



# Colombian Journal of Anesthesiology

## Revista Colombiana de Anestesiología

www.revcolanest.com.co



### Education in anesthesia

## Regional anesthesia guided by ultrasound in the pudendal nerve territory<sup>☆</sup>



María Fernanda Rojas-Gómez<sup>a,\*</sup>, Rafael Blanco-Dávila<sup>b</sup>, Verónica Tobar Roa<sup>c</sup>, Ana María Gómez González<sup>d</sup>, Ana María Ortiz Zableh<sup>e</sup>, Alfredo Ortiz Azuero<sup>f</sup>

<sup>a</sup> MD, Universidad Industrial de Santander, Anaesthetist, Universidad Militar Nueva Granada, Fellow in Ultrasound-guided regional anaesthesia of the CLASA-WFSA-SBA Program, Anaesthetist, Sociedad Especializada de Anestesiología SEA S.A. Clínica Carlos Ardila Lulle, Floridablanca, Colombia

<sup>b</sup> MD, Anaesthesia Department, Corniche Hospital, Abu Dhabi, United Arab Emirates

<sup>c</sup> MD, Universidad Autónoma de Bucaramanga, Urologist, Pontificia Universidad Javeriana, Master in Clinica Research on Organ, Tissue and Cell Donation and Transplant, Universidad de Barcelona, Urologist, Centro Urológico Foscal CUF, Floridablanca, Colombia

<sup>d</sup> MD, Universidad Autónoma de Bucaramanga, First Year Resident of Urology, Universidad Autónoma de Bucaramanga, Floridablanca, Colombia

<sup>e</sup> MD, Intern, Pontificia Universidad Javeriana. Bogotá, D.C., Colombia

<sup>f</sup> MD, Universidad del Rosario, Urologist, Fundación Puigvert Barcelona, Urologist, Centro Urológico Foscal CUF, Floridablanca, Colombia

### ARTICLE INFO

#### Article history:

Received 28 July 2016

Accepted 11 May 2017

Available online 1 July 2017

#### Keywords:

Ultrasonography  
Ultrasonography, interventional  
Pudendal nerve  
Anesthesia, regional  
Nerve block

### ABSTRACT

**Introduction:** Pudendal nerve blocks have a wide range of clinical applications for the management of acute post-operative pain in urologic, gynecological surgery, in coloproctology, as well as in pain medicine for differential diagnosis, and for the management of pudendal neuropathies. However, despite its benefits it is infrequently used.

**Objective:** To perform a detailed description of the most recent ultrasound-guided techniques with the aim of encouraging safe and reproducible learning.

**Materials and methods:** We have performed a broad, non-systematic review of the literature through Medline, Embase and Science Direct between 1985 and 2016, to evaluate the most relevant articles, using the following key words: pudendal nerve anatomy, pudendal nerve, pudendal nerve blocks, pudendal nerve ultrasound, pudendal neuralgia, nerve entrapment, chronic pain, Alcock canal, and pelvic pain. The search was limited to articles published in Spanish, English and French.

**Results:** Recent descriptions were found of a large number of anatomic variants, which are described in detail and shown in graphic documents in order to facilitate the sonoanatomic correlation of nerve location as a guide for the performance of the pudendal nerve block through the different approaches.

<sup>☆</sup> Please cite this article as: Rojas-Gómez MF, Blanco-Dávila R, Tobar Roa V, Gómez González AM, Ortiz Zableh AM, Ortiz Azuero A. Anestesia regional guiada por ultrasonido en territorio del nervio pudendo. Rev Colomb Anestesiología. 2017;45:200-209.

\* Corresponding author at: Sociedad Especializada de Anestesiología SEA S.A., Clínica Carlos Ardila Lulle, Carrera 24 No. 154-106, Floridablanca, Colombia.

E-mail address: [mariafernanda.mfrojas@gmail.com](mailto:mariafernanda.mfrojas@gmail.com) (M.F. Rojas-Gómez).

2256-2087/© 2017 Sociedad Colombiana de Anestesiología y Reanimación. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Conclusions:** The deep and detailed knowledge of the anatomy of the pudendal nerve and its variations is essential for the realization of Regional Anesthesia techniques guided by images. These promising techniques should continue to be evaluated with clinical studies.

© 2017 Sociedad Colombiana de Anestesiología y Reanimación. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Anestesia regional guiada por ultrasonido en territorio del nervio pudendo

### R E S U M E N

#### Palabras clave:

Ultrasonografía  
Ultrasonografía intervencional  
Nervio pudendo  
Anestesia regional  
Bloqueo nervioso

**Introducción:** Los bloqueos del nervio pudendo poseen un amplio rango de utilidades clínicas en el manejo agudo de dolor POP en cirugía urológica, ginecológica, en coloproctología así como en Medicina del dolor en diagnóstico diferencial y manejo de las neuropatías del nervio pudendo. Sin embargo su aplicación es relativamente infrecuente a pesar de los beneficios. **Objetivo:** Realizar una descripción detallada de las técnicas más recientes guiadas por ultrasonografía con el objeto de motivar su aprendizaje de una manera segura y reproducible.

**Materiales y métodos:** Se realizó una revisión amplia, no sistemática de la literatura a través de Medline, Embase y Science Direct desde 1985 hasta 2016, evaluando los artículos más relevantes, utilizando las palabras clave: anatomía del nervio pudendo, nervio pudendo, bloqueos del nervio pudendo, ultrasonido del nervio pudendo, neuralgia del pudendo, atrapamiento nervioso, dolor crónico, canal de Alcock y dolor pélvico. La búsqueda se limitó a artículos publicados en español, inglés y francés.

**Resultados:** Se encontraron recientes descripciones de una gran cantidad de variantes anatómica, que se describen en detalle y muestran en documentos gráficos con el propósito de facilitar la correlación sonoanatómica de la localización del nervio como guía para la realización de bloqueos de nervio pudendo a través de los diferentes abordajes.

**Conclusiones:** El conocimiento profundo y detallado de la anatomía del nervio pudendo y sus variaciones es esencial para la realización de técnicas de anestesia regional guiada por imágenes. Estas técnicas promisorias deben continuar evaluándose con estudios clínicos.

© 2017 Sociedad Colombiana de Anestesiología y Reanimación. Publicado por Elsevier España, S.L.U. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Pudendal nerve blocks have a wide range of clinical applications<sup>1,2</sup> that involve anaesthetic/analgesic goals: haemorrhoid,<sup>3-6</sup> ano-rectal, vaginal, and perineal<sup>7</sup> surgery; labour,<sup>8</sup> episiotomies,<sup>9,10</sup> prostate biopsy,<sup>11</sup> prostate brachytherapy,<sup>12</sup> interstitial cystitis,<sup>13</sup> and penile surgery.<sup>14</sup> Moreover it is an integral part of the diagnosis and therapy of pudendal neuropathy of which little is known, although there is growing research into its pathophysiology and therapeutic approaches.<sup>2,14-20</sup>

Despite the above, pudendal nerve blocks are not a popular technique in daily practice in general, urologic or obstetric surgery, perhaps because of lack of knowledge of the block or because of the frequency of blind blocks with variable or incomplete results.<sup>8</sup> At present, with the popularity of ultrasound-guided blocks<sup>21-32</sup> it is important to review the anatomy, sonoanatomy and some relevant technical aspects that may make its implementation a safe and reproducible practice.

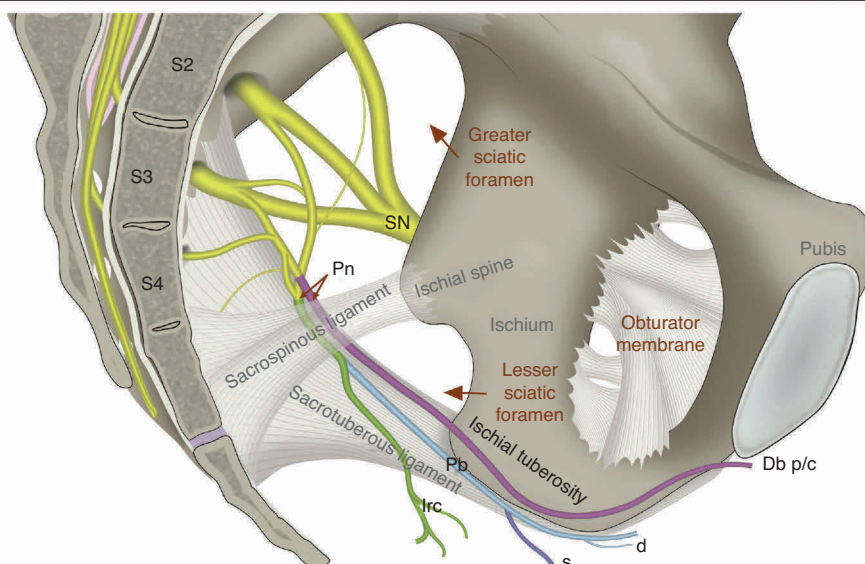
## Objective

Pudendal nerve blocks are an option to consider in certain urologic, gynaecologic and coloproctology procedures and, more recently, also in the pain clinic, thanks to the growing development of ultrasound as a neurolocalisation technique. The objective of this study was to review the indications and techniques for pudendal blocks, taking into account recent detailed descriptions of the complexity and anatomic variants of the pudendal nerve as determining factors for success with the block, and for the education process required to disseminate the benefits.

## Pudendal nerve anatomy

The pudendal nerve is the main nerve of the perineum,<sup>33</sup> the pelvic floor muscles<sup>18,34</sup> and the external sexual organs. It was described by Benjamin Alcock in 1836 as he studied the course of the internal pudendal artery<sup>35-37</sup>; since that time,

Nerve roots	Branchings		Sensory innervation	Motor innervation	Autonomic
Pudendal nerve (Pn)  S1 S2-S4 S5  Anatomic presentation  30% autonomic and 70% somatic: 50% sensory and 20% motor	Dorsal branch of the penis/clitoris S2 (DBp/c)	Clitorid branch	Erectile tissue of the corpus cavernosum and crus of the penis/clitoris and the skin over the dorsolateral aspect of the foreskin, glans and penis/clitoris	Muscles involved in erection	Erection initiation and maintenance (parasympathetic)
		Pubic Branch			
	Perineal branch (Pb)	Deep/muscular (d)	Lower third of the vagina and urethra	Superficial and deep transverse perineal muscle, bulbospongiosus, ischiocavernosus, urethral sphincter, ant. portion of the ext. anal sphincter and variable areas of the levator ani	Conscious sensation of the need to urinate
		Superficial: Medial Branch Posterolateral Branch	Posterior portion of the perineal skin and scrotum/labia majora and labia minora	To the external sphincter and variable innervation of the levator ani	
	Inferior rectal branch S3 (Irb)		Sensory innervation of the anal circumference skin, the caudal third of the rectum and posterior vulvar	Levator ani muscle and external anal sphincter	Conscious awareness of the need to defecate



**Fig. 1 – Anatomy and function of the pudendal nerve (Pn), formed by the roots of S2–S4. Its branches include the dorsal branch of the penis/clitoris DBp/c; the perineal branch (Pb) with its deep (d) and superficial (s) branches, as well as the inferior rectal branch (Irb) in its relation with the sacrospinous and sacrotuberous ligaments; the greater and lesser sciatic foramen; the ischial spine and the sciatic nerve (SN).**  
 Source: María Fernanda Rojas Gómez MD.

interesting descriptions of its complexity and anatomic variability have been made.<sup>35,38-44</sup> The nerve receives input from the primary ventral roots of S2–S4 in the sacral plexus, forming 1, 2 or three trunks before its final branching<sup>41,45</sup>; variable contributions from S1 and/or S5<sup>46-49</sup> have also been described. When supply to the plexus is mainly from S2 and S3, it is called a prefixed plexus, and when the main contributions are from S3 and S4, it is called a postfixed plexus.<sup>43</sup>

The pudendal nerve consists of 70% somatic fibres and 30% autonomic fibers. The visceral branch has 4–6 branches that connect with the roots of S2–S4 in order to form the pelvic sympathetic and parasympathetic plexus as shown in Fig. 1.<sup>48,50</sup>

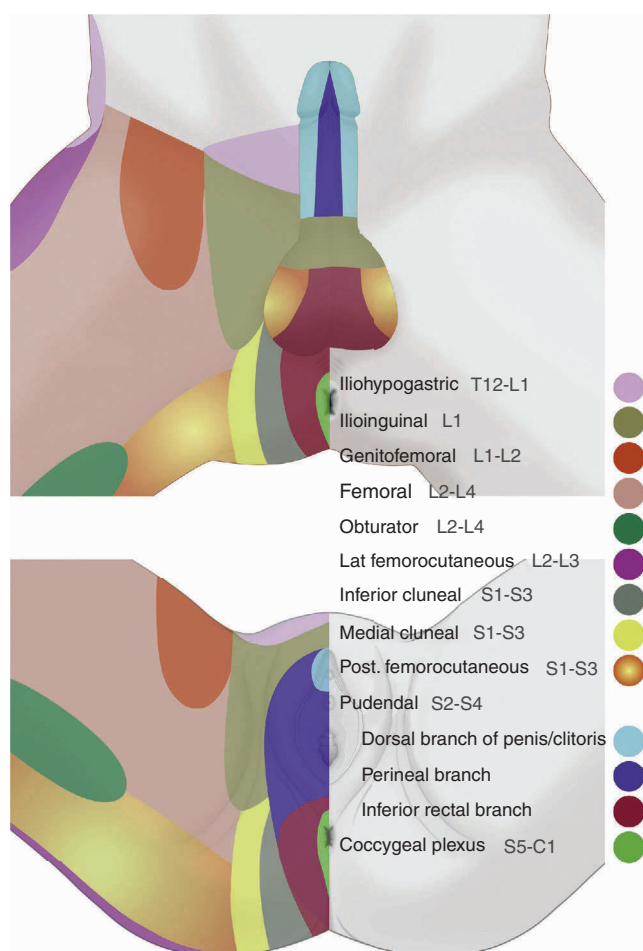
Three nerve branches have been described: the inferior rectal branch, the perineal branch and the dorsal branch of the penis/clitoris. The perineal branch divides into the superficial and deep branches, and the former divides into the medial and posterolateral of the scrotum/labia.<sup>51</sup> Interconnections

between the perineal and rectal branches and the posterior femorocutaneous nerve are frequent.<sup>52</sup>

It is important to highlight their functional role in micturition, defecation, erection, ejaculation and childbirth.<sup>14,38,41,53</sup> Fig. 2 illustrates the dermal distribution territories of the nerves of the genital area.

The perineal nerve emerges from the pelvis through the greater sciatic foramen in a caudal course towards the piriformis muscle and the sciatic nerve. Later, it re-enters the pelvis through the lesser sciatic foramen, dorsal to the sacrospinous ligament and ventral to the sacrotuberous ligament.<sup>8,35,41,44,54-57</sup> It is in the interligamentous portion of its course where compressive nerve pathologies may be frequently found (see Figs. 3 and 4).

In the anatomic descriptions by doctors Gabrielli and Olave,<sup>43</sup> the pudendal nerve is shown to be present either as a single trunk (53.3%), as two trunks (36.7%) or as three trunks (6.7%). Pasuk Mahakkanuk et al.<sup>42</sup> found the pudendal nerve



**Fig. 2 – Perineal dermatomes showing the dermal distribution territories of the iliohypogastric, ilioinguinal, genitofemoral, femoral, pudendal, inferior cluneal, obturator, posterior femorocutaneous, lateral femorocutaneous nerves, and the coccygeal plexus, which may present frequent anatomic variations and interconnections.**  
Source: María Fernanda Rojas Gómez MD.

as a single trunk (56.2%), two trunks (31.5%) and three trunks (12.3%). In their anatomic assessments, Furttmuller et al.<sup>44</sup> found that the perineal and the rectal branches arise from a common trunk most of the time; they also found a common trunk between the dorsal branch of the penis and the perineal branch, but less frequently between the dorsal branch of the penis and the inferior rectal branch, thus forming two and even three trunks from their origin.

In the posterior portion of the ischioanal fossa, immediately after the sacrospinous ligament, the nerve branches for the first time, giving rise to the inferior rectal nerve, which penetrates the internal fascia of the obturator muscle in order to innervate its anal territory.<sup>47,58</sup> Mahakkanukrauh et al. found that, in 21% of cases, the inferior rectal nerve arises independently from the root of S4 without being part of the pudendal trunk.<sup>41</sup> The perineal branch penetrates medially into the internal fascia of the obturator muscle, sliding towards the base of the urogenital diaphragm where it divides

into its superficial and deep terminal branches. The dorsal branch of the penis/clitoris arises from Alcock's canal<sup>38</sup> and continues proximal to the inferior pubic ramus anteriorly; the course through Alcock's canal has been described as one of the most susceptible areas for nerve entrapment. In their work, O'Bichere et al. showed that the dorsal branch of the penis/clitoris may arise directly from S2 in 25% of cases.<sup>48</sup>

The internal pudendal artery and vein are also found along the course of the pudendal nerve and its branches.<sup>41</sup> This is very helpful in identifying the nerve under echo Doppler (see Fig. 5).<sup>1,49,59</sup> At the gluteal level, the internal pudendal artery was found lateral to the nerves in 60% of cases, medial in 35% and on either side of the nerves (double), and slightly lateral and ventral to them, in 5% of cases.<sup>2,53,57,60,61</sup>

## Technique

Pudendal nerve blocks may be performed through two approaches: anterior/perineal<sup>1,2,7,54</sup> or posterior/transgluteal.<sup>2,49,56,59,62-65</sup> The perineal approach is used for distal entrapments or for anaesthetic/analgesic purposes in gynaecological, urological or colorectal surgery. The posterior approach has been used in recent years in proximal nerve entrapment syndrome, with a high rate of success in terms of the diagnostic/therapeutic objective, although with a moderate 21.7% risk of sacral plexus blockade.<sup>2</sup>

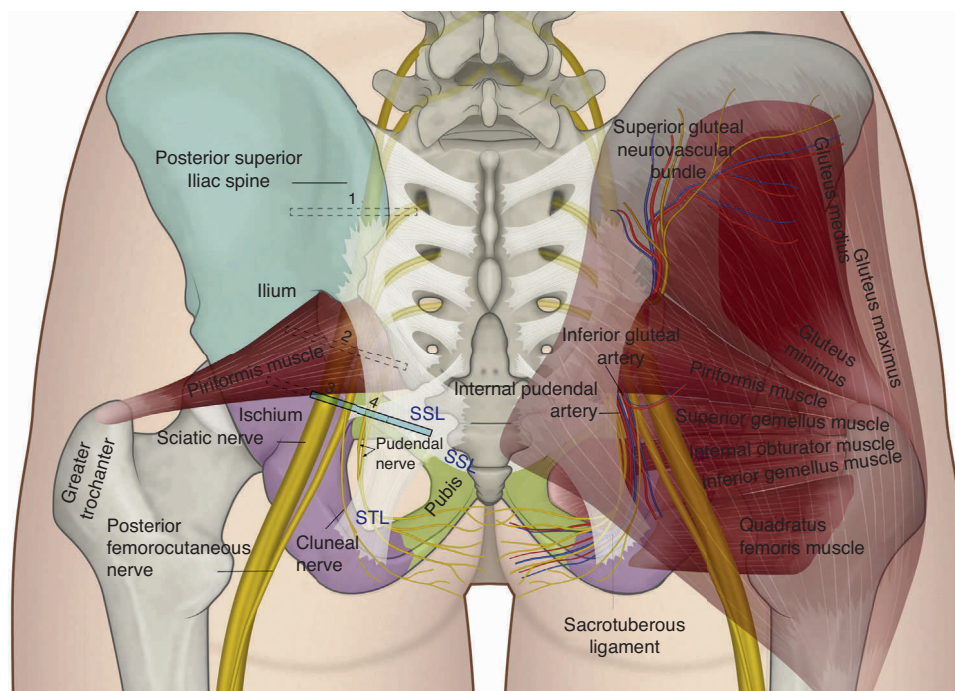
Techniques for pudendal nerve blocks described include: 1. anatomical landmarks<sup>15</sup>; 2. neurostimulation<sup>6,66</sup>; 3. fluoroscopy<sup>49</sup>; 4. tomography<sup>67-69</sup>; and, more recently, blockage guided by ultrasound.<sup>1,7,49,59,70-72</sup> We believe that ultrasound is better than other techniques in terms of practical use and results<sup>71</sup> and, therefore, we will focus on the sonoanatomic descriptions that enable a refined and reproducible practice in order to increase the frequency of success in terms on the specific goals proposed for each individual patient.<sup>60,61</sup>

## Posterior approach

In 2001, Kovacs et al. described the ultrasound-guided block technique at the level of the ischial spine in cadavers<sup>73</sup> and Rofaefel did so in humans in 2008.<sup>59</sup> Following the protocol consisting of the informed consent, monitoring, positioning, asepsis, antisepsis, and sedation for all blocks, with the patient on lateral decubitus and the area to be blocked facing upwards and the knees slightly flexed, or in prone position with soft support under the pelvis,<sup>65</sup> an identification scan is performed using a linear or convex transducer depending on the patients's constitution. In the average adult patient, the pudendal nerve is located 5–6 cm from the skin.<sup>59</sup> leading to a more frequent use of the convex transducer, which is placed initially across the proximal gluteal area and then moved obliquely as shown in Fig. 3.

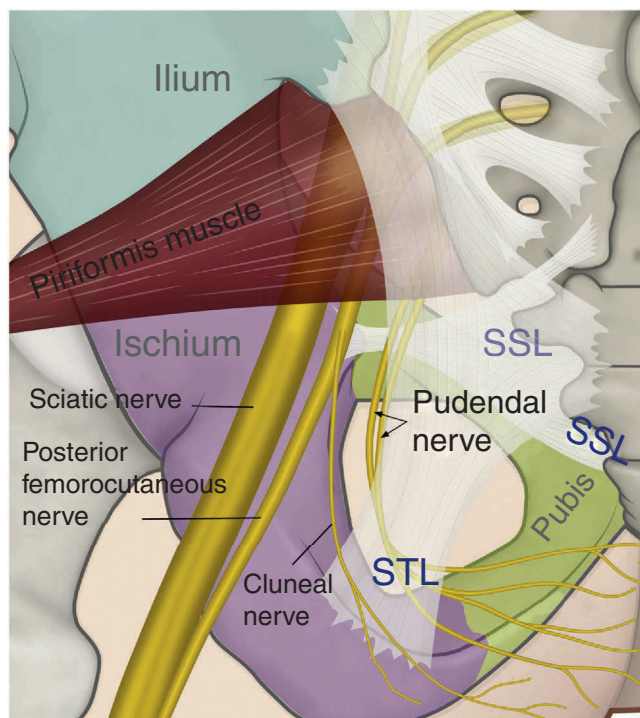
Once the settings are adjusted and the image optimised, the following structures need to be recognised, from proximal to distal: in transducer's **position 1**, posterosuperior iliac spine; in **position 2**, greater sciatic foramen, sacral and iliac ridge, piriformis muscle, sacral plexus, superior gluteal artery





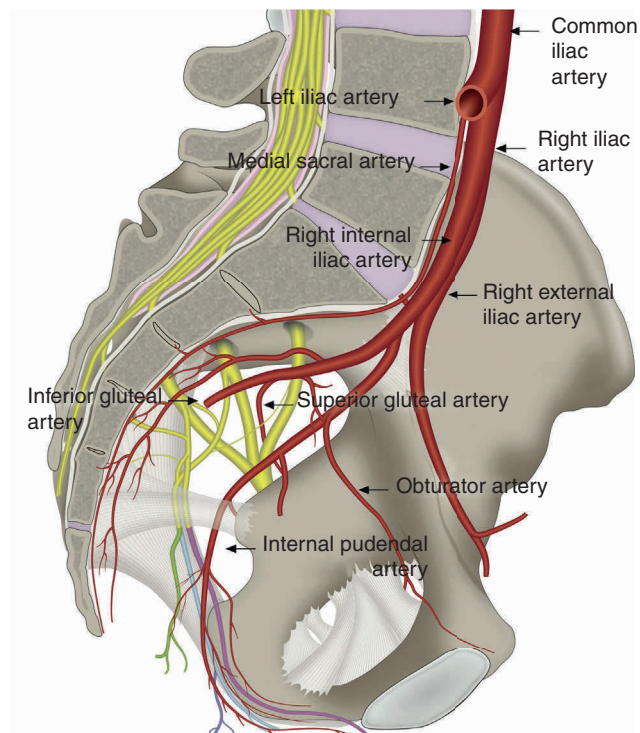
**Fig. 3** – Gluteal anatomy and recommended position for the ultrasound transducer for assessment: (1) at the level of the postero-superior iliac spine; (2) at the level of the greater sciatic foramen; (3) at the level of the ischial spine; and (4) medial to the ischial spine.

Source: María Fernanda Rojas Gómez MD.



**Fig. 4** – Relationship of the sacrospinous (SSL) and sacrotuberous (STL) ligaments (made transparent in order to show the deep structures), and the course of the pudendal, sciatic and posterior femorocutaneous nerves.

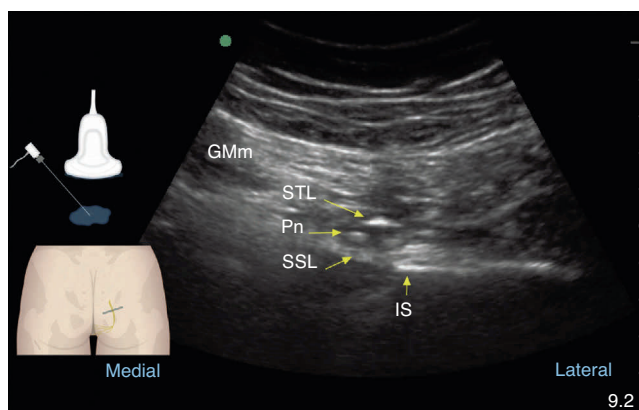
Source: María Fernanda Rojas Gómez MD.



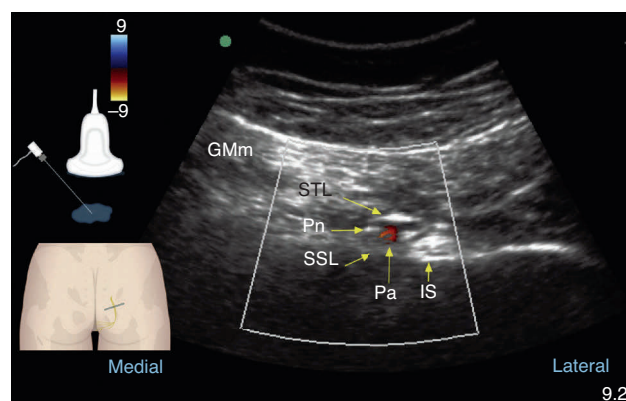
**Fig. 5** – Internal pudendal artery, a branch of the internal iliac artery, and its relation with the sacrospinous and sacrotuberous ligaments and the internal pudendal nerve.

Source: María Fernanda Rojas Gómez MD.

and, deep down, bowel movement may be recognised. In the transducer's **position 3**, the ischial spine must be recognised as a straight hyperechoic line with the acoustic shadow deep to it<sup>74</sup>; the sacrospinous ligament as a continuation of the hyperechoic line of the ischial spine, of lower echogenicity than the bone; the sacrotuberous ligament, superficial and parallel to the sacrospinous ligament, deep to the gluteus maximus muscle, the sciatic nerve and the inferior gluteal artery. With the transducer in this position, on the medial edge of the image, attention must be focused on the identification of the internal pudendal artery and the pudendal nerve, the latter being difficult to visualise because of its small size of 3.6 mm.<sup>73,75</sup> In their work, Bellingham et al. were able to identify the nerve only 57% of the time with an experienced operator<sup>49</sup>; at this level, it is found in the interfascial plane medial to the pudendal vessels in the majority of cases.<sup>65</sup> Once these structures have been recognised, the transducer should be moved in the same angle until the pudendal neurovascular bundle appears in the centre of the ultrasound image and the transducer is in **position 4**. This is where the puncture will be made either in-plane from medial to lateral, or out-of-plane, as shown in **Figs. 6 and 7**, using a short-bevel 80-100 mm x 22G needle according to the patient's constitution. Sensory or motor neurostimulation may be used in the proximity of the nerve in order to determine the presence of paresthesia/motor contraction in the territory of the pudendal nerve. It is important to check for the intensity point at which the stimulus disappears in order to confirm that the needle is not intraneural and, ideally, that intensity must be between 0.2 and 0.3 mAmp.<sup>2</sup> Once it is in the right position, the drug is administered slowly and in a fragmented manner, in accordance with the stated objective, with frequent aspiration. For chronic pain, a mix of long-acting local anaesthetic and corticosteroid is used in a volume ranging from 4 to 6 cc.<sup>13,49</sup> Fitchner et al. suggest a slightly more caudal technique at the entry point to Alcock's canal in order to reduce the risk of a sciatic nerve block.<sup>2</sup>



**Fig. 6 – Gluteal ultrasound during pudendal nerve (Pn) recognition. The nerve is deep to the gluteus maximus muscle (GMm), the sacrotuberous ligament (STL), and superficial to the sacrospinous ligament (SSL). The ischial spine (IS) is found lateral to those structures. Source: Author.**



**Fig. 7 – Colour Doppler ultrasound at the gluteal level: pudendal nerve (Pn), gluteus maximus muscle (GMm), deep to the sacrotuberous ligament (STL) and superficial to the sacrospinous ligament (SSL); the internal pudendal artery (Pa) and the ischial spine are found lateral to these structures. Source: Author.**

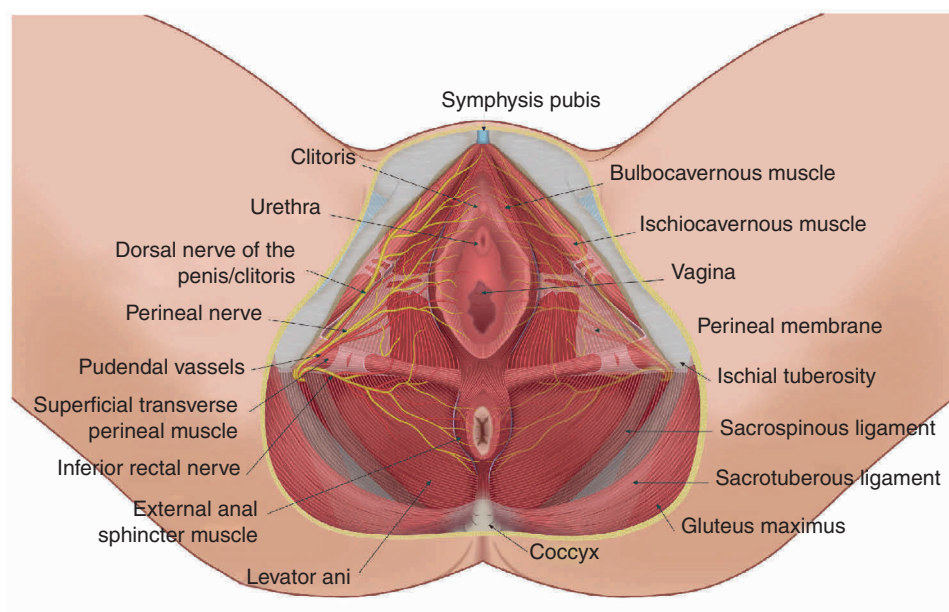
### Anterior approach

The ultrasound-guided perineal approach was reported by Parras and Blanco in 2013.<sup>1</sup> Given that the nerve is very superficial in the perineal area, high or intermediate frequency transducers are recommended.<sup>1,7,70</sup> After monitoring with the patient in lithotomy position, sedation, skin asepsis and transducer protection, the transducer is placed lateral to the vulvar/scrotal junction with the rectum, in an oblique sagittal or transverse position, to identify the perineal anatomy and the pudendal neurovascular bundle distally (see **Fig. 8**).

The transducer must be placed medial to the bony ridge of the ischiopubic ramus of the ischial tuberosity, and attention must be focused on looking for small hyperechoic structures of approximately 3 mm<sup>76</sup> that might correspond to the branches of the pudendal nerve. Recognition may be impaired because of their small diameter, and colour Doppler must be used for identifying the internal pudendal artery. Once the vascular structure is identified, B mode is selected again and the correlation between the colour Doppler and the hypoechoic image of the artery is determined. The branches of the pudendal nerve are close to the branching of the artery.<sup>1</sup> The neurovascular bundle must be situated in the centre of the screen (see **Fig. 9**).

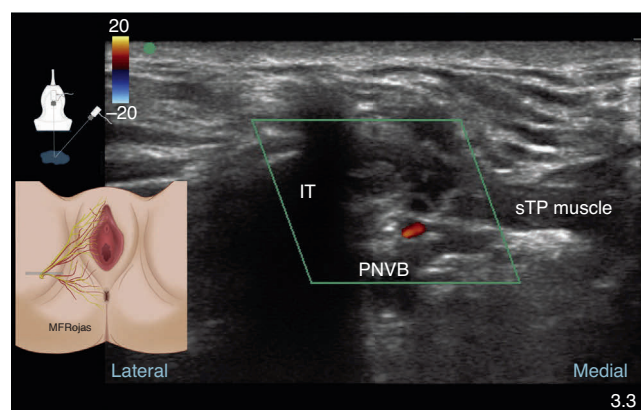
The skin is infiltrated with a fine needle in order to reduce the discomfort caused by the penetration of the blunt 22G x 50 mm neurostimulation needle. It is advanced in-plane or out-of-plane towards the target. Using a neurostimulation intensity of 0.6–0.4 mAmp,<sup>9</sup> look for the contraction of the anal sphincter or of the peripheral perineal structures in proximity to the neural structure, in order to confirm that the inferior rectal nerve is close<sup>3</sup>; safety guidelines must be applied in order to avoid intraneural puncture. Roffaeel et al. showed that the use of neurostimulation is not 100% reliable for the identification of the pudendal nerve<sup>59</sup>; this may be due perhaps to the low percentage of motor fibres it contains or the small size





**Fig. 8 – Perineal anatomy.**

Source: María Fernanda Rojas Gómez MD.



**Fig. 9 – Perineal ultrasound in colour Doppler mode showing the ischial tuberosity (IT), superficial transverse perineal muscle (sTP) and the pudendal neurovascular bundle (PNVB).**

Source: María Fernanda Rojas Gómez MD.

of its branches. Once the correct position of the needle has been confirmed, a response obtained or the internal pudendal artery seen, gentle aspiration is applied in order to ensure that the tip of needle is not inside the lumen of a blood vessel before starting the slow injection of the local anaesthetic mix, aspirating regularly and watching the ultrasound monitor for the correct distribution of the local anaesthetic; after the infiltration, the injected aqueous solution helps with the recognition of the nerve structures as it enhances echogenic contrast.<sup>1</sup>

The recommended volume of the selected local anaesthetic mix will depend on the objective of the block, although the recommended volume is usually 0.1 and 0.15 ml/kg on each side.<sup>77</sup> Long-acting drugs with a high safety profile, such as

levobupivacaine, must be considered,<sup>1,16</sup> always within the context of multimodal analgesia. The same applies when the concomitant use of corticosteroids is indicated.

Although in these approaches the drug mass used is low, it is advisable to be vigilant of the patient's state of consciousness and haemodynamic status at all the time, and watchful of the local anaesthetic distribution in the ultrasound image.

## Complications

Although the reported rate of complications is low, they may still occur, and they include pudendal nerve injury, vascular injury, intravascular application of the drug mix, muscle weakness in the sciatic nerve territory, muscle pain, urinary or faecal incontinence, and numbness in the pudendal nerve area.<sup>16</sup>

## Conclusions

A deep detailed knowledge of the pudendal nerve anatomy and its variants is essential for the use of imaging-guided regional anaesthesia techniques.

Ultrasound has shown to be of great help in nerve localisation in order to guide and control the application of anaesthetic or analgesic mixes in a more accurate, safe and efficient way. Special attention must be given to overall safety measures, the correct placement of the tip of the needle in relation to the nerve<sup>78</sup> in order to reap the benefits of analgesia, and comfort with the procedures in which the block is indicated. Additional clinical studies are required for the evaluation of these promising techniques.

## Financing

The authors declare not having received any form of financial support for this work.

## Conflicts of interest

The authors have no disclosures regarding conflict of interest.

## Acknowledgements

We are grateful to doctors Alejandro Corujo, Antonio Bonilla, Ciro Alfonso Rodríguez and José Ariel Giraldo for their interest in reviewing this paper and making contributions.

## REFERENCES

- Parras T, Blanco R. Bloqueo pudendo ecoguiado Ultrasonido Guided Pudendal Block. *Cir Mayor Ambul.* 2013;18:31-5.
- Fichtner Bendtsen T, Parras T, Moriggl B, Chan V, Lundby L, Buntzen S, et al. Ultrasound-guided pudendal nerve block at the entrance of the pudendal (Alcock) canal description of anatomy and clinical technique. *Reg Anesth Pain Med.* 2016;41:140-5.
- Imbelloni LE, Vieira EM, Gouveia MA, Netinho JG, Spirandelli LD, Cordeiro JA. Pudendal block with bupivacaine for postoperative pain relief. *Dis Colon Rectum.* 2007;50:1656-61.
- Relato A, Case P. Bloqueo bilateral do nervo pudendo para hemorroidectomia. *Rev Bras Anestesiol.* 2006;56:168-73.
- Kim J, Lee DS, Jang SM, Shim MC, Jee DL. The effect of pudendal block on voiding after hemorrhoidectomy. *Dis Colon Rectum.* 2005;48:518-23.
- Cubes J, Siver S, Zabala S, Llopis R. Nerve stimulator guided pudendal block in hemorrhoidectomy for postoperative pain relief. *Reg Anesth Pain Med.* 2010;35:E166.
- Parras T, Blanco R. Bloqueo perineal ecoguiado: abordaje anterior como técnica analgésica en vulvectomía. *EuroEco.* 2014;5:95-7.
- Reding C, Ramirez P, Villagomez Z, Barbolla J, Rosique I. Bloqueo de Nervios Pudendos en Obstetricia. In: *Memorias del IX Congreso Mexicano de Anestesiología, 1962 Nov; Mexico DF, Mexico:* 1962.
- Aissaoui Y, Bruyere R, Mustapha H, Bry D, Kamili ND, Miller C. A randomized controlled trial of pudendal nerve block for pain relief after episiotomy. *Obstet Anesth Dig.* 2009;29:101.
- Arslan M, Yazici G, Dilek U. Pudendal nerve block for pain relief in episiotomy repair. *Obstet Anesth Dig.* 2005;87:156-7.
- Venegas-Ocampo P, Castillo-De Lira H, Robles-Scott M, Landa-Soler M, López-Mariscal M, Mendoza-Peña F, et al. Comparación de la efectividad del bloqueo perineal de los nervios pudendos como método anestésico en la biopsia transrectal de próstata guiada por ultrasonido. *Rev Mex Urol.* 2010;70:164-70.
- Schenck M, Schenck C, Rübber H, Stuschke M, Schneider T, Eisenhardt A, et al. Pudendal nerve block in HDR-brachytherapy patients: do we really need general or regional anesthesia? *World J Urol.* 2013;31:417-21.
- Lean LL, Hegarty D, Harmon D. Analgesic effect of bilateral ultrasound-guided pudendal nerve blocks in management of interstitial cystitis. *J Anesth.* 2012;26:128-9.
- Sedy J, Nanka O, Spaskova J, Jarolim L. Clinical implications of a close vicinity of nervus dorsalis penis/clitoridis and os pubis. *J Sex Med.* 2008;5:1572-81.
- Weinschenk S, Hollmann MW, Strowitzki T. New perineal injection technique for pudendal nerve infiltration in diagnostic and therapeutic procedures. *Arch Gynecol Obstet.* 2015;293:805-13.
- Vancaillie T, Eggermont J, Armstrong G, Jarvis S, Liu J, Beg N. Response to pudendal nerve block in women with pudendal neuralgia. *Pain Med.* 2012;13:596-603.
- Guan Y, Wendong S, Zhao S, Liu T, Liu Y, Zhang X, et al. The vascular and neurogenic factors associated with erectile dysfunction in patients after pelvic fractures. *Int Braz J Urol.* 2015;41:959-66.
- Itza Santos F, Salinas J, Zarza D, Gómez Sancha F, Allona Almagro A. Update in pudendal nerve entrapment syndrome: an approach anatomic-surgical, diagnostic and therapeutic. *Actas Urol Esp.* 2010;34:500-9.
- Spinosa J, Bisschop EDE, Laurençon J. Original article differential staged sacral reflexes allow a localization of pudendal neuralgia. *J Neurosci.* 2009;28:24-8.
- Antolak SJ, Power Point Pudendal nerve perineural injections. Effective treatment of pudendal neuropathy; 2011.
- Royse CF, Canty DJ, Faris J, Haji DL, Veltman M, Royse A. Core review: physician-performed ultrasound: the time has come for routine use in acute care medicine. *Anesth Analg.* 2012;115:1007-28.
- Gelfand HJ, Ouanes JPP, Lesley MR, Ko PS, Murphy JD, Sumida SM, et al. Analgesic efficacy of ultrasound-guided regional anesthesia: a meta-analysis. *J Clin Anesth.* 2011;23:90-6.
- Neal JM, Brull R, Chan VWS, Grant Sa, Horn J-L, Liu SS, et al. The ASRA evidence-based medicine assessment of ultrasound-guided regional anesthesia and pain medicine. *Reg Anesth Pain Med.* 2010;35 Suppl. 1:S1-9.
- Carli F, Kehlet H, Baldini G, Steel A, McRae K, Slinger P, et al. Evidence basis for regional anesthesia in multidisciplinary fast-track surgical care pathways. *Reg Anesth Pain Med.* 2011;36:63-72.
- Mathur V, Bravos ED, Vallera C, Wu CL. Regional anesthesia and patient outcomes: evidence-based medicine. *Tech Reg Anesth Pain Manag.* 2008;12:163-70.
- Fischer B. Benefits, risks, and best practice in regional anesthesia: do we have the evidence we need? *Reg Anesth Pain Med.* 2010;35:545-8.
- Helayel PE, Bruggemann D, Rodrigues G. Bloqueos Nerviosos Guiados por Ultrasonido. *Rev Bras Anestesiol.* 2007;57:60-70.
- Liu SS. Evidence basis for ultrasound-guided block characteristics onset, quality, and duration. *Reg Anesth Pain Med.* 2015;40:1.
- Liu SS, Ngeow JE, YaDeau JT. Ultrasound-guided regional anesthesia and analgesia. *Reg Anesth Pain Med.* 2009;34:47-59.
- McCartney CJL, Lin L, Shastri U. Evidence basis for the use of ultrasound for upper-extremity blocks. *Reg Anesth Pain Med.* 2010;35 Suppl.:S10-5.
- Gart MS, Gosain AK. Evidence-based medicine. *Plast Reconstr Surg.* 2014;134:1345-55.
- Han SM, Moon DE, Kim YH, Park H, Lee MK, Sa G. Ultrasound-guided pudendal nerve pulsed radiofrequency in patients with refractory pudendal neuralgia. *Anesth Pain.* 2014;9:250-3.
- Gorniak G, King PM. The peripheral neuroanatomy of the pelvic floor. *J Women's Heal Phys Ther.* 2016;40:3-14.
- Guaderrama NM, Liu J, Nager CW, Pretorius DH, Sheean G, Kassab G, et al. Evidence for the innervation of pelvic floor muscles by the pudendal nerve. *Obstet Gynecol.* 2005;106:774-81.



35. Colebunders B, Matthew MK, Broerm N, Persing JA, Dellon AL. Benjamin Alcock and the pudendal canal. *J Reconstr Microsurg*. 2011;27:349-53.
36. Hawtrey CE, Williams RD. Historical Evolution of transurethral resection at the University of Iowa: Alcock and Flocks. *J Urol*. 2008;180:55-61.
37. Amarenco G, Lanoe Y, Perrigot M. A new canal syndrome: compression of the pudendal nerve in Alcock's canal or perineal paralysis of cyclists. *Press Med*. 1987;16:399.
38. Hruby S, Ebmer J, Dellon AL, Aszmann OC. Anatomy of pudendal nerve at urogenital diaphragm – New critical site for nerve entrapment. *Urology*. 2005;66:949-52.
39. Robert R, Prat-Pradal D, Labat JJ, Bensignor M, Raoul S, Rebai R, et al. Anatomic basis of chronic perineal pain: role of the pudendal nerve. *Surg Radiol Anat*. 1998;20:93-8.
40. Maldonado PA, Chin K, Garcia AA, Corton MM. Anatomic variations of pudendal nerve within pelvis and pudendal canal: clinical applications. *Am J Obstet Gynecol*. 2015;213, 727e1-6.
41. Mahakkanukrauh P, Surin P, Vaidhayakarn P. Anatomical study of the pudendal nerve adjacent to the sacrospinous ligament. *Clin Anat*. 2005;18:200-5.
42. Gabrielli C, Olave E. Aspectos Anatómicos y Topográficos del Nervio Pudendo en la Región Glútea. *Int J Morphol*. 2011;29:168-73.
43. Furtmüller GJ, McKenna CA, Ebmer J, Dellon AL. Pudendal nerve 3-dimensional illustration gives insight into surgical approaches. *Ann Plast Surg*. 2014;73:670-8.
44. Grigorescu BA, Lazarou G, Olson TR, Downie SA, Powers K, Greston WM, et al. Innervation of the levator ani muscles: description of the nerve branches to the pubococcygeus, iliococcygeus, and puborectalis muscles. *Int Urogynecol J Pelvic Floor Dysfunct*. 2008;19:107-16.
45. O'Bichere A, Green C, Phillips RK. New, simple approach for maximal pudendal nerve exposure: anomalies and prospects for functional reconstruction. *Dis Colon Rectum*. 2000;43:956-60.
46. Ogiwara H, Morota N. Pudendal afferents mapping in posterior sacral rhizotomies. *Neurosurgery*. 2014;74:171-5.
47. Shafik A, El-Sherif M, Youssef A, Olfat ES. Surgical anatomy of the pudendal nerve and its clinical implications. *Clin Anat*. 1995;8:110-5.
48. Martens FMJ, Heesakkers JPFA, Rijkhoff NJM. Surgical access for electrical stimulation of the pudendal and dorsal genital nerves in the overactive bladder: a review. *J Urol*. 2011;186:798-804.
49. Bellingham GA, Bhatia A, Chan C-W, Peng PW. Randomized controlled trial comparing pudendal nerve block under ultrasound and fluoroscopic guidance. *Reg Anesth Pain Med*. 2012;37:262-6.
50. Beco J, Pesce F, Siroky M, Weiss J, Antolak S. Pudendal neuropathy and its pivotal role in pelvic floor dysfunction and pain. In: ICS/IUGA conference. 2010. p. 0-12.
51. Benson JT, Griffis K. Pudendal neuralgia, a severe pain syndrome. *Am J Obstet Gynecol*. 2005;192(SPEC. ISS): 1663-8.
52. Hwang K, Nam YS, Kim DJ, Han SH, Hwang SH. Posterior cutaneous nerve of the thigh relating to the restoration of the gluteal fold. *Ann Plast Surg*. 2008;60:357-61.
53. Thompson J, Gibb J, Genadry R, Burrows L, Lambrou N, Buller JL. Anatomy of pelvic arteries adjacent to the sacrospinous ligament: importance of the Coccygeal Branch of the Inferior Gluteal Artery. *Obstet Gynecol*. 1999;94:973-7.
54. Khoder W, Hale D. Pudendal neuralgia, vol. 41. *Obstetrics and Gynecology Clinics of North America*; 2014. p. 443-52.
55. Stav K, Dwyer PL, Roberts L. Pudendal neuralgia. Fact or fiction? *Obstet Gynecol Surv*. 2009;64:190-9.
56. Bondar A, Egan M, Jochum D, Amarenco G, Bouaziz H. Case report: pudendal nerve injury after a sciatic nerve block by the posterior approach. *Anesth Analg*. 2010;111: 573-5.
57. Van der Walt S, Oettlé A C, Patel HRH. Surgical anatomy of the pudendal nerve and its branches in South Africans. *Int J Impot Res*. 2015;27:128-32.
58. Van der Walt S, Oettlé AC, van Wijk FJ. The pudendal nerve and its branches in relation to Richter's procedure. *Gynecol Obstet Invest*. 2016;81:275-9.
59. Rofaeel A, Peng P, Louis I, Chan V. Feasibility of real-time ultrasound for pudendal nerve block in patients with chronic perineal pain. *Reg Anesth Pain Med*. 2008;33:139-45.
60. Tagliafico A, Perez MM, Martinoli C. High-Resolution ultrasound of the pudendal nerve: normal anatomy. *Muscle Nerve*. 2013;47:403-8.
61. Tagliafico A, Bignotti B, Miguel Perez M, Reni L, Bodner G, Martinoli C. Contribution of ultrasound in the assessment of patients with suspect idiopathic pudendal nerve disease. *Clin Neurophysiol*. 2014;125:1278-84.
62. Silverman D, Chan L, Gray D, Wein A, Harty M, Smith T. Pudendal nerve block in the Greater Sciatic Foramen: A New Technique for transurethral Surgery. *Reg Anesth*. 1987;12:143-7.
63. Prat-Pradal D, Metge L, Gagnard-Landra C, Mares P, Dauzat M, Godlewski G. Anatomical basis of transgluteal pudendal nerve block. *Surg Radiol Anat*. 2009;31:289-93.
64. Kovacs P, Gruber H. Study of Pudendal Nerve Location with Ultrasound. In: IUGA. Innsbruck, Austria, Innsbruck Medical University Department of Radiology Anichstr. 35, Sept 6-9 2006. p. 2-5.
65. Shafik A, Doss SH. Pudendal canal: surgical anatomy and clinical implications. *Am Surg*. 1999;65:176-80.
66. Kim SH, Song SG, Paek OJ, Lee HJ, Park DH, Lee JK. Nerve-stimulator-guided pudendal nerve block by pararectal approach. *Color Dis*. 2012;14:611-5.
67. Ricci P, Lema R, Sola V, Wash A, Pardo J. Infiltración del nervio Pudendo guiada por Tomografía Axial Computada, por vía transglútea: terapia frente al dolor ocasionado por neuralgia del nervio pudendo. *Rev Chil Obstet Ginecol*. 2009;74: 94-101.
68. Torres JH, Bernal S, Felice GAT, Bernat JB. Tratamiento del dolor perineal crónico causado por neuralgia del nervio pudendo mediante radiofrecuencia. *Objetivo docente. Radiología*. 2014;56:1-21 ((Espec Cong): 221).
69. Calvillo O, Skaribas IM, Rockett C. Computed tomography-guided pudendal nerve block. A new diagnostic approach to long-term anoperineal pain: a report of two cases. *Reg Anesth Pain Med*. 2000;25:420-3.
70. Peng PWH, Tumber PS. Ultrasound-guided interventional procedures for patients with chronic pelvic pain – a description of techniques and review of literature. *Pain Phys*. 2008;11:215-24.
71. Bhatia A, Brull R. Is ultrasound guidance advantageous for interventional pain management? A systematic review of chronic pain outcomes. *Anesth Analg*. 2013;117: 236-51.
72. Gofeld M. Ultrasonography in Pain Medicine: a critical review. *Pain Practice*. 2008;8:226-40.
73. Kovacs P, Gruber H, Piegger J, Bodner G. New, simple, ultrasound-guided infiltration of the pudendal nerve: ultrasonographic technique. *Dis Colon Rectum*. 2001;44:1381-5.
74. Narouze S, Peng PWH. Ultrasound-guided interventional procedures in pain medicine: a review of anatomy, sonoanatomy, and procedures. Part II: axial structures. *Reg Anesth Pain Med*. 2009;35:386-96.

75. Elahi F, Callahan D, Greenlee J, Dann TL. Pudendal entrapment neuropathy: a rare complication of pelvic radiation therapy. *Pain Phys.* 2013;16:E793-7.
76. Kowalska B, Sudoł-szopińska I. Anatomia prawidłowa i ultrasonograficzna wybranych nerwów obwodowych. Część II: Wybrane nerwy obwodowe kończyny górnej Normal and sonographic anatomy of selected peripheral nerves. Part II: Peripheral nerves of the upper limb. *J Ultrason.* 2012;131-47.
77. Naja Z, Ziade MF. Nerve stimulator guided pudendal nerve block decreases posthemorrhoidectomy pain. *Can J Anaesth.* 2005;52:62-8.
78. Abdallah FW, Macfarlane AJR, Brull R. The requisites of needle-to-nerve proximity for ultrasound-guided regional anesthesia: a scoping review of the evidence. *Reg Anesth Pain Med.* 2016;41:221-8.