

ABSTRACT

- **Pudendal neuralgia is a debilitating condition** and an important cause of chronic pelvic and perineal pain. It causes a significant impact on quality of life, psychosocial distress, sexual dysfunction, and problems with partner-relationships. It is also noted to have an increased association with depression, anxiety, and fatigue.
- **Currently, the diagnosis of pudendal neuralgia is based on the Nantes Diagnostic Criteria**, which relies on clinical findings and is not specific, leading to an average time to diagnosis of 4.5 years from the onset of symptoms to definitive treatment.[1]
- Patients who present with pain – such as tingling, numbness, muscle weakness, genital pain and/or urinary symptoms – because of compressed nerves, are commonly misdiagnosed, leading to misdirected and inefficacious treatments. **On average, patients with intrapelvic nerve entrapments undergo 1.2 ineffective surgical procedures, aimed at the wrong cause of pain.**[1]
- **Once accurately diagnosed, treatment via laparoscopy has shown to be successful in resolving symptoms and relieving pain.**[1,2]
- Therefore, diagnosis is the main factor standing between patients and effective treatment. **Tractography is a 3D modeling technique** used to visually represent neural tracts using data collected by diffusion-weighted images (DWI) and has already been used to map the lumbosacral plexus.[3]
- We have piloted the use of this technique in patients undergoing pelvic MRI and MR Neurography for the investigation of intrapelvic neuropathy. **The objective of this study is to analyze the tractography reconstruction and compare it with neurography and intraoperative findings.**

METHODS

- This is a **retrospective tractographic reconstruction of DWI sequences collected from patients who underwent laparoscopic detrapment of the sacral plexus**, as previously described.[1] As per since the last quarter of 2015 our standard preoperative workup protocol was established with pelvic MRI with MR Neurography (MRN) and DWI sequences, which are used for anatomical analysis and preoperative planning.
- Axial DWI sequence is performed with diffusion-weighted spin echo single-shot echo planar imaging (EPI) with following parameters: echo time=85 ms, repetition time= 9900 ms, time of acquisition= 7:55, sense factor= 3, field of view= 258 mm, matrix size= 128 x 160, number of slices= 50, isotropic size = 1.6 x 1.6 x 4.0, b values= 0, 50, 500, 700 , gradient directions= 6. Two information generated from the DTI sequence will aid in the study of the lumbosacral plexus: fiber tractography and fractional anisotropy (FA).
- **These images are used solely for anatomical visualization and preoperative planning, but not for diagnostic purposes. All diagnosis is based on clinical Preoperative Neuropelvic Assessment (PNA) and Urodynamics**, as previously described.[1]
- In March 2018, all the stored DWI sequences were reprocessed for tractography analysis. All patients had signed a consent authorizing the use of MR and surgical images and clinical data for research, educational and quality improvement purposes.
- **Data was tabulated and MR Tractography (MRT) results were compared to PNA, MR Neurograph (MRN) results and to intraoperative findings. Primary outcome was the correlation between MRT and intraoperative findings. Secondary outcomes were MRN and PNA correlation with intraoperative findings and MRT correlation with clinical outcomes.**

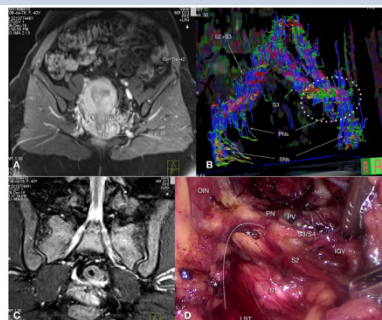


Figure: Example of the only exam where MRN signal (C) was altered. A: Axial oblique cut showing abnormal tributaries (*) of the internal iliac vein (IV) and varicose inferior gluteal vein (IGV) and pudendal vein (PV) entrapping nerve roots S1, S2 and S3; B: S2+S3 MRT – dotted line marks the entrapment area, characterized by confluence of tracts and flattening of the pudendal nerve (PN); C: Intraoperative findings after decompression confirming image findings – dotted line marks the sciatic notch. (LST – Lumbosacral Trunk; OIN – Obturator Internus Muscle)

Pt#	Preoperative Hypothesis	MR Tractography Result	MR Neurography Results	Intraoperative Findings	Clinical Success
1	Vascular/Endometriotic entrapment of Sciatic and Pudendal Nerves	Entrapment of Sciatic and Pudendal Nerve	Normal	Vascular Entrapment of Sciatic and Pudendal Nerve	No
3	Vascular entrapment of S3 on the right	Entrapment of S2/S3	Normal	Vascular entrapment of S2/S3	Yes
4	Vascular Entrapment of S1 on the right	Entrapment of S1 on the right	Normal	Vascular Entrapment of S1	Yes
5	Vascular entrapment of S2/S3	Entrapment of S3 on the right	Normal	Vascular entrapment of S2/S3	Yes
7	Vascular/Endometriotic entrapment of Sciatic and Pudendal Nerves on the Left	Entrapment of S1, S2, S3 and S4 on the Left	Normal	Vascular Entrapment of S1, S2, S3 and S4 on the Left	Yes
8	Endometriotic/Vascular entrapment of left sciatic and pudendal nerves	Entrapment of S1, S2, S3 and S4 on the Left	Normal	Endometriotic entrapment of S1, S2, S3 and S4 and sciatic and pudendal nerves on the left	No
9	Endometriotic/Vascular entrapment of left sciatic and pudendal nerves	Entrapment of S2, S3 and S4	Altered Signal S2/S3	Endometriotic entrapment of S2, S3 and S4 and vascular entrapment of the pudendal nerve on the left	Yes
10	Endometriotic/Vascular entrapment of left S2, S3 and S4	Normal - limited analysis due to image artifact produced by hip replacement prosthesis	Normal - limited analysis due to image artifact produced by hip replacement prosthesis	Piriformis entrapment of S1, S2, and S3 on the left	Yes
11	Fibrotic entrapment of left lumbosacral trunk	Inconclusive - limited analysis due to image artifact produced by hip replacement prosthesis	Inconclusive - limited analysis due to image artifact produced by hip replacement prosthesis	Fibrotic entrapment of left lumbosacral trunk	Yes
12	Piriformis entrapment of S2 on the right	Entrapment of S2/S3 on the right	Normal	Piriformis entrapment of S2/S3 on the right	Yes
13	Piriformis entrapment of S1 on the right	Entrapment of S1 on the right	Normal	Piriformis and Vascular entrapment of S1 on the right	Yes
14	Vascular entrapment of left pudendal nerve	Vascular entrapment of left pudendal nerve	Normal	Vascular entrapment of left pudendal nerve	Yes
	Endometriotic entrapment of S2 on the right	Normal	Normal	Nor structural nerve entrapment; possible entrapment due to pelvic cecum	Yes

RESULTS

- A total of 14 patients (11 women, 3 men) were included in this analysis. Tabulated results are displayed on the table.
- **Twelve out of 14 MRT reconstructions were considered satisfactory.** Two had limited results secondary to artifacts generated by orthopedic hardware.
- **On all twelve cases whose MRT reconstruction was considered technically reliable, diffusion rate and tractographic analyses were capable of identifying the site of entrapment found intraoperatively. Of these, 10 had satisfactory clinical outcomes (>50% symptom reduction on VAS).**
- **PNA diagnosis was correct in 13 out of the 14 cases.**
- MRN was only altered in one case, which coincidentally had a Tarlov cyst.

CONCLUSIONS

- **The perfect correlation between MRT and intraoperative findings are extremely encouraging.**
- This study, however, has several important limitations: it is a **retrospective analysis with MRT interpretation performed in light of intraoperative findings; there is no control group to allow for estimation of positive and negative predictive values.**
- **A pilot prospective blinded case-control study has already been designed to set the basis for a larger trial that will allow for the establishment of sensitivity and specificity of MRT to diagnose pudendal neuralgia and other intrapelvic nerve entrapments.** If the results of this larger trial are as good as expected, we might finally have an objective and reliable diagnostic tool, that could potentially reduce the gap between the onset of symptoms and final diagnosis, the number of unnecessary and ineffective surgical procedures, facilitate research by reducing the selection bias and, finally, increase the success rate of treatments for this devastating condition.
- **MRN sequences played an important role for anatomical localization, but showed no diagnostic value.**
- **Larger controlled trials are still needed, but MRT is a potential candidate for an objective diagnostic tool for pudendal neuralgia and other intrapelvic nerve entrapments. MRN alone has no diagnostic value for intrapelvic nerve entrapments.**

REFERENCES

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3. van der Jagt PK, Dik P, Froeling M, Kwee TC, Nievelstein RA, ten Haken B, Leemans A. Architectural configuration and microstructural properties of the sacral plexus: a diffusion tensor MRI and fiber tractography study. Neuroimage. 2012 Sep;62(3):1792-9. doi:10.1016/j.neuroimage.2012.06.001