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Neuroradiological value of high resolution magnetic resonance neurography (MRN) in the diagnosis of sciatic neuropathy presumably related to COVID-19

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***Abstract*---**Background: In the context of sciatic neuropathy, there have been many etiologies and the need for differentiating between the possible underlying causes is an important matter for early diagnosis and management. COVID-19 has been associated with many peripheral neuropathies and sciatic neuropathy could be potentially a complication. Although, very rare with limited cases published in the literature to date. Methods: We investigated the role of MR neurography in evaluating sciatic neuropathy presumably post-COVID-19 infection in one of our cases after exclusion of other possible causes of sciatic neuropathy using STIR MR neurography. Results: Our STIR MR neurography demonstrated increased signal and size of the left sciatic nerve with 2ry muscular edema in the biceps femoris muscle in keeping radiologically with sciatic neuropathy. Conclusion: MR neurography has proven to be valuable in narrowing the differential diagnosis of the reported imaging findings and showed a very good correlation to the NCVs, laboratory investigations, and sural nerve biopsy. Although a very rare

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complication, COVID-19 could be a potential direct cause of sciatic neuropathy.

***Keywords*---**COVID-19, Sciatic neuropathy, Magnetic resonance neurography.

Introduction

Recently, there have been evolving clinical entities per the spread of the global Coronavirus disease 2019 (COVID-19) pandemic worldwide including ischemic strokes, encephalitis, and peripheral neuropathies. Although the main worldwide urge is still finding treatment and manipulating the vaccines to counterpart the ongoing virus mutations, the growing risk of these associated neurological complications remains alarming harm to our patients' health [1, 2]. However, peripheral neuropathies associated with COVID-19 infection are still understood with very limited published statistical data mainly on sciatic neuropathies. Yet, few cases were described recently as sequelae of COVID-19 post-hospitalization [3]. Sciatic neuropathy is one of the most common lower limb neuropathies with most of the patients presenting with foot drops [4]. Many etiologies have been encountered in the context of sciatic neuropathy including lumbosacral root compression, piriformis syndrome, neoplastic, and infective causes. Therefore, an early accurate diagnosis of sciatic neuropathy has been mandatory to avoid associated co-morbidities [5]. Clinical and neurophysiological examination mainly nerve conduction velocity (NCV) has been the gold standard for the diagnosis of sciatic neuropathy. However, some NCV limitations were reported in terms of difficulty in accurate lesion localization and physical discomfort to the patients [6]. Magnetic resonance imaging (MRI) as a non-invasive diagnostic modality has been increasingly used for the assessment of patients with suspected sciatic neuropathy [7-12]. Magnetic resonance neurography (also called MRN or MR neurography) refers to MR imaging dedicated to the peripheral nerves especially. It is a term that encompasses radiological sequences that enable better visualization of the peripheral nerve fascicles through the applications of fat-suppression techniques to achieve excellent contrast between the nerve and perineural structures owing to suppression of perineural fat [13, 14]. Therefore, we investigated the role of MRN as a technique in our clinical setting in the diagnosis of a case with unexplained left sciatica and foot drop post-COVID-19 infection in comparison to the clinical and neurophysiological examinations.

Methods

STIR axial and coronal sequences on a slice thickness of 2 mm were done with TE=65 ms and TR=4007 ms on 1.5 Tesla MR (Ingenia; Philips Medical Systems, Best, Netherlands). The sciatic nerve size and signal changes as well as related thigh muscular changes that correspond to our patient's symptoms were evaluated on MRN.

Results

A 52-year-old female patient, who previously was fit and well presented in December 2021 with a PCR-proven COVID-19 infection. She presented with moderate symptoms and was treated at home, but was bid-ridden for 10 days. During which, full laboratory investigations were performed and came positive for HB1AC ; (8.1 %). Therefore, she was diagnosed accidentally with type 2 diabetes and treated accordingly with a mixture of oral antidiabetic drugs before meals and long-acting insulin analog at bedtime. She was well-treated after 10 days. Her blood sugar levels were deemed controlled (postprandial levels 158 mg/dl).

One month later, in January 2022, she presented with painful weakness and numbness of her left leg and foot. Her HBA1C was controlled at around (6.3 %). On her clinical examination, there was severe hypoesthesia below her knee level MRI aside from her medial aspect corresponding to saphenous nerve territory. lumbosacral spine (LSS) was requested. Additionally, nerve conduction velocity (NCV) and electromyogram (EMG) were ordered.

Her lumbosacral MRI came normal and complementary post-gadolinium sequences in the same MR session were afterward done to exclude the possibility of Guillain–Barré syndrome (GBS), given this possibility after reporting many cases recently post COVID-19 infection [15, 16]. Post-contrast sequences revealed no enhancing conus medullaris or cauda equina nerve roots. Her NCV examination revealed absent motor and sensory responses in both left tibial and common peroneal nerves suggestive of a left sciatic nerve lesion. Her EMG revealed active denervation in all sciatic innervated muscles with no motor unit action potential (MUAP) found under voluntary control in the left biceps femoris (short head), lateral gastrocnemius, and tibial anterior muscles Table (1).

MR neurography was acquired and revealed a long segment of STIR weighted images (WIs) involving the left sciatic nerve fascicles, starting proximally in the left hip and extending distally till the sciatic bifurcation with no definite lesion/neoplasm demonstrated in Figure (1). Additionally, there was diffuse patchy edema involving the biceps femoris (short head) denoting subacute 2ry denervation muscular changes Figure (1).

She was referred for CSF analysis and sural nerve biopsy for more confirmation of the nerve findings demonstrated on MRN and to speculate beyond the possible causes of sciatic neuropathy. And during the past period, she was well tolerated on insulin with normal blood sugar levels and HBA1C. Her CSF analysis showed normal both protein and cytology with no oligoclonal bands or atypical cells detected. Her CSF virology specimen came negative for EBV, CMV, HSV-I, HSV-II, and VZV.

Her sural nerve biopsy revealed a complete loss of myelinated fibers with diffuse endoneurial axonal edema and subtotal loss of her unmyelinated axons. No evidence of peri-vascular inflammation or vasculitis. No evidence of a demyelinating process and/or amyloid deposition was noted. No evidence of neoplasia or lymphoproliferative process was demonstrated. Therefore, our MRN findings correlated well with NCV and EMG findings and to a great extent with the

sural nerve biopsy and her CSF analysis findings. Consequently, the patient was diagnosed by exclusion with left sciatic neuropathy, presumably following COVID-19 viral infection.

Discussion

Our dedicated MR neurography findings, in this case, demonstrated evident unilateral sciatic neuropathy in terms of signal and size changes with associated secondary muscular denervation changes Figure (1). Additionally, our findings were consistent with the clinical patient complaint and our neurophysiological findings Table (1). Therefore, our implementation of MRN in the loop of this case scenario has added value in narrowing the possible differential diagnosis and potential related neuropathy causes in this patient.

Since the diagnosis of sciatic neuropathy was traditionally made from a combination of clinical history, physical examination, and electro-diagnostic studies. The evolving need for a non-invasive rapid modality such as MRN has been crucial in the early diagnosis of sciatic neuropathy [10].

In our routine clinical practice, sciatic neuropathy is commonly misdiagnosed as spinal stenosis or herniated intervertebral disk, whereas lumbosacral plexus lesions and polyradiculopathy may also cause similar symptoms [17]. Other causes were idiopathic, iatrogenic injuries, trauma, radiation therapy, piriformis syndrome, neoplasms, and rarely vascular malformations, anatomic factors, inflammatory and as a part of diabetic and amyloid polyneuropathies [18].

We tried to investigate beyond the possible causes related to our findings. Firstly, a normal MRI study of the lumbosacral spine of our case excluded the compressive etiologies such as herniated disc or piriformis syndrome. Many neurological complications of the coronavirus disease 2019 (COVID-19) pandemic, such as encephalitis, ischemic stroke, and acute inflammatory demyelinating polyneuropathy (AIDP) have been documented in the literature [1], [19].

Recently, a spectrum of peripheral neurological complications of COVID-19 has been observed in patients infected with COVID-19. Direct neuronal invasion, complement-mediated inflammation, and endothelial dysfunction have been proposed as the underlying mechanisms for COVID-19 neurological injury COVID-19 patients have also been found to have moderately reduced serum levels of ADAMTS-13, and subsequent excessive microthrombi in vasa nervorum could cause nerve ischemia and fascicular infarction in the setting of a refractory hypercoagulable state, not fully mitigated by current anti-inflammatory, anticoagulation, and antithrombotic therapies [20].

Possible expected causes of isolated sciatic neuropathy related to COVID-19 in our case included compressive etiology due to long home stay and bid-ridden status [21], diabetic history of the patient [12], or the direct effect of coronavirus [3]. Controlled blood sugar levels and HBA1C as well as delayed symptoms after recovery made the first two causes less likely. Additionally, the pathologically proven sural nerve edema made COVID-19 a potential direct cause.

Our findings were similar to Michaelson et al, who described three cases of sciatic neuropathy after hospitalization with COVID-19 with the potential direct coronavirus cause as the result of uncontrolled systemic inflammation triggering microthrombotic angiopathy involving the vasa nervorum.
Although the theory is still totally unclear with very few reported cases in the literature to date, COVID-19 would be a possible direct cause of sciatic neuropathy and the latter could be added to the spectrum of peripheral neurological complications with COVID-19, especially with more reported cases in the literature in the future.

Conclusion

MR neurography has added a diagnostic value to our clinical and neurophysiological examination in narrowing the differential possible causes of sciatic neuropathy in this patient. MRN has demonstrated accurately the location as well as the pattern of involvement in a feasible way comparable to other modalities. Additionally, it has guided us to further support the idea that sciatic neuropathy could be a potential direct complication of COVID-19.

Abbreviations:
ADAMTS: a disintegrin and metalloproteinase with thrombospondin motifs
AIDP: Acute inflammatory demyelinating polyneuropathy
CMV: Cytomegalovirus
CSF: Cerebrospinal fluid
EBV: Epstein-Barr virus
EMG: Electromyograph
GBS: Guillain–Barré syndrome
HBA1C: Hemoglobin A1C
HSV: Herpes Simplex Virus
LSS: Lumbosacral spine
MRI: Magnetic resonance imaging
MRN: Magnetic resonance neurography
MUAP: Motor Unit Action Potential
NCV: Nerve conduction velocity
VZV: Varicella Zoster Virus

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References

1. Mao, L., H. Jin, M. Wang, et al., *Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China.* JAMA neurology, 2020. 77(6): p. 683-690.
2. Elmokadem, A.H., D. Bayoumi, M. Mansour, et al., *COVID-19-associated acute invasive fungal sinusitis: Clinical and imaging findings.* Journal of Neuroimaging, 2022.

3. Michaelson, N.M., A. Malhotra, Z. Wang, et al., *Peripheral neurological complications during COVID-19: A single center experience.* Journal of the neurological sciences, 2022. 434: p. 120118.
4. Distad, B.J. and M.D. Weiss, *Clinical and electrodiagnostic features of sciatic neuropathies.* Physical Medicine and Rehabilitation Clinics, 2013. 24(1): p. 107-120.
5. Ergun, T. and H. Lakadamyali, *CT and MRI in the evaluation of extraspinal sciatica.* The British journal of radiology, 2010. 83(993): p. 791-803.
6. Chen, Y., E.M. Haacke, and J. Li, *Peripheral nerve magnetic resonance imaging.* F1000Research, 2019. 8.
7. Filler, A.G., J. Haynes, S.E. Jordan, et al., *Sciatica of nondisc origin and piriformis syndrome: diagnosis by magnetic resonance neurography and interventional magnetic resonance imaging with outcome study of resulting treatment.* Journal of Neurosurgery: Spine, 2005. 2(2): p. 99-115.
8. Chitranjan, H. Kandpal, and K. Madhusudhan, *Sciatic hernia causing sciatica: MRI and MR neurography showing entrapment of sciatic nerve.* The British Journal of Radiology, 2010. 83(987): p. e65-e66.
9. Lewis, A.M., R. Layzer, J. Engstrom, N.M. Barbaro, and C.T. Chin, *Magnetic resonance neurography in extraspinal sciatica.* Archives of Neurology, 2006. 63(10): p. 1469-1472.
10. Chhabra, A., T. Soldatos, G. Andreisek, et al., *High resolution 3T MR neurography in sciatic neuropathy.* Skeletal Radiology, 2011. 40 (4): p. 500.
11. Cejas, C., M. Aguilar, L. Falcón, N. Caneo, and M. Acuña, *High resolution (3 T) magnetic resonance neurography of the sciatic nerve.* Radiología (English Edition), 2013. 55(3): p. 195-202.
12. Vaeggemose, M., M. Pham, S. Ringgaard, et al., *Magnetic resonance neurography visualizes abnormalities in sciatic and tibial nerves in patients with type 1 diabetes and neuropathy.* Diabetes, 2017. 66(7): p. 1779-1788.
13. Chhabra, A., A.J. Madhuranthakam, and G. Andreisek, *Magnetic resonance neurography: current perspectives and literature review.* European Radiology, 2018. 28(2): p. 698-707.
14. Chhabra, A., *Peripheral MR neurography: approach to interpretation.* Neuroimaging Clinics, 2014. 24(1): p. 79-89.
15. Abu-Rumeileh, S., A. Abdelhak, M. Foschi, H. Tumani, and M. Otto, *Guillain–Barré syndrome spectrum associated with COVID-19: an up-to-date systematic review of 73 cases.* Journal of neurology, 2021. 268(4): p. 1133-1170.
16. Kamel, W.A., I.I. Ismail, and J.Y. Al-Hashel, *Guillain-Barre syndrome following COVID-19 infection: first case report from Kuwait and review of the literature.* Dubai Medical Journal, 2021. 4(2): p. 107-111.
17. Feinberg, J. and S. Sethi, *Sciatic neuropathy: case report and discussion of the literature on postoperative sciatic neuropathy and sciatic nerve tumors.* HSS Journal®, 2006. 2(2): p. 181-187.
18. Thawait, S., K. Wang, T. Subhawong, et al., *Peripheral nerve surgery: the role of high-resolution MR neurography.* American journal of neuroradiology, 2012. 33(2): p. 203-210.
19. Toscano, G., F. Palmerini, S. Ravaglia, et al., *Guillain–Barré syndrome associated with SARS-CoV-2.* New England Journal of Medicine, 2020. 382(26): p. 2574-2576.
20. Morici, N., M. Bottiroli, R. Fumagalli, C. Marini, and M. Cattaneo, *Role of von Willebrand factor and ADAMTS-13 in the pathogenesis of thrombi in SARS-CoV-*

2 infection: time to rethink. Thrombosis and haemostasis, 2020. 120(09): p. 1339-1342.
21. Hobson-Webb, L.D. and V.C. Juel, *Common entrapment neuropathies*. CONTINUUM: Lifelong Learning in Neurology, 2017. 23(2): p. 487-511.

Table (1) A summary of **(A)** EMG findings **(B)** NCV findings. L= left; MUAP= motor unit action potential; Med.=medius; Max=maximus; 0=none; +1=at one site; +2= at two sites; +3=at more than two sites; Pop.=popliteal; CMAP=compound motor action potential.

(A) EMG findings		
Muscle	**Spontaneous activity**	**MUAP recruitment**
L Adductor L.	0	Normal
L Vastus Medialis	0	Normal
L Gluteus Max.	0	Normal
L Gluteus Med.	0	Normal
L Semitendinosis	+1	Reduced
L Biceps Femoris	+3	No MUAP
L Med. Gastrocnemius	+1	Reduced
L lateral Gastrocnemius	+3	No MUAP
L Semimembranosis	+1	Reduced
L Tibial Anterior	+3	No MUAP
L proneus Longus	+2	Reduced
(B) NCV findings		
Mixed sensory and motor	**Left sural**	**Left superficial peroneal**
	No response	No response
CMAP	**Left Ankle**	**L pop. Fossa**
	No response	No response

Figure (1) (A&B) MIP STIR MRN images coronal (A) and axial images (B) for both thigh regions, noted the hypertrophied left sciatic nerve (arrowed) compared to the right side with high signal within the fascicles denoting neuropathy and 2ry muscle edematous changes in the left biceps femoris (dash arrowed).