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Ultrasound of Sciatic Nerve Problems Compared to MRI

Feid T. Malghooth, Hamada M. Khater and Mohamed A. Tawfik
Department of Radiodiagnosis, Faculty of Medicine, Benha University
E-mail: faid1993tariq@gmail.com

Abstract

Background: Sciatic nerve injuries and diseases may cause severe pain and disability. Management and therapy of these disorders need accurate diagnosis and assessment. Magnetic resonance imaging (MRI) can provide important information about the cause of sciatic nerve problem whether herniated or degenerative disc or other conditions, and it can determine the best course of treatment whether surgery of physical therapy or other non-surgical treatment. This study aimed to compare ultrasound and MRI sciatic nerve diagnosis accuracy and reliability. Methods: This cross-sectional research comprised 45 sciatic nerve-symptomatic individuals. All patients received extensive history gathering, physical examination, clinical assessment using visual analogue scale and Oswestry disability index to assess pain severity and functional impairment, ultrasonography, and MRI.. Results: There was statistically significant difference between ultrasound findings and MRI findings on sciatic nerve tumour, neurofibromas, piriformis syndrome, and injection injury (p=0.001–0.004). Overall sciatic nerve issues were more common in MRI (42 patients, 93.33%) than ultrasound (37 patients, 82.22%), p=0.03). Conclusion: MRI indicated a greater prevalence of sciatic nerve issues than ultrasound, and US and MRI differed in diagnosis.

Keywords: Ultrasound; Sciatic Nerve; Problems; MRI.

Introduction

Sciatic nerve injuries and diseases may cause severe pain and disability. Management and therapy of these disorders need accurate diagnosis and assessment (1). Recently, ultrasonographic testing has become a promising sciatic nerve injury diagnostic tool, having various benefits over standard imaging (2, 3).

Ultrasound has several advantages for sciatic nerve assessment (4). Ultrasound is a non-invasive, radiation-free imaging modality that may be conducted at the point of treatment, making it accessible to more healthcare professionals and eliminating patient transportation to specialised imaging centres (5, 6).

Ultrasound also allows real-time sciatic nerve evaluation during different motions and functional activities, which may help identify nerve compression, entrapment, or impingement. Visualising the sciatic nerve in multiple planes and obtaining high-resolution pictures allows for extensive evaluation of nerve anatomy, surrounding tissues, and anomalies (3, 7).

MRIs may diagnose sciatic nerve problems including herniated or degenerative discs and decide the appropriate treatment, such as surgery, physical therapy, or other non-surgical methods (8).

This research examined the diagnostic accuracy and reliability of ultrasonography and MRI for sciatic nerve disorders.

Patients and methods

This cross-sectional research comprised 45 sciatic nerve-symptomatic individuals, at the Radiology Department, Benha University Hospitals, and other Iraqi centres.

Patients gave informed permission in writing. Every patient got a study purpose explanation and a secret code number. The Benha University Faculty of Medicine Research Ethics Committee authorised the project.

Inclusion criteria were adult patients (18 years and older) with lower extremity pain, numbness, tingling, or weakness suggesting sciatic nerve problems, those with a clinical suspicion of injuries or entrapment based on history, physical examination, or initial diagnostic evaluation, and those who gave informed consent to participate in the study.

Exclusion criteria were paediatric patients (under 18 years old) due to differences in anatomy and clinical presentation, ultrasound contraindications, pregnancy or breastfeeding, MRI contraindications, previous surgical intervention or trauma, and lower extremity neurological or systemic diseases.

All studied cases were subjected to the following: **Detailed history taking, including [**Demographic data (age, sex, BMI), medical history, allergies, and family history of sciatic nerve problems, physical examination was performed by the primary investigator to assess the patient's symptoms, medical history, and relevant clinical findings]. **Clinical evaluation:** Pain intensity and functional impairment were assessed using patient-reported outcome measures such the VAS and ODI.

VAS images require respondents to self-evaluate their pain on a 10cm-long horizontal line with pain legends, with values ranging from 0 (no pain) to 10 (the greatest pain) (9).

ODI comprises eleven measures to evaluate how much back (or leg) pain affects everyday living. Ten parts cover pain and everyday life. The 6-point scale

(0-5) rates each item; a higher score implies more LBP disability (10).

Ultrasonographic examination:

A commercial ultrasound machine and high-frequency linear array transducer (7-12 MHz) were used for ultrasounds. Supine or lateral decubitus positions were chosen depending on comfort and examination area. We put a sterile gel or coupling agent to the skin over the sciatic nerve to improve acoustic coupling and picture quality. To get the best pictures, the ultrasound transducer was positioned perpendicular or parallel to the sciatic nerve and gently pressed. From hip to posterior thigh to popliteal fossa, longitudinal and transverse scanning planes visualised the sciatic nerve. Real-time imaging assessed sciatic nerve dynamics during limb movement or provocative manoeuvres.

MRI:

Participants had 1.5-tesla MRIs. The MRI procedure includes T1-weighted, T2-weighted, short tau inversion recovery, and any other required sequences. Participants were supine and the sciatic nerve was scanned from lumbosacral to ankle.

Image acquisition and analysis:

The lead investigator examined the photos. Ultrasound characteristics such sciatic nerve diameter, cross-sectional area, echogenicity, vascularity, anomalies, and compressive lesions were recorded. The sciatic nerve was measured and compared to reference values or the contralateral side. Ultrasound and MRI were reviewed for sciatic nerve diagnosis and evaluation based on their diagnostic accuracy, reliability, agreement, and clinical importance.

Outcome measures:

The primary outcome measure was ultrasound and MRI sciatic nerve diagnosis accuracy. To assess if a positive or negative ultrasound result properly indicated a sciatic nerve damage, positive and negative predictive values were determined. **The secondary outcomes** included assessment of nerve morphology and pathology, and patient-reported outcomes.

Statistical analysis

SPSS v26 (IBM Inc., Armonk, NY, USA) performed statistical analysis. Mean and SD were used to compare quantitative variables between groups using unpaired Student's t-test. Qualitative variables were given as frequency and percentage (%) and analysed using Chi-square or Fisher's exact tests. A two-tailed P value < 0.05 was deemed significant.

Cases

Case (1):

A 10-year-old kid with leukaemia had a left gluteal injection, significant discomfort, and progressive muscular weakening in the left thigh and foot. Electrophysiological investigations demonstrated a positive ipsilateral straight leg raise, while MRI of the pelvis showed subcutaneous and left gluteal muscle collections and bone marrow leukaemia infiltration in the left iliac crest. The left sciatic nerve has somewhat thinner perineural oedema on MRN than the right nerve. **Figure 1.**

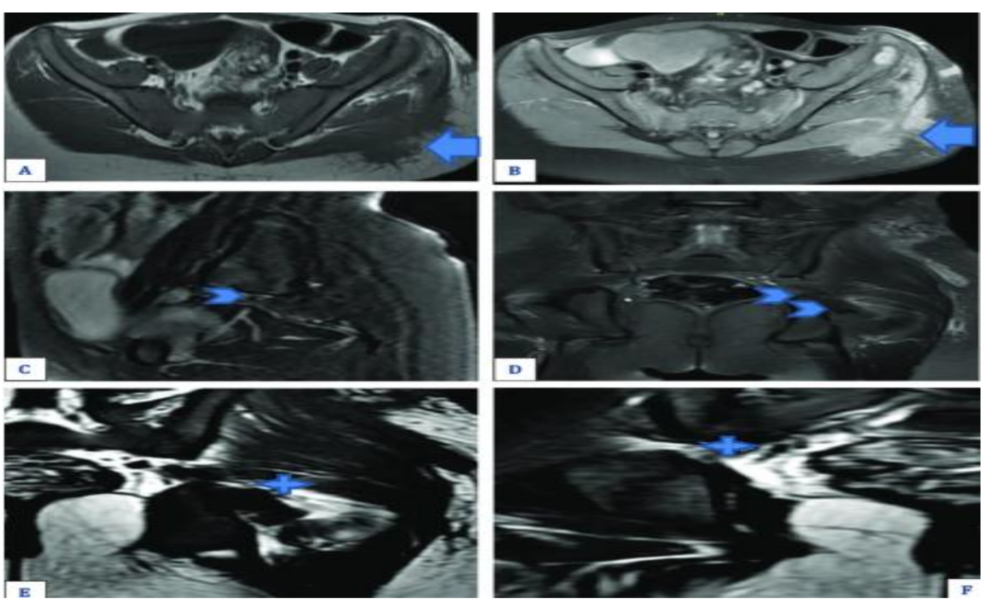

Fig. (1) MRI of the pelvis showed area of subcutaneous and left gluteal muscles collections associated with a focus of bone marrow leukemic infiltration in the left iliac crest (arrows in A and B). MRN shows a perineural edema related to the left sciatic nerve with mildly reduced thickness (open arrow in C and D), compared with the normal right-sided nerve (Arrow in E and F)

Case (2):
Figure 2 illustrates sciatic nerve bifurcation and piriformis muscle passage. The sciatic nerve bifurcates via the piriformis muscle and beneath
in the posterior hip in the ultrasound pictures following of the same patient.

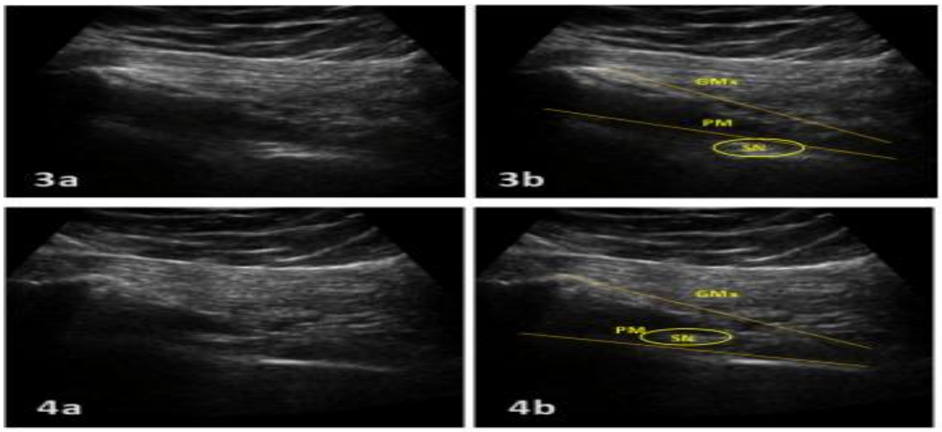

Fig. (2) Figures 3a and 3b: Sciatic Nerve Passing Under Piriformis Muscle Figures 4a and 4b: Sciatic Nerve Passing Through Piriformis Muscle The above ultrasound images are of the same patient and reveal the sciatic nerve bifurcation, passing through the piriformis muscle and underneath in the posterior hip region. Figures 3a and 3b show the sciatic nerve passing under the piriformis muscle as highlighted. Figures 4a and 4b show the same muscle with a better view of the sciatic nerve passing through the piriformis muscle. From top to bottom, it displays subcutaneous fat tissue, the gluteus maximus muscle, and the piriformis muscle situated between the greater trochanter and sacroiliac bone. Labels indicate GMx for gluteus maximus muscle, PM for piriformis muscle, and SN for sciatic nerve.

Results
Males predominated with 25 (55.56%) and females 20 (44.44%). Ages varied from 25 to 65, with a mean± SD of 45.47±10.46. Patients aged
<30 years (11.11%), 30-<40 years (26.67%), 40-50 years (40.0%), and ≥50 years (22.22%) were identified.. **Table 1**

Table (1) Sex and age distribution among study group.

		No.	%
Sex	**Female**	20	44.44%
	Male	25	55.56 %
Age (years)	**<30 years**	5	11.11 %
	30-<40 years	12	26.67 %
	40-<50 years	18	40.0 %
	≥50 years	10	22.22%
Total		45	100.0%

Muscle weakness was reported by 66.67% of patients, numbness and tingling by 62.22%, sensory manifestations by 60%, back discomfort by 40.0%, foot drop by 28.89%, and urine and stool incontinence by 24.44%. Regarding lesion causes Lumbar spondylosis was 20.0%, nerve root impingement 15.56%, increased sciatic nerve
calibre 6.67%, muscular atrophy 13.33%, bone lesions (mets and tumours) 11.11%, vertebral bone fracture 13.33%, pelvic bone fracture 11.11%, decrease nerve calibre 6.67%, and congenital bone defect (spina bifda) 2.22%. **Tabl**

Table 2: Distribution of the studied cases according to complaints & etiology of lesions (n=45)

	No.	%
Complaints		
Muscle weakness	30	66.67%
Numbness and tingling	28	62.22%
Sensory manifestations	27	60.0%
Back pain	18	40.0%
Foot drop	13	28.89%
Urinary and bowel incontinence	11	24.44%
According to etiology of lesions		
Lumbar spondylosis	9	20.0%
Nerve root impingement	7	15.56%
Muscular atrophy	6	13.33%
Bone lesions (mets and tumors)	5	11.11%
Vertebral bone fracture	6	13.33%
Pelvic bone fracture	5	11.11%
Increased sciatic nerve caliber	3	6.67%
Decreased sciatic nerve caliber	3	6.67%
Congenital bone defect (spina bifda)	1	2.22%

There was statistically significant difference between ultrasound findings and MRI findings regarding sciatic nerve tumor (p=0.001), neurofibromas (p=0.007), piriformis syndrome (p=0.002), sciatic nerve injection injury (p=0.004). **Table 3**

Table (3) Comparison between Ultrasound findings and MRI findings regarding different sciatic nerve problems

	Ultrasound findings (n=37)		**MRI findings (n=42)**		**X²**	**p-value**
	No.	**%**	**No.**	**%**		
Traumatic neuroma	4	10.81%	5	11.90%	0.603	0.438
Sciatic nerve tumor	1	2.70%	3	7.14%	3.510	**0.001**
Sciatic nerve schwannoma	1	2.70%	2	4.76%	2.277	0.517
Neurofibromas	5	13.51%	5	11.90%	7.163	**0.007**
Peripheral neuropathies	6	16.21%	7	16.66%	1.502	0.144
Sciatica	7	18.91%	8	19.04%	1.574	0.127
Piriformis syndrome	5	13.51%	4	9.52%	9.231	**0.002**
Sciatic nerve stiffness	5	13.51%	6	14.28%	0.603	0.438
Sciatic nerve injection injury	3	8.10%	2	4.76%	5.709	**0.004**

Chi-square test

Table 4 shows higher statistically significant frequency of overall sciatic nerve problems in MRI was 42 patients (93.33%) comparing to
Ultrasound was 37 patients (82.22%), with p-value (p=0.0

Table (4) Comparison between Ultrasound findings and MRI findings according to overall sciatic nerve problems

Overall eye problems	Ultrasound findings (n=45)		MRI findings (n=45)		Test value	p-value
	No.	%	No.	%		
Normal	8	17.78%	3	6.67%	13.47	**0.03**
Abnormal	37	82.22%	42	93.33%		

Using: x2: Chi-square test for Number (%) or Fisher's exact test, when appropriate, **p-value <0.05 is highly significant.

Discussion

Current research group demographics showed male preponderance (55.56%).

According to Abd El-Azeem et al. (11), the study population was 60% male. Hashem et al. (12) in Saudi Arabia reported 60% females, but our sample was different.

For the present research, the average age of patients was 45.47±10.46, with 40% aged 40-<50.

Our findings align with Bilgici et al. (13), indicating a mean patient age of 40.2 ± 19.54 years. Our findings contradicted Cook et al. (14) meta-analysis, which found that 18–25-year-olds were the most common (41.4%). Growing older was risky.

Muscle weakness, numbness and tingling, sensory symptoms, back discomfort, foot drop, and urine and bowel incontinence dominated the research (66.67%; 62.22%; 60%; 40.0%; 28.89%; 24.44%).

Cherian and Li (15) found that sensory symptoms (paraesthesia or pain) and motor weakness are the most prevalent complaints upon presentation.

These findings contradicted Topuz et al. (16), who found that intramuscular injection-induced sciatic nerve damage most typically presented with discomfort, which often concealed function loss.

Lumbar spondylosis, nerve root impingement, increased sciatic nerve calibre, muscular atrophy, bone lesions (mets and tumours), vertebral bone fracture, pelvic bone fracture, decrease nerve calibre, and congenital bone defect (spina bifda) were the main causes of lesions in this study.

Our findings coincided with Chhabra et al. (17), who found idiopathic (65%), iatrogenic (24%), and trauma (12%) sciatic neuropathy. In another research by Kline et al. (1998), thigh-level sciatic damage was generally caused by a gunshot wound, femur fracture, laceration, or contusion.

In the current study, ultrasound findings included traumatic neuroma, sciatic nerve tumour, schwannoma, neurofibromas, peripheral neuropathies, sciatica, piriformis syndrome, sciatic nerve stiffness, and sciatic nerve injection injury (10.81%, 2.70%, 13.51%, 16.21%, 18.91%, 13.51%, and 8.10%).

Wang et al. (18) found that ultrasound could locate, range, and thicken the wounded sciatic nerve in rabbits, which was important for peripheral nerve crush injury healing and rehabilitation.

Traumatic neuroma, sciatic nerve tumour, schwannoma, neurofibromas, peripheral neuropathies, sciatica, piriformis syndrome, sciatic nerve stiffness, and injection injury were found on MRI.

Molinier et al. (19) revealed MRI findings suggesting a cause for newly detected sciatic nerve tumours. MRI is best for distinguishing benign from malignant peripheral nerve sheath tumours.

Ultrasound and MRI results vary significantly for sciatic nerve tumour, neurofibromas, piriformis syndrome, and sciatic nerve injection damage (p=0.001–0.002). Overall sciatic nerve issues were more common in MRI (93.33%) than ultrasound (82.22%) (p=0.03).

According to Bilgici et al. (13) research, 70% of sciatic nerve visualisation and identification were good/excellent, and 30% were poor. Sonographic study identified the injury site well in 70% of instances and poorly in 30%. In a crushed injury model, Ni et al. (20) found dynamic changes in rat sciatic nerves using high-frequency ultrasound.

Ultrasound helped Wu et al. (21) diagnose a sciatic nerve schwannoma and remove it surgically by discriminating between several sources of posterior thigh discomfort. Ultrasound is portable, accessible, and allows dynamic inspection, unlike MRI. They examined ultrasound's ability to diagnose piriformis syndrome. Ultrasound had tremendous diagnostic power.

PS patients had similar muscle changes on ultrasound and MRI. (US) may be a reliable and convenient PS diagnosis method, according to Zhang et al. (22).

Abadir et al. (23) found sciatic nerve damage in all cases using US.

Conclusion

MRI indicated a greater prevalence of sciatic nerve issues than ultrasound, and US and MRI differed in diagnosis.

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Author contribution

Authors contributed equally to the study**.**

Conflicts of interest

No conflicts of interest

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