

## Retrospective Study

# e Role of 3 Tesla MR Neurography and CT-guided Injections for Pudendal Neuralgia: Analysis of Pain Response

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Disclaimer: There was no external funding in the preparation of this manuscript. Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 08-21-2018  
Revised manuscript received:  
11-16-2018  
Accepted for publication:  
12-12-2018

Free full manuscript:  
www.painphysicianjournal.com

**Background:** Magnetic resonance neurography (MRN) has an increasing role in the diagnosis and management of pudendal neuralgia, a neurogenic cause of chronic pelvic pain.

**Objective:** The objective of this research was to determine the role of MRN in predicting improved pain outcomes following computed tomography (CT)-guided perineural injections in patients with pudendal neuralgia.

**Study Design:** This study used a retrospective cross-sectional study design.

**Setting:** The research was conducted at a large academic hospital.

## Methods:

**Patients:** Ninety-one patients (139 injections) who received MRN and CT-guided pudendal blocks were analyzed.

**Intervention:** A 3Tesla (T) scanner was used to evaluate the lumbosacral plexus for pudendal neuropathy. Prior to receiving a CT-guided pudendal perineural injection, patients were given pain logs and asked to record pain on a visual analog scale.

**Measurement:** MRN findings for pudendal neuropathy were compared to the results of the CT-guided pudendal nerve blocks. Injection pain responses were categorized into 3 groups – positive block, possible positive block, and negative block.

**Statistical Tests:** A chi-square test was used to test any association, and a Cochran-Armitage trend test was used to test any trend. Significance level was set at .05. All analyses were done in SAS Version 9.4 (SAS Institute, Inc., Cary, NC).

**Results:** Ninety-one patients (139 injections) who received MRN were analyzed. Of these 139 injections, 41 were considered positive (29.5%), 52 of 139 were possible positives (37.4%), and 46 of 139 were negative blocks (33.1%). Of the patients who had a positive pudendal block, no significant difference was found between the MRN result and the pudendal perineural injection response ( $P = .57$ ). Women had better overall response to pudendal blocks, but this response was not associated with MRN findings ( $P = .34$ ). However, positive MRN results were associated with better pain response in men ( $P = .005$ ). Patients who reported bowel dysfunction also had a better response to pudendal perineural injection ( $P = .02$ ).

**Limitations:** Some limitations include subjectivity of pain reporting, reporting consistency, absence of a control group, and the retrospective nature of the chart review.

**Conclusion:** Pudendal perineural injections improve pain in patients with pudendal neuralgia and positive MRN results are associated with better response in men.

**Key words:** MRI, MRN, CT injection, pudendal neuralgia, pudendal nerve, pelvic pain, chronic pelvic pain, pudendal neuropathy

**Pain Physician 2019; 22:E333-E344**

**C**hronic pelvic pain is a frequent problem in the United States, known to affect 7% to 24% of the general population (1) and costs 2 billion dollars to the US health care system annually from direct and indirect expenses (2). The quality of life of patients is greatly affected, restricting their ability to sit, defecate, urinate, and engage in sexual activity. Pudendal neuralgia causes chronic pelvic pain, accounting for approximately 4% of all cases (3,4) with the average age of onset at 50 to 70 years (4). The condition is most common in women, although men are likely underdiagnosed. It is estimated that 11% of men in the United States have experienced chronic prostatitis-like pain, and pudendal neuralgia is one of the possible etiologies of this pain (1).

Mechanical injury is the dominant cause of most cases of pudendal neuralgia, either due to compression (entrapment), traction, or a combination of these etiologies (5-9). Iatrogenic injury can also occur from pelvic and orthopedic surgeries, in which the nerve is manipulated or put under prolonged traction. Pelvic organ prolapse repair surgeries using mesh or midurethral slings have been suspected as other potential causes of pudendal neuropathy (10,11). Topography-wise, the pudendal nerve is hypothesized to become entrapped or injured at multiple primary sites from proximal to distal along its course. The lesions could be as high as the sacral plexus and as distal as the terminal branches of the pudendal nerve distal to the Alcock's canal (12).

Pudendal neuralgia is commonly unilateral and can present with a variety of symptoms, most commonly deep pelvic or vaginal pain (13-15). A seated position is a characteristically aggravating factor of pudendal neuralgia, with relief of symptoms upon standing or

sitting on a toilet seat (6). Symptoms may be associated with urinary, bowel, or sexual dysfunction (1). Patients may also develop associated pelvic floor, gluteal, and hip myofascial dysfunction disorders, which can cause pain affecting adjacent regions of the lower abdomen, groin, deep pelvis, legs, and gluteal region (16).

The Nantes criteria were developed for the diagnosis of pudendal neuralgia (Table 1). However, these criteria have not been shown to be specific for pudendal neuralgia as there is significant overlap with disorders of pelvic floor myofascial pain (12). In most settings, the diagnosis of pudendal neuralgia is primarily clinical, based on history and a thorough pelvic exam (17). Pelvic floor muscle spasms may be palpated with external, transvaginal, or transrectal approaches. Sensory testing involving response to light touch and pinprick does not typically elicit numbness but can demonstrate hypersensitivity in the pudendal distribution (12). Tinel's sign can be observed at the ischial spine or Alcock's canal medial to the ischial tuberosity. A cotton swab may be used to gently elicit unilateral vulvodinia, a sign of pudendal neuralgia (12). Ipsilateral perineal muscle atrophy with anal deviation may be apparent in severe axonal pudendal neuropathy (1). Neurophysiologic tests, including electromyography (EMG) and pudendal nerve terminal motor latency testing (PNTML), are not specific enough to be confirmatory or localizing, but may assist in the diagnosis of pudendal neuralgia (18,19).

Magnetic resonance neurography (MRN) is being increasingly employed in the diagnosis and management of peripheral neuropathy (20-23). This high-resolution imaging modality can localize pudendal neuropathy and has been reported to be valuable to guide interventions for pudendal neuralgia such as therapeutic injections and surgery (24). MRN findings include signal alterations, especially hyperintensity and/or prominence of the affected pudendal nerve. Neuropathy localization is possible on MRN, as the signal alteration on T2-weighted images and/or caliber change is most pronounced near the sites of entrapment. Conventional magnetic resonance imaging (MRI) will only identify more apparent organic causes, such as thickened fascia, local scarring, or uncommonly a mass lesion, as the pudendal nerve is not typically visible on conventional MRI due to vascular signal contamination, lack of diffusion imaging, and lower resolution. In suspected pudendal abnormalities, a confirmatory perineural injection is commonly performed, which may serve diagnostic or therapeutic purposes (25,26). The needle may be inserted in the clinic or radiology

Table 1. *Nantes Criteria for diagnosis of pudendal neuralgia.*

<p><b>Nantes Criteria</b></p> <ul style="list-style-type: none"> <li>• Pain in region innervated by the pudendal nerve extending from anus to clitoris</li> <li>• Pain is more severe when sitting</li> <li>• Pain does not awaken patients from sleep</li> <li>• Pain without objective sensory impairment</li> <li>• Pain relieved by diagnostic pudendal block</li> </ul> <p><b>Exclusion Criteria</b></p> <ul style="list-style-type: none"> <li>• Pain exclusively in the coccygeal, gluteal, hypogastric, or pubic area (without pain in pudendal nerve distribution)</li> <li>• Pruritus</li> <li>• Exclusively paroxysmal pain</li> <li>• Abnormalities on imaging (MRI, CT, etc.) that may explain the pain</li> </ul>
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Abbreviations: MRI, magnetic resonance imaging; CT, computed tomography

suites using different routes (12). Image guidance of needle injections exhibits excellent face validity. While ultrasound (US) and magnetic resonance (MR) guidance are radiation-free, there are certain limitations in terms of observer skill needed, lack of nerve visualization in many patients on US, and universal availability of MR-guided procedures – let alone the additional expense of scanning (26-28). Computed tomography (CT) is widely available and is being used for pudendal injections (29-31). The role of MRN in determining which patients experience positive or negative responses to injections, though, has not been clear.

At our tertiary care institution, we have employed MRN- and CT-guided pudendal blocks to evaluate and treat pudendal neuralgia for many years. To systematically assess the role of MRN and pain relief response (outcomes) to CT-guided pudendal perineural injections in the management of patients with pudendal neuralgia, we aimed to evaluate a consecutive series of such patients who were primarily referred from the institutional pelvic floor clinic. We hypothesized that those who received CT-guided pudendal perineural injections and who had a positive MRN finding would experience more favorable outcomes than those who had negative findings for pudendal neuralgia on MRN.

## METHODS

For this HIPAA-compliant retrospective cross-sectional evaluation, institutional IRB approval was obtained, and the informed consent was waived.

### Patients

A search of the university hospital electronic health records was conducted for patients who received a CT-guided pudendal perineural injection and who were primarily referred by the pelvic rehabilitation clinic from April 2013 to February 2018. A minority of patients were referred from other clinics. Exclusion criteria included injections that were not pudendal, repeat injections, interventions that included another nerve or muscle injected simultaneously, lack of pain immediately prior to the procedure, no available follow-up, or duplicate entries (Fig. 1).

### MRN Lumbosacral Plexus Protocol

The MRN lumbosacral (LS) plexus protocol at our institution includes evaluation of the lumbosacral spine and peripheral nerves in the abdomen and pelvis. The protocol is outlined in Table 2. All included imaging examinations were performed on a 3 Tesla (T) scanner (Achieva, Ingenia, Philips Healthcare, Best, the Nether-

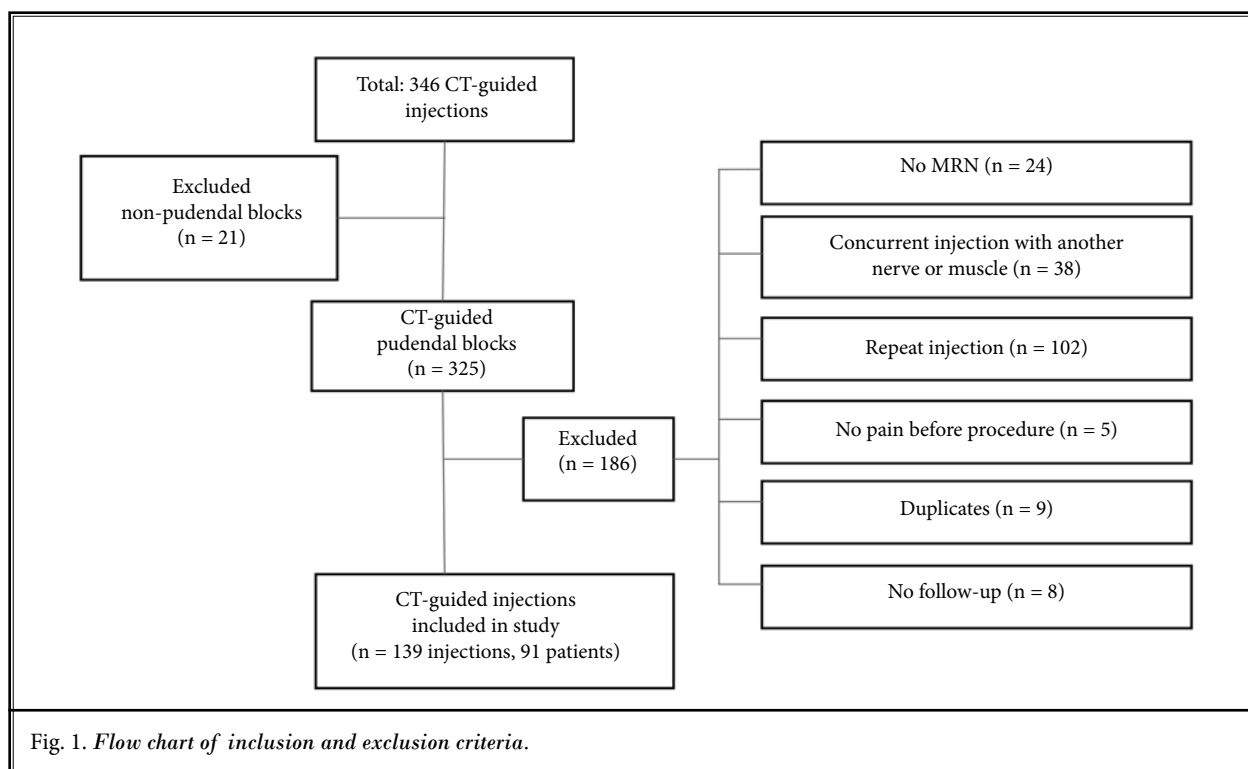


Table 2. *Imaging protocol and parameters for MRN LS plexus.*

Sequence	TR (ms)	TE (ms)	Gap	Turbo Factor	Acquisition Time	Voxel (mm)
Axial T1W	500	8	10%	8	4 min 39 s	40.6 × 0.6 × 4.0
Axial T2W SPAIR	4000	60	10%	7	6 min 13 s	1.0 × 1.0 × 4.0
3D fsT2W TSE	2000	78	0	100	8 min	1.5 × 1.5 × 1.5
Sagittal T2W spine	3500	120	10%	19	4 min 18 s	0.9 × 1.1 × 4.0
Axial T2W spine	3000	120	10%	27	4 min 19 s	1.0 × 1.0 × 5.0
Axial DTI	16,000	54	0		5 min	3.5 × 3.5 × 5.0

Abbreviations: DTI, diffusion tensor imaging; fsT2W TSE, fat-suppressed T2-weighted turbo spin echo; ms, milliseconds; SPAIR, spectral adiabatic inversion recovery; T1W, T1-weighted; TE, echo time; TR, repetition time; MRN, magnetic resonance neurography; LS, lumbosacral.

lands) using torso XL and spine coils as the standard of care. The images were formally read by one of three musculoskeletal fellowship trained radiologists using a structured report containing a template with nerve findings as a separate section. The template included pathological lesions of the bone, spine, muscle, peripheral nerves, masses, and other visceral findings. MRN findings for pudendal neuropathy included increased signal and/or thickening of the pudendal nerve on axial T2-weighted and diffusion tensor imaging (DTI) images ( $b = 0, 600 \text{ s/mm}^2$ ) with or without the presence of thickening of local fascia, local scarring, and masses. Final impression of pudendal neuropathy from the reports was recorded as a positive MRN or negative MRN. To evaluate the impact of MRN on response to perineural injections, the scans were not read a second time, and only reports were used for data collection. Most of these patient reports had been prospectively used by the referring physicians for treatment decisions.

### CT-guided Pudendal Perineural Injection Technique

A uniform technique was used in all injections using the same injectate drug combination, and performed by the same 3 musculoskeletal radiologists who read the MRN scans, but not necessarily on the same patients they read the scans for. As per this technique, the patient was placed in the prone position and examined with a multislice CT scanner from the acetabular roof to the pubic symphysis. The pudendal nerve, ischial spine, sacrospinous and sacrotuberous ligaments were identified and entry site marked. The patient was then prepped and draped in typical sterile fashion. Under intermittent CT guidance, a 22-gauge spinal needle was then advanced through the sacrospinous ligament at the approximate level between the ischial spine and ischial tuberosity adjacent to the pudendal nerve,

immediately proximal to Alcock's canal. The nerve is less dense than the adjacent vessel and can be easily identified on CT in the pudendal neurovascular bundle. A 0.75 mL of (1:5) diluted non-ionic iodinated contrast agent was then injected to verify the spread of injectate around the nerve and its extension anteriorly and inferiorly into the pudendal canal. After verification of needle tip placement, a 5-mL solution consisting of 2 mL of lidocaine 2%, 2 mL of bupivacaine 0.5%, and 1 mL of dexamethasone 4 mg was injected. The procedure was repeated on the other side if the patient was receiving bilateral pudendal blocks.

### Pain Records

Immediately prior to receiving the pudendal perineural injections, the patients were given a pain log (Fig. 2) and instructed to record their pain scores for each corresponding time point. The pain scores ranged from 0 to 10, with 0 being no pain and 10 being extreme pain. The patients were then asked to bring their pain scores to their next follow-up appointment at the clinic. The pain logs were then scanned into the electronic medical record system, and in addition, pain scores on a visual analog scale (VAS) were also recorded on the next follow-up visit note. For the small minority of patients not followed at the pelvic rehabilitation clinic, pain scores were collected from follow-up notes charted in the electronic health records from other providers at our institution.

### Data Collection

A detailed chart review was performed by a research physical medicine and rehabilitation (PMNR) student in consensus with PMNR and radiology faculty to obtain demographics (age, gender); chief complaint; initial presenting symptoms; date of injection and MRN; MRN results; other neuropathies reported on MRN;

Patient Identification Sticker

### CT-guided Injection or Nerve Block: Pain Record –

**Instructions:** please fill out for whichever side you had injected. Rate pain from 0-10 on a 10 point scale. If you had both sides injected, fill out for each side independently (pain scores may be different side to side). If you have the tailbone or something else in the midline injected, simply fill out one side.

<b>LEFT side</b>	<b>RIGHT side</b>
Pre-procedure pain level: _____ 0 1 2 3 4 5 6 7 8 9 10	Pre-procedure pain level: _____ 0 1 2 3 4 5 6 7 8 9 10
Post-procedure pain levels:  30 min: _____ 0 1 2 3 4 5 6 7 8 9 10  1 hour: _____ 0 1 2 3 4 5 6 7 8 9 10  2 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  4 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  8 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  24 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  48 hours: _____ 0 1 2 3 4 5 6 7 8 9 10	Post-procedure pain levels:  30 min: _____ 0 1 2 3 4 5 6 7 8 9 10  1 hour: _____ 0 1 2 3 4 5 6 7 8 9 10  2 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  4 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  8 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  24 hours: _____ 0 1 2 3 4 5 6 7 8 9 10  48 hours: _____ 0 1 2 3 4 5 6 7 8 9 10

Fig. 2. Patient pain record for CT-guided pudendal perineural injection.

prior MRIs and results; pain scores immediately before and after injection; days of pain relief; patient-reported qualitative improvement in pain, quality of life, and pain score at follow-up; injection complications; and if any surgery was performed to treat the pain. Information was extracted from hospital chart records and recorded on a Microsoft Excel (2016) spreadsheet.

### Data Evaluation

Responses to CT-guided pudendal nerve blocks were categorized into 3 groups: positive block, possible positive block, and negative block. For the CT-guided pudendal perineural injection to be considered a positive block, the “must-meet” criteria were: 1) a decrease in pain score of at least 50% within the first 24 hours

after receiving the injection, and 2) the response was sustained at 24 and 48 hours, i.e., pain did not increase again above 50% after the initial drop below 50%. A negative block was considered when the decrease in pain score was less than 2 points. Those that were considered possible positive blocks demonstrated some benefit to the patient without meeting the strict criteria of a positive block. This included patients who reported a delay in pain relief starting more than 24 hours after

the time of injection, decrease in pain score of less than 50% but more than 2 points, and patients who had a significant drop in pain score that was not sustained to the 48-hour time point.

### Statistical Analysis

Cross-tabulations were generated to compare the association between MRN results and the improvement of pain score. The improvement of pain score was categorized as 0 = no improvement, 1 = possible improvement, or 2 = confirmed improvement. A chi-square test was used to test any association, and a Cochran-Armitage trend test was used to test any trend. Significance level was set at .05. All analyses were done in SAS Version 9.4 (SAS Institute, Inc., Cary, NC).

## RESULTS

### Patient Population

A total of 139 CT-guided pudendal blocks were included in the sample from a total of 91 patients, and 48 of 91 patients received bilateral pudendal blocks. Patients were aged 24 to 86 years (mean = 54 years, standard deviation (SD) = 14 years) with a male to female ratio of 1:2.1. The most common chief complaint was pelvic pain (86/91). At the initial presentation, the mean [SD] pain score was 5 [2] and 9 [2], respectively. Table 3 summarizes the demographic and clinical characteristics of the study population.

### CT-Injection Response

Of 139 pudendal nerve blocks, 41 were considered positive (29.5%), 52 were possible positives (37.4%), and 46 were negative blocks (33.1%). Under each of these groups, the percentages of positive and negative MRN results are listed in Table 4. No complications were reported following pudendal perineural injections.

### MRN Findings

Among the 90 of 139 positive MRN cases of pudendal nerve abnormalities, 15 of 90 were associated with scarring around the pudendal nerve, 18 of 90 had prior hysterectomies, 4 of 90 had Alcock's fascia thickening, 2 of 90 had residual mesh, 2 of 90 had obturator internus fatty infiltration, 2 of 90 had obturator internus edema, and 1 of 90 had obturator internus atrophy. Two of 90 cases were associated with sacrotuberous ligament scarring or thickening, and 2 of 90 had sacrospinous ligament thickening.

Table 3. Baseline population characteristics.

Parameter	Frequency (%)
Patients (n = 91)	
Men	29 (32)
Women	62 (68)
Chief Complaint (n = 91)	
Pelvic pain	86 (95)
Sexual dysfunction	4 (4)
Defecatory dysfunction	1 (1)
Duration of pain (n = 86)	77 + 91 mos
Mean Pain on Presentation (n = 84)	
0-3	26 (31)
4-6	31 (37)
7-10	27 (32)
Max Pain on Presentation (n = 87)	
0-3	1 (1)
4-6	8 (9)
7-10	78 (90)
Prior Pelvic/Abdominal Surgery (n = 88)	72 (82)
Associated Symptoms	
Pelvic floor dysfunction (n = 80)	74 (93)
Urinary dysfunction (n = 82)	71 (87)
Bowel dysfunction (n = 80)	58 (73)
Sexual dysfunction (n = 84)	52 (58)
Psychiatric conditions (n = 85)	75 (88)

Table 4. MRN results within CT-guided block groups (n = 139).

Positive Block (n = 41, 29.5%)	Positive MRN	68.293% (28)
	Negative MRN	31.707% (13)
Possible Positive Block (n = 52, 37.4%)	Positive MRN	67.308% (35)
	Negative MRN	32.692% (17)
Negative Block (n = 46, 33.1%)	Positive MRN	58.696% (27)
	Negative MRN	41.304% (19)

Abbreviations: CT, computed tomography; MRN, magnetic resonance neurography.

Table 5. CT-guided nerve block results within MRN groups (n = 139).

Positive MRN (n = 90, 64.7%)	Positive block	31.111% (28)
	Possible positive block	38.889% (35)
	Negative block	30.000% (27)
Negative MRN (n = 49, 35.3%)	Positive block	26.531% (13)
	Possible positive block	34.649% (17)
	Negative block	38.776% (19)

Abbreviations: CT, computed tomography; MRN, magnetic resonance neurography

### Impact of MRN

Table 5 summarizes numbers of positive, possible positive, and negative responses to blocks in patients with positive and negative MRNs. Figs. 3-5 demonstrate some examples of such cases.

### Comparing CT-Injection Response and MRN Results

No significant association was found between MRN results and positive blocks ( $P = .57$ ). Although 29 of 91 patients received sedation during the pudendal nerve block, no significant association was found between sedation and pudendal block outcomes ( $P > .05$ ). Although no systematic quality-of-life surveys were formally conducted, 70 of 127 blocks were reported helpful by the patients on follow-up visits, but there was no signifi-

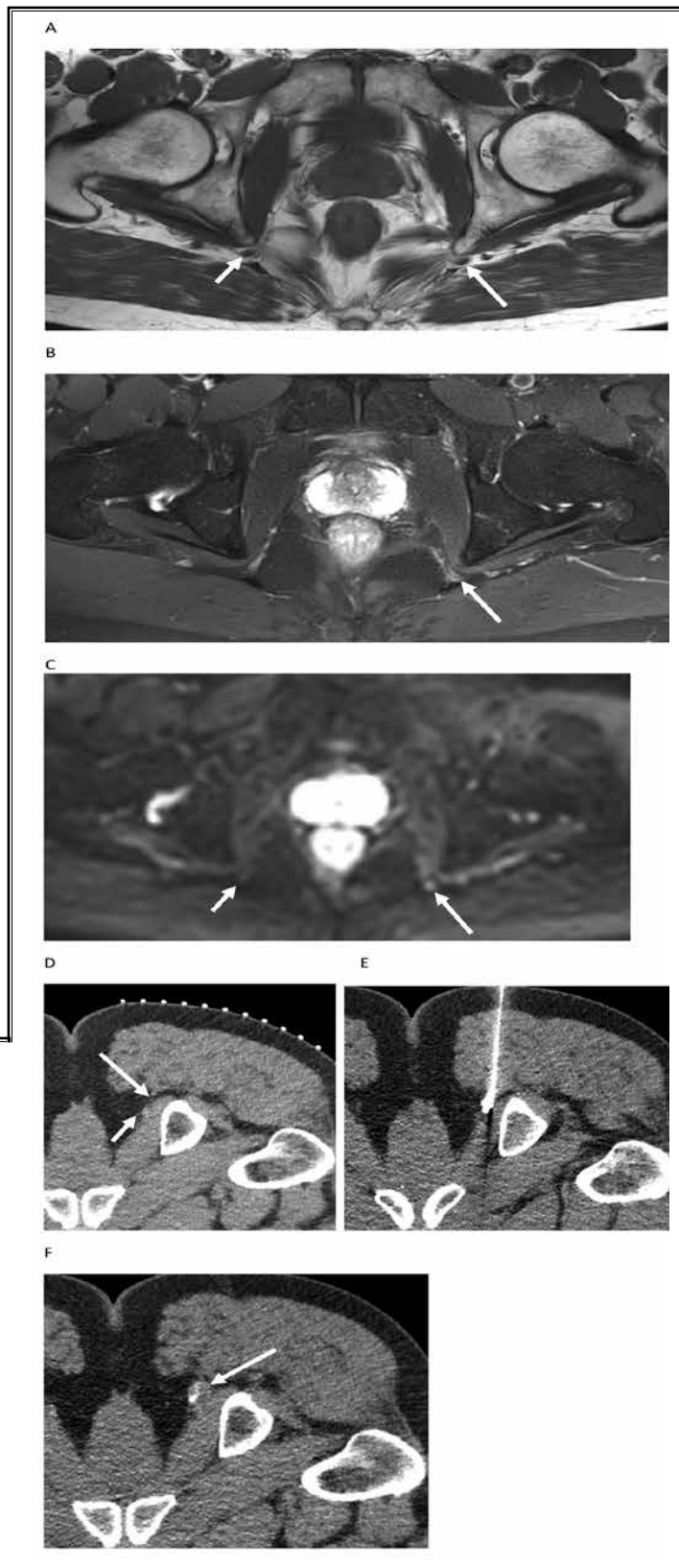
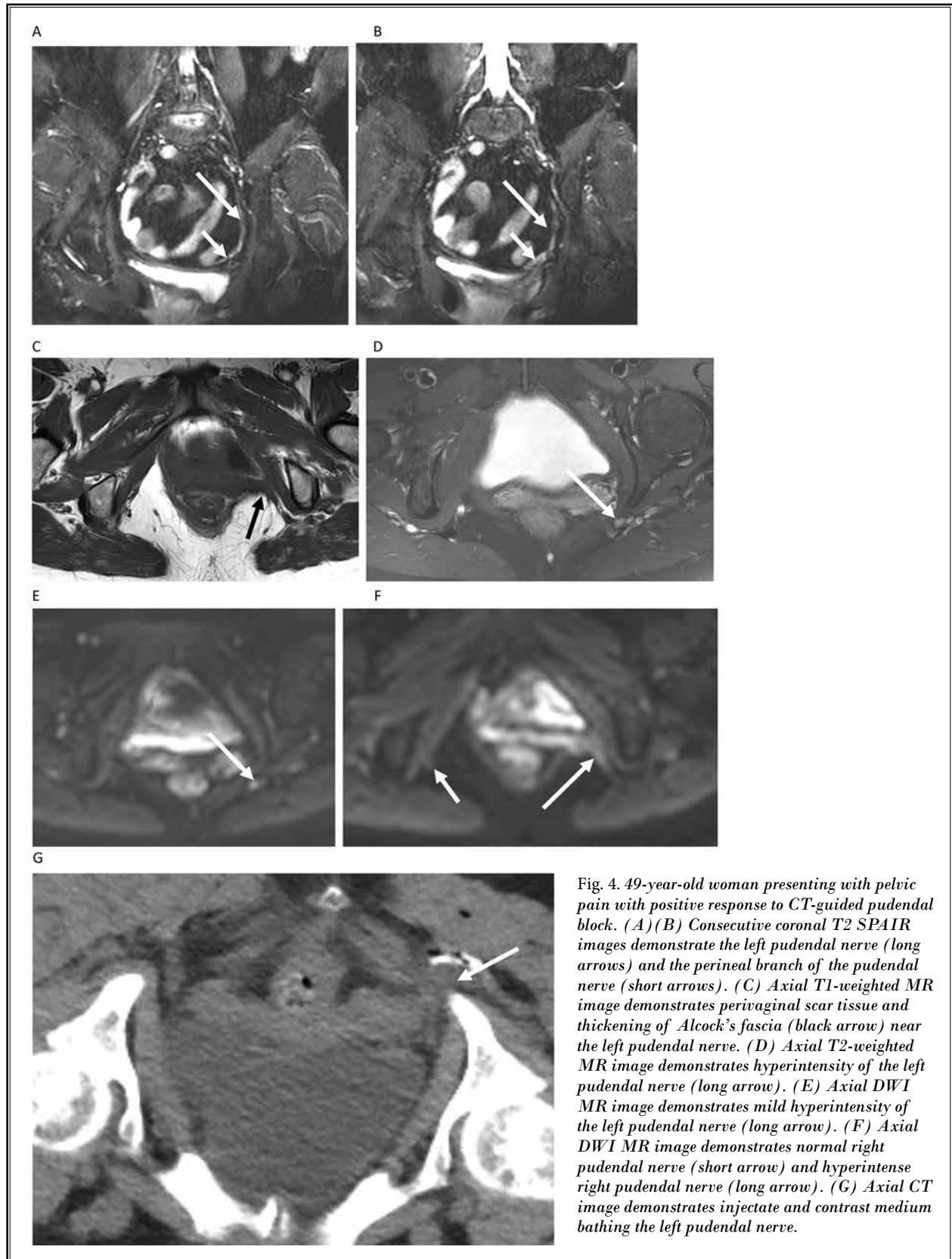


Fig. 3. 58-year-old man presenting with pelvic pain who had good response to CT-guided pudendal block. (A) Axial T1-weighted MR image demonstrates left pudendal nerve (long arrow) and right pudendal nerve (short arrow). (B) Axial T2 SPAIR MR image demonstrates increased signal of the left pudendal nerve (long arrow). (C) Axial DWI MR image demonstrates increased signal in the left pudendal nerve (long arrow) with a normal right pudendal signal (short arrow). (D) Axial CT image demonstrates nearly isodense pudendal nerve (long arrow) and hyperdense pudendal artery (short arrow). (E) Axial CT image following needle placement demonstrates the tip of the injection needle adjacent to the pudendal nerve. (F) Axial CT image following injection of 5 mL of mixture solution demonstrates immersion of pudendal nerve in the injectate (arrow).



**Fig. 4.** 49-year-old woman presenting with pelvic pain with positive response to CT-guided pudendal block. (A)(B) Consecutive coronal T2 SPAIR images demonstrate the left pudendal nerve (long arrows) and the perineal branch of the pudendal nerve (short arrows). (C) Axial T1-weighted MR image demonstrates perivaginal scar tissue and thickening of Alcock's fascia (black arrow) near the left pudendal nerve. (D) Axial T2-weighted MR image demonstrates hyperintensity of the left pudendal nerve (long arrow). (E) Axial DWI MR image demonstrates mild hyperintensity of the left pudendal nerve (long arrow). (F) Axial DWI MR image demonstrates normal right pudendal nerve (short arrow) and hyperintense right pudendal nerve (long arrow). (G) Axial CT image demonstrates injectate and contrast medium bathing the left pudendal nerve.



cant association between self-reported helpfulness of blocks and MRN results ( $P = .79$ ).

### Other Variables Compared

There was a significant trend associated with gender and injection outcomes. Women were more likely to have a better response to pudendal block compared to men. However, when stratifying the analysis by gender, no significance was found between MRN results and the response in women ( $P = .34$ ); however, positive MRN results were associated with a better response in men ( $P = .005$ ).

There was also a significant association between bowel dysfunction and pudendal block response, with those who have bowel dysfunction reporting a better response ( $P = .02$ ).

There was no significant association between pudendal nerve block response and variables such as the duration of pain symptoms ( $P = .21$ ), average pain at presentation ( $P = .54$ ), pain score at follow-up ( $P = .02$ ), prior surgery ( $P = .98$ ), pelvic floor dysfunction ( $P = .51$ ), time between MRN and pudendal block ( $P = .11$ ), and the pain score immediately prior to receiving the pudendal block ( $P = .33$ ).

### DISCUSSION

The diagnosis of pudendal neuralgia is primarily clinical; however, a complex combination of other pelvic symptoms renders the final diagnosis challenging. Several other confounding clinical findings such as pelvic floor dysfunction and bowel, sexual, and bladder dysfunction compound the clinical diagnosis, in addition to the underlying psychological components of depression and

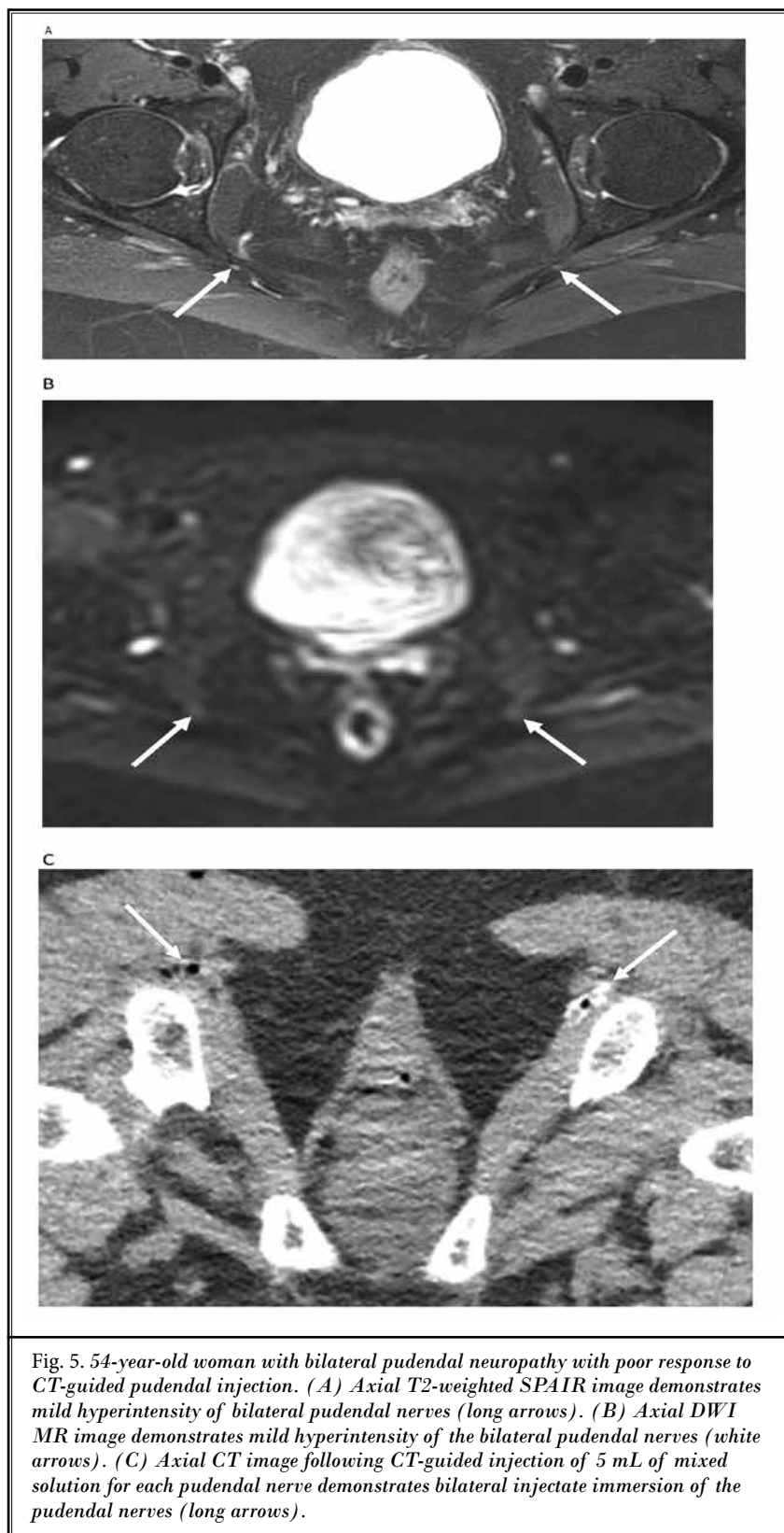


Fig. 5. 54-year-old woman with bilateral pudendal neuropathy with poor response to CT-guided pudendal injection. (A) Axial T2-weighted SPAIR image demonstrates mild hyperintensity of bilateral pudendal nerves (long arrows). (B) Axial DWI MR image demonstrates mild hyperintensity of the bilateral pudendal nerves (white arrows). (C) Axial CT image following CT-guided injection of 5 mL of mixed solution for each pudendal nerve demonstrates bilateral injectate immersion of the pudendal nerves (long arrows).

anxiety. Secondary gain in patients with prior pelvic mesh surgeries is another complicating factor that may have affected our results. It is possible that these patients entrap tiny perineal branches of the pudendal nerve due to secondary scarring from mesh; however, the response to injection may be delayed or suboptimal due to other financial and psychological gains related to legal implications of these surgeries and the environment. Future research should evaluate patient response to multidisciplinary treatment in specific subsets of patients. MRN along with CT-guided pudendal perineural injection has been used to assist in the diagnosis, since MRN can demonstrate neuropathy-related signal alterations and CT-guided injections allow high accuracy of needle placement (31,32). MRN was positive in 64.7% of nerves, and CT-guided pudendal blocks had a therapeutic impact in 66.9% of patients reporting a significant decrease in pain. Almost one-third of the patients reported a decrease in pain greater than 50% following pudendal block. This reinforces the benefit of pudendal blocks in the diagnosis of pudendal neuralgia, as outlined in the Nantes criteria, as well as in its management. It is unclear whether the patients who did not receive benefit from the block were possibly misdiagnosed, had other concurrent pathology, or if the intervention was not successful. MRN also allowed exclusion of central causes of pudendal neuralgia in the sacral plexus. In addition, these results should be considered in light of the facts that 1) we excluded patients with multiple neuropathies, which may have impacted the statistical significance level of the results; 2) a negative block (no pain relief) after accurate injection is thought to rule out pudendal neuralgia, but one injection may not produce the desired result in a patient on heavy pain medications or with multifactorial problems; and 3) a positive block (pain relief after injection) is not an absolute specific test for pudendal involvement due to potential placebo effects. Finally, the positive block is also hypothesized to limit pain from superficial pelvic floor muscles and sphincters innervated by the pudendal nerve, which may be the actual source of pelvic pain instead of the nerve itself.

### Limitations

The recording of pain scores is classically very subjective and requires that the patient use their best judgement in estimating their current pain level. A few patients were not able to bring their pain logs upon follow-up, and therefore had to recall their pain scores based on memory, introducing potential error.

While we considered a 50% decrease in pain score as a positive nerve block, this could have been affected by the intensity of pain scores reported by the patients. For example, a patient's pain reduction from a score of 8 out of 10 to a 6 out of 10 may mean a more significant decrease in the perception of pain as compared to a patient whose pain score decreased from a 3 out of 10 to a 1 out of 10. However, the latter would be considered a positive block while the former only a possible positive. This is one of the reasons why the possible positive category was introduced. Patients' pain scores are also variable from day to day and may decrease or increase by more than 50%. This type of data is very difficult to record from patients and requires a consistent log of pain levels to determine if this natural variability affects perceived pain scores after an intervention.

Some other limitations to this study include the absence of a control group and the retrospective nature of the chart review. However, there was no significant association when comparing pudendal nerve block response to variables such as the duration of pain symptoms, average pain at presentation, and the pain score immediately prior to receiving the pudendal block. Another limitation is that the data collection was not 100% uniform; in a minority of cases, there were other data reporters in different departments apart from the pelvic rehabilitation clinic. Interestingly, patients with bowel dysfunction reported a better response. Since all blocks were performed at the ischial spine, the relief is expected as the inferior hemorrhoidal branch is also bathed by injectate at this level.

### CONCLUSION

In the future, more accurate models of depicting pain levels and overall quality of life in patients would be beneficial in quantifying the therapeutic effect of pudendal blocks. Although limited by the high cost of MRN, a larger prospective trial with a control group would demonstrate more definitive conclusions on the benefits of MRN and CT-guided injections for pudendal neuralgia as well as other potential etiologies of chronic pelvic pain.

To summarize, patients with pudendal neuralgia present with complex symptoms, and almost two-thirds of these patients demonstrate positive MRN findings; a similar number benefit from injections. Pudendal blocks improve pain in patients with pudendal neuralgia and positive MRN results are associated with a better response in men.

**Author Contributions:**

J Ly: Project development, data collection, manuscript writing

KM Scott: Project development, data management, manuscript writing/editing

Y Xi: Data analysis, manuscript writing

O Ashikyan: Data management, manuscript editing

A Chhabra: Project development, manuscript writing/editing

Disclosures: Avneesh Chhabra, MD serves as a consultant with ICON Medical and Treace Medical Inc. AC also receives royalties from Jaypee and Wolters publishing company.

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