeared after 12 sessions of back treatment but there was no information about changes in H- reflex as it was not measured after the end of treatment**[5]**

The potential cause of knee pain with spinal origin was unclear but the following possibilities might explain it. According to **(Hashimoto et al., 2018)[23],** the altered mechanical loading to the knee due to changing the dynamic alignment of the lumbar spine through repeated mechanical loading. So the mechanical loading in the direction preferred rapidly results in symptomatic and functional improvements in the Derangement Syndrome**.**

The pain of derangement was often constant and remained constant until the displaced tissue was reduced. Repeated movements that increased the displacement also increased the obstruction that in turn increased the pain. Repeated movements that progressively reduced the pain also progressively reduced the obstruction and derangement and allowed the restoration of normal pain-free movement**[24]**

Another explanation suggested for the H- reflex changes through the hypoalgesic effect of applying mechanical loading to the spine on knee pain**[23]**. According to a systematic review demonstrated hyperalgesia in people with knee osteoarthritis [**25]** and discussed the hypoalgesic effect of spinal mobilization **[26]**

(Badghish et al., 2015b)[5]Suggested the cause of changes was lumbosacral nerve root impingement and pain might be explained by Hilton law which showed that any nerve passed on a joint give it sensory innervation.

In contrast to the study of **(Badghish et al., 2015b)[5]** which included wide range of ages of patient (23-89yrs) that characterized by different physiological state so we chose to have a close age group (25-45yrs) to have similar physiological state as we tried to create a homogenous group with similar state and characteristics.

To confirm the homogeneity principle, one of our inclusion criteria was investigating patients with unilateral knee pain only not unilateral or bilateral knee pain such in **(Badghish et al., 2015b)[5]** to be sure that pain came from unilateral lesion, not due to systematic disease and to have a reference point to measure the difference between affected and non-affected side.

Our study included patients with knee pain last for 3 months to exclude any acute or subacute pain caused by inflammatory process due to degenerative changes or for any other cause but **(Badghish et al., 2015b)[5]**chose to include patients with symptoms start from 2 weeks till 20 years and **(Hashimoto et al., 2018)[23]** took patients complained from pain for more than 1 month which might increase the possibilities of knee pain.

We excluded patients with high body mass index (BMI) as there was a strong relationship between obesity and chronic pain as presented in a review for **(Okifuji & Hare, 2015)[27]** as they mentioned that there were several potential mechanisms that might link the two phenomena, including mechanical/structural factors, chemical mediators, depression, sleep and lifestyle.

In the same line with**(Badghish et al., 2015b)[5]**but in a different way of methodology of **(Hashimoto et al., 2018)[23]** that depending on MDT which needed a therapist well trained to be able to confirm diagnosis and it required 4 sessions to achieve a final diagnosis . We used an assessment tool highly reliable and specific. H-reflex was one of the most used tools to investigate lumbosacral nerve root functions and the chance for knowing if the pain has a spinal origin or not was available **[13].**

Conclusion:

There was high relation between lumbosacral radiculopathy and pain in patients with unilateral knee pain .There was a significant correlation between knee pain and H/H ratio, a non-significant correlation between knee pain and latency difference.Our present study revealed the importance of careful screening assessments of the lumbar spine in patients with a primary complaint of knee pain.

Recommendations:

The following suggested recommendations are for further researches:

1. A similar study should be conducted on large sample to provide a wide representation of the data

2. A randomized control trial must be conducted to confirm our results that the knee pain might originate from lumbar spine.
3. Investigating the effect of different back treatment interventions on knee pain patients.

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