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## Case Report

# Daily persistent headache with nutcracker physiology and spinal epidural venous congestion: Treatment with lumbar vein embolization <sup>☆</sup>

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## ARTICLE INFO

## Article history:

Received 3 June 2022

Revised 10 August 2022

Accepted 14 August 2022

## Keywords:

Headache

Renal nutcracker syndrome

Epidural space

Therapeutic embolization

Interventional radiology

## ABSTRACT

Nutcracker phenomenon (NCP) can cause various congestion syndromes secondary to the superior mesenteric artery (SMA) compressing the left renal vein (LRV) resulting in venous reflux. It has recently been suggested that reflux into the lumbar vein (LV) and epidural venous plexus (EVP) may cause headaches in some patients with NCP. This report illustrates an example of a patient with refractory headaches and imaging findings suggestive of NCP that underwent treatment with percutaneous LV embolization. The patient is a 60-year-old female with daily persistent headaches for 5 years that failed numerous headache preventative medications. Time-resolved magnetic resonance angiography demonstrated NCP with reflux and congestion of the LV and EVP. Catheter-based venography confirmed these findings and the patient was treated with percutaneous embolization of the LV. This case report demonstrates the use of LV embolization to prevent EVP reflux and treat daily headaches due to NCP. The patient's headache resolved the next day. She has been headache-free for 5 months post-treatment. These findings support prior data suggesting that NCP can cause retrograde LV flow, EVP congestion, and elevated cerebrospinal fluid pressures leading to daily persistent headaches. Percutaneous embolization of the LV may be a minimally invasive treatment option for refractory headaches in patients with NCP, retrograde LV flow, and EVP congestion.

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<sup>☆</sup> Competing Interests: No conflict of interest exists.

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<https://doi.org/10.1016/j.radcr.2022.08.049>

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## Introduction

Compression of the left renal vein (LRV) by the superior mesenteric artery (SMA) as it crosses the aorta is referred to as nutcracker phenomenon (NCP) [1–3]. A recent study by Riberio et al. studied the prevalence of nutcracker phenomenon (NCP) on computed tomography angiography (CTA) in healthy individuals. The study showed that beak sign and an acute aortomesenteric angle were present in 15.3% and 30.5% of healthy individuals, respectively [4]. This extrinsic compression impedes venous drainage and increases venous pressure which can cause flank pain, hematuria, and proteinuria, also known as nutcracker syndrome [5]. This congested blood can decompress into adjoining venous systems such as the gonadal vein and can trigger various pain pathways such as pelvic congestion syndrome. D'Archambeau et al. reported that 83% of the patients treated for pelvic congestion syndrome showed imaging findings of NCP [6].

Recently, Rozen et al. published a case series which demonstrates that 8/12 (67%) patients with new daily persistent headache (NDPH) had LRV compression, lumbar vein (LV) dilatation, and early spinal epidural venous plexus (EVP) enhancement on MRI [7]. They utilized contrast enhanced time-resolved magnetic resonance angiography (trMRA) in patients with NDPH to demonstrate that NCP can cause retrograde left second lumbar vein (L2LV) flow and secondary EVP congestion [7]. The authors hypothesized that the EVP congestion causes a subsequent congestion of the cerebral venous system leading to elevation of cerebrospinal fluid (CSF) pressure which, in turn, results in the development of refractory headaches. Based on this principle, it can be theorized that percutaneous embolization of the L2LV may redirect blood flow through other collateral pathways, and therefore relieve the spinal EVP congestion which would then resolve the persistent headache. The presented case demonstrates an example of percutaneous L2LV embolization used to treat refractory daily headaches in the setting of NCP with retrograde L2LV flow and EVP congestion.

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## Case report

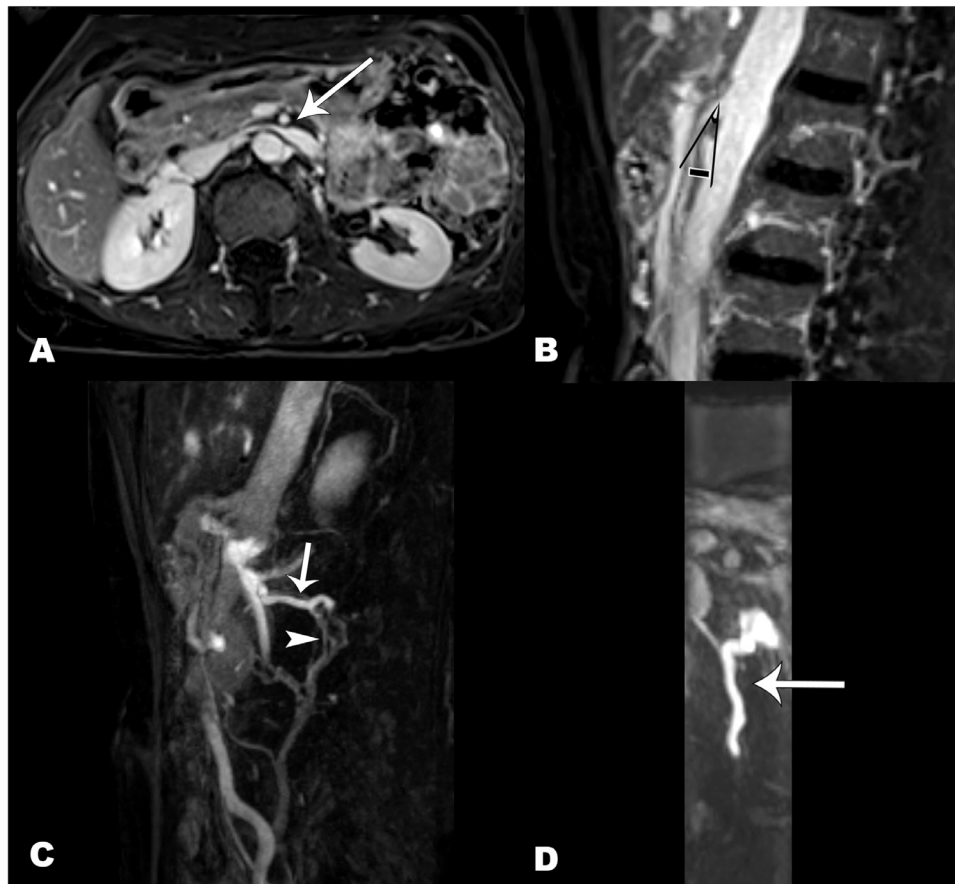
The patient is a 60-year-old female initially evaluated by a fellowship-trained headache neurologist for NDPH. She had been presenting with daily persistent headaches for 5 years which she described as a pressure sensation, as if her head would “blow off.” The headache was holocranial in location, could be of moderate to severe intensity and lacked any migrainous or cranial autonomic symptoms. She awoke with the initial headache and the head pain could awaken her from sleep. No known precipitating event was identified at the time of daily persistent headache onset. Attempts to manage the headache previously using numerous migraine preventive medications and other therapeutic interventions including onabotulinum toxin A and nerve block procedures (greater occipital nerve injections) were unsuccessful.

An extensive neuroimaging workup (magnetic resonance imaging (MRI), angiography (MRA), and venography (MRV)) was performed and ruled out all secondary causes of headache such as mass lesion, Chiari malformation, venous sinus thrombosis and hydrocephalus. The brain MRI did show a partial “empty sella” but no optic nerve sheath distention. Acetazolamide was prescribed at a dose of 250 mg 3 times per day and the patient's headache improved by 80%, however, after several months this improvement subsided even at an elevated dose up to 500mg extended release twice daily. She was switched to spironolactone without benefit and then indomethacin sustained release, but never recaptured the initial improvement she had on acetazolamide. The immediate worsening of her headache in the Trendelenburg position was indicative that an abnormal reset of CSF pressure to an elevated state was at least part of the etiology of her headache syndrome [8].

There was a temporary resolution of her head pain following CSF removal via lumbar puncture (LP), which later recurred after approximately 1 month. Her CSF opening pressure (in the prone position) was 21 cm H<sub>2</sub>O. She underwent multiple LPs since this was the only modality that provided short-term alleviation of her pressure-based headaches. The main differential diagnosis outside of NDPH for this patient was idiopathic intracranial hypertension (IIH) but her lack of papilledema, normal BMI and a normal CSF opening pressure ruled out this syndrome. At this stage, options to provide long-term relief from headache were discussed.

The authors were particularly interested in the role of NCP in patients with refractory NDPH with an elevated CSF pressure phenotype. The patient was offered additional workup using a contrast-enhanced trMRA with dynamic sequences centered over the L2LV to evaluate blood flow around the spinal canal. The trMRA demonstrated severe narrowing of the LRV by the superior mesenteric artery (SMA) with a decreased SMA angle and aortomesenteric distance, all of which were consistent with NCP (Figs. 1A and B). Dynamic blood flow imaging demonstrated an enlarged L2LV with retrograde flow and EVP congestion (Figs. 1C and D). It was postulated that the patient's headache was the result of NCP with retrograde L2LV flow and EVP congestion. Therefore, it was decided to proceed with percutaneous endovascular L2LV embolization to redirect blood flow and decrease the EVP congestion.

The patient was placed in the supine position and access was obtained into the LRV from a right internal jugular vein (RIJV) approach. Venography from the LRV demonstrated retrograde flow into an enlarged common trunk supplying the gonadal vein and L2LV with associated EVP enhancement (Figs. 2A and B). There was no pressure gradient from the LRV to the inferior vena cava (IVC) due to decompression of blood into the L2LV and gonadal vein. Subsequent venography through the L2LV demonstrated retrograde flow with congestion of the EVP. Embolization of the L2LV was performed using multiple microcoils. The follow-up LRV venogram demonstrated no further flow into the L2LV (Figs. 2C and D). At the completion of the procedure, there was complete resolution of spinal EVP congestion. The following day the patient's daily persistent headache was completely resolved and she remains headache-free 5 months postintervention.



**Fig. 1 – (A and B) Axial (A) and sagittal (B) magnetic resonance angiography (MRA) of the patient demonstrates the presence of a beak sign (arrow in A) and decreased superior mesenteric artery (SMA) angle ( $30.5^\circ$ ) (thin black lines) and aortic mesenteric distance (AMD) (thick black line). (C and D) Sagittal (C) and axial (D) reformat of the dynamic time-resolved MRA (trMRA) demonstrates retrograde flow through the enlarged left second lumbar vein (L2LV) (white arrows in C and D) with enhancement of epidural venous plexus (EVP) (arrowhead in C).**

Patient consent was obtained and this case report complies with Health Insurance Policy Accountability Act (HIPAA) regulations.

## Discussion

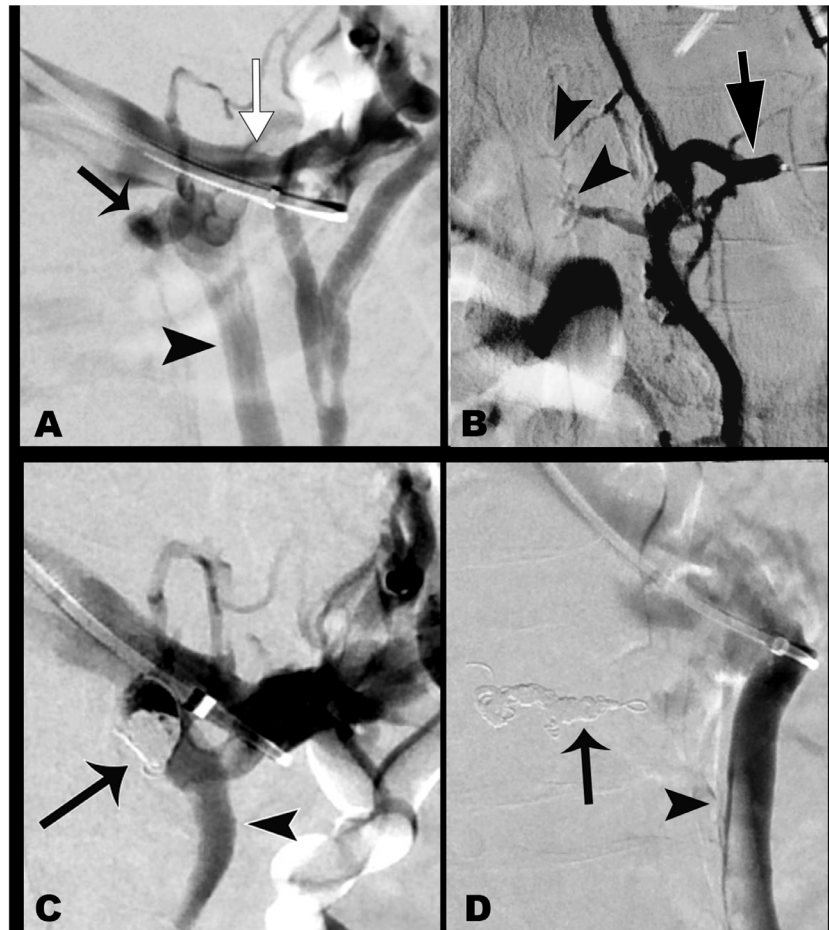
Various congestion syndromes associated with NCP are secondary to impaired LRV drainage which then decompresses into communicating systems. Similarly, a diversion of blood into the communicating L2LV and spinal epidural venous plexus (EVP) may alter the delicate balance between spinal and intracranial venous pressures resulting in elevated CSF pressure and refractory headaches [9]. Percutaneous LV embolization is based on the principle that redirecting the L2LV reflux can potentially relieve the EVP congestion and treat the headache.

A recent study that analyzed trMRA centered on the L2LV in patients with NDPH has demonstrated that there is a potential association between NCP and retrograde L2LV flow and EVP congestion [7]. This is similar to the pathophysiology impli-

cated to cause headaches and myelopathies with the Queckenstedt maneuver or IVC and renal vein occlusion [10,11]. The LRV venographic findings in this case further confirm that the venous congestion due to NCP can cause retrograde flow in the L2LV and EVP congestion which may present as daily persistent headaches.

Surgical procedures such as renal autotransplant and/or renal vein transposition are the primary treatment options available for nutcracker syndrome [12,13]. Percutaneous embolization of refluxing veins has shown improvement in other venous compression syndromes, such as gonadal vein embolization for the treatment of pelvic venous congestion syndrome [6,14–16]. Since the underlying mechanism of EVP congestion and headaches associated with NCP is similar, embolization of the L2LV can be of potential benefit when there is direct reflux into the EVP from an L2LV communicating with the LRV. In some patients, this venous reflux is drained through prevertebral pathways and not the L2LV, in which case they would not be eligible for this embolization.

In this case, embolization of the L2LV was successfully performed with multiple detachable microcoils. The rationale for



**Fig. 2 – (A and B) Preintervention left renal vein (LRV) venography demonstrated venous decompression from the LRV (white arrow in A) into an enlarged L2LV (black arrows in A and B) and gonadal vein (arrowhead in A). The retrograde flow through the L2LV results in enhancement of the EVP (arrowheads in B). (C and D) Postintervention LRV venography demonstrated successful embolization of the lumbar vein using microcoils (arrows in C and D). No retrograde L2LV flow and EVP enhancement is seen, only venous decompression via an enlarged gonadal vein can be appreciated (arrowheads in C and D).**

selecting microcoils as the embolic agent was due to their accurate deployment, ease of use with the ability to retract and reposition as needed, reliability for complete occlusion, and availability in multiple sizes. The microcoils used in this patient ranged from size 3-5 mm and were oversized by 1-2 mm relative to the vein diameter. Microplugs could be a feasible alternative; however, the lack of appropriate sizes limited their utilization. Technical success was achieved at the end of the procedure with complete resolution of retrograde L2LV flow and EVP congestion. An immediate symptomatic benefit was observed as the patient reported complete alleviation of her headache the following day. This improvement may be mediated through a decrease in intracranial and CSF pressures. Over the entire follow-up period of 5 months there was no recurrence of headache.

This case report raises the possibility that percutaneous embolization of the L2LV may improve refractory headaches in patients with imaging evidence of NCP, retrograde L2LV flow, and EVP congestion. Furthermore, it supports the hypothesis that NDPH with imaging findings suggestive of NCP may be caused by secondary EVP congestion. LV embolization, which

is a minimally invasive outpatient procedure, has the potential to open the door to less invasive treatment paradigms for NCP associated headaches. Although this technique shows significant symptomatic relief, the possibility of a placebo effect exists and this further requires assessment through prospective evaluation and tracking of long-term outcomes prior to uniformly adopting this treatment strategy. Furthermore, the downstream consequences of redirecting blood flow through other collaterals such as the gonadal veins are unknown at this time.

#### Patient consent

This is to certify that written informed consent was obtained from the patient prior to submission of this case report titled “Daily persistent headache with nutcracker physiology and spinal epidural venous congestion: Treatment with lumbar vein embolization.” The copy of the patient consent is in

possession of the corresponding author and can be shared on reasonable request.

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