



## Salvage Ultrasound-guided Targeted Cryoablation of The Perispermatic Cord For Persistent Chronic Scrotal Content Pain After Microsurgical Denervation Of The Spermatic Cord

Nahomy Calixte, Ibrahim Guven Kartal, Bayo Tojuola, Ahmet Gudeloglu, Mohamed Etafy, Jamin V. Brahmbhatt, Richard A. Mendelson, Michael Chetta, and Sijo J. Parekattil

<b>OBJECTIVE</b>	To assess the efficacy of ultrasound-guided targeted cryoablation (UTC) of the perispermatic cord as a salvage treatment for patients who failed microsurgical denervation of the spermatic cord.
<b>METHODS</b>	Retrospective review of 279 cases (221 patients: 58 bilateral) undergoing UTC between November 2012 and July 2016, performed by 2 fellowship trained microsurgeons. UTC was performed using a 16-gauge cryo needle (Endocare, HealthTronics, Austin, TX). Branches of the genitofemoral, ilioinguinal, and inferior hypogastric nerves were cryoablated medial and lateral to the spermatic cord at the level of the external inguinal ring. Level of pain was measured preoperatively and postoperatively using the visual analog scale and Pain Index Questionnaire-6 (QualityMetric Inc., Lincoln, RI).
<b>RESULTS</b>	Median age was 43 years, operative duration 20 minutes, and postoperative follow-up 36 months (24-60). Subjective visual analog scale outcomes: 75% significant reduction in pain (11% complete resolution and 64% $\geq 50\%$ reduction in pain). Objective Pain Index Questionnaire-6 outcomes: 53% significant reduction at 1 month (279 cases), 55% at 3 month (279 cases), 60% at 6 month (279 cases), 63% at 1 year (279 cases), 65% at 2 years (275 cases), 64% at 3 years (232 cases), 59% at 4 years (128 cases) and 64% at 5 years (53 cases) post-op. Complications: 2 wound infections, 4 penile pain cases (resolved in a few months).
<b>CONCLUSION</b>	UTC of the perispermatic cord is a safe potential treatment option for the salvage management of persistent chronic scrotal pain in patients who have failed microsurgical denervation of the spermatic cord. UROLOGY 130: 181–185, 2019. © 2019 Elsevier Inc.

Chronic scrotal pain (CSP) syndrome or chronic orchialgia (CO) is a common condition in urology that causes significant negative impact on

patient quality of life.<sup>1,2</sup> These patients represent a management dilemma with limited treatment options with patients with chronic pain persisting after appropriate treatment requiring a different approach focussing on pain management often resulting in the long-term administration of narcotic pain relief drugs prescribed and administered under the care of a licensed physician. CSP is defined as intermittent or constant pain of varying degree in one or both testicles for a duration of at least 3 months with a significant impact on quality of life.<sup>3-5</sup> This pain may be a result of prior vasectomy, inguinal hernia surgery, scrotal surgery, and recurrent epididymitis or may be idiopathic.<sup>6-11</sup>

Evidence based literature and clinical practice guidelines on management of CSP are limited resulting in scant recommendations for treatment of, or corrective procedures for the condition. Currently, an estimated 100,000 men are affected by CSP and the number is expected to continue to rise.<sup>12,13</sup>

### Authors Contributions:

- (1) Conception and design: Dr Parekattil
- (2) Administrative Support: Dr Parekattil and Dr Brahmbhatt
- (3) Provision of study material or patients: Dr Parekattil and Dr Brahmbhatt
- (4) Collection and assembly of data: Dr Calixte, Dr Parekattil
- (5) Data analysis and interpretation: Dr Parekattil, Dr Calixte, Dr. Mendelson & Dr. Chetta
- (6) Manuscript writing: All authors
- (7) Final approval of manuscript: All authors

**Funding:** None.

**Financial Disclosure:** None.

From the Personalized Urology & Robotics Clinic, South Lake Hospital, Clermont, FL; the University of Central Florida, Orlando, FL; the Keiser University Graduate School, Fort Lauderdale, FL; and the Talent Metrics Inc., Orlando, FL

Address correspondence to: Sijo Parekattil, M.D., Personalized Urology & Robotics Clinic, South Lake Hospital, 1920 Don Wickham Drive, Clermont, FL. E-mail: sijojp@gmail.com

Submitted: April 9, 2018, accepted (with revisions): April 23, 2019

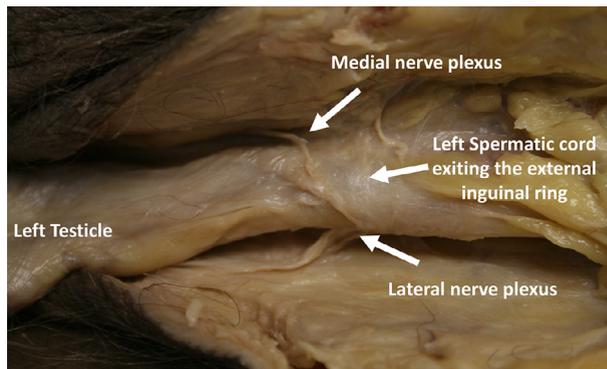
The paucity of treatment options for these patients often leads them to seek treatment from multiple urologists in succession, resulting in patients seeing an average of 4.5 urologists seeking treatment for the condition.<sup>14</sup>

The pathophysiology of CSP is poorly understood. The afferent innervation of the testis and epididymis, fibers carried in the genital branch of the genitofemoral nerve, and the ilioinguinal nerve have been described as possible origins.<sup>15</sup> A recent study by Parekattil et al<sup>16</sup> compared spermatic cord biopsies in men with CSP vs men with no diagnosis of CSP (nonpain controls). Three groups of nerve fibers were identified as the possible sources of pain indicating that the cause of the CSP is neurologic in origin. The nerves identified as potential causal sources of the pain associated with CSP were located in the cremasteric muscle fibers, perivascular tissue, and the posterior cord lipomatous tissues. Parekattil identified and named this group of nerves the “trifecta nerve complex” in the literature. These nerves were noted to have significant wallerian degeneration, approximately 84% in men with CSP, vs nonpain controls demonstrating 20% wallerian degeneration ( $P = .0008$ ).<sup>16</sup> This hypothesis was further supported by the study by Oka et al who collected spermatic cords from 11 men undergoing orchietomy and also biopsied a third of the spermatic fascia from 36 men undergoing microsurgical varicocelectomy and found that of the nerves, 50% were identified near the vas deferens and 20% in the spermatic fascia<sup>17</sup> although they do not describe the posterior lipomatous tissue that Parekattil mentioned.

We believe that a small cohort of men may actually have some genetic defect that predisposes them to Wallerian degeneration in some of their peripheral nerves and then there may be some traumatic or instigating event such as a vasectomy or hernia repair that then hyperactivates these nerves.<sup>16</sup> A type of 2-hit theory. This may explain how we have also found such similar degeneration in men with sports injuries and also men with idiopathic pain.<sup>16</sup>

Microsurgical denervation of the spermatic cord (MDSC) is one treatment option for men with CSP who have failed conservative treatment options. This technique was first described by Devine et al in 1978 on 2 patients.<sup>5</sup> The first large series reported on 95 testicular units in 79 patients with a pain-free success rate of 71% and pain reduction in 88% of patients.<sup>1</sup> Our group has also reported significant pain reduction in 86% of patients who underwent robotic assisted targeted MDSC.<sup>18</sup>

There are a number of men who do not respond favorably to MDSC. For these men, there are more aggressive treatment options such as orchietomy or epididymectomy. Orchietomy has demonstrated varying results. Davis et al<sup>3</sup> demonstrated that inguinal orchietomy relieved the pain in 73% of men when compared with 55% of men who underwent scrotal orchietomy for postvasectomy pain syndrome. Chen et al performed epididymectomy to treat CO with a 50% success rate.<sup>9</sup> Complications to orchietomy or epididymectomy performed



**Figure 1.** Anatomical dissection image showing the medial and lateral nerve plexuses which are derived from nerve fibers from the ilioinguinal, genito-femoral, and inferior hypogastric nerves. (Color version available online.)

through the use of either modality include the development of neurologic pain, or what has become known in the everyday vernacular as “phantom pain” of which the causal mechanism is not well or widely known/studied. A study by Puhse et al reported that 53% of 238 postorchietomy patients reported some kind of phantom pain experience. Approximately 25% of postorchietomy patients experience some form of the phantom testis phenomenon.<sup>14</sup> Nonpainful phantom sensations accounted for 64% of the phantom testis experiences, while male gonad hallucinations accounted for the remaining 36%.<sup>19</sup>

Cryoablation has been previously used for peripheral nerve ablation.<sup>20,21</sup> One possibility for the failure in pain relief after MDSC may be that there are residual nerves around the spermatic cord that are causing the persistent pain. Prior cadaver dissection studies have shown a medial and lateral plexus of nerves outside the spermatic cord as the cord exits the external inguinal ring<sup>16</sup> as shown in Figure 1. Proximal dissection of these nerve plexuses revealed nerve fiber contributions from the ilioinguinal nerve, genitofemoral nerve and inferior hypogastric nerves in both the medial and lateral plexi. This may explain why many men who fail MDSC seem to get temporary relief in pain after a spermatic cord block. Targeted percutaneous cryoablation of these nerves may be a potential treatment option for these MDSC failure cases. Cryoablation is a minimally-invasive organ sparing option that affords a less invasive intervention option when compared with a radical orchietomy or epididymectomy. This study presents outcomes for the treatment of CSP with ultrasound-guided targeted perispermatic cord cryoablation (UTC) in men who have persistent pain after MDSC.

## METHODS

### Patient Selection

Between November 2012 and July 2016, 279 procedures were performed on 221 patients (58 bilateral cases). All patients underwent UTC by 2 fellowship trained microsurgeons. The

median age was 43 years (16-77). All patients reported persistent pain after undergoing a prior MDSC and had transient pain relief after a spermatic cord block. Pain relief was defined as greater than 50% reduction in pain for at least a few hours. Prior to MDSC all patients underwent a thorough evaluation including a detailed physical examination to identify the precise location of the persistent pain. Scrotal ultrasound was performed at least once on all patients to exclude structural abnormality including tumor, torsion, varicocele, hydrocele, spermatocele, inguinal hernia, and epididymo-orchitis. Computerized tomography of the abdomen was performed when a history of back pain or trauma was reported, or any other reason for concerns regarding the possible existence of intrabdominal pathology as a cause of referred pain. Persistence of significant pain for >3 months after MDSC was a selection criterion for UTC. One hundred and ninety-seven patients had been previously treated with MDSC by the authors, 24 had been referred to our center after failed MDSC done at other centers. If MDSC was performed at a different center, the surgical operative report of the prior procedure was reviewed to understand the technique that was utilized. However, there did seem to be a wide variation in terms of what surgeons describe as an MDSC.

Our center is more of a referral center for CO. Thus, almost all the patients have had extensive imaging in terms of scrotal u/s and CT abdomen prior to coming to our center to rule out any other causes of the pain. Most have failed conservative treatment options such as: antibiotics, anti-inflammatories, physical therapy, and acupuncture. We only perform UTC on patients that have had a temporary relief in pain to a nerve block in that area.

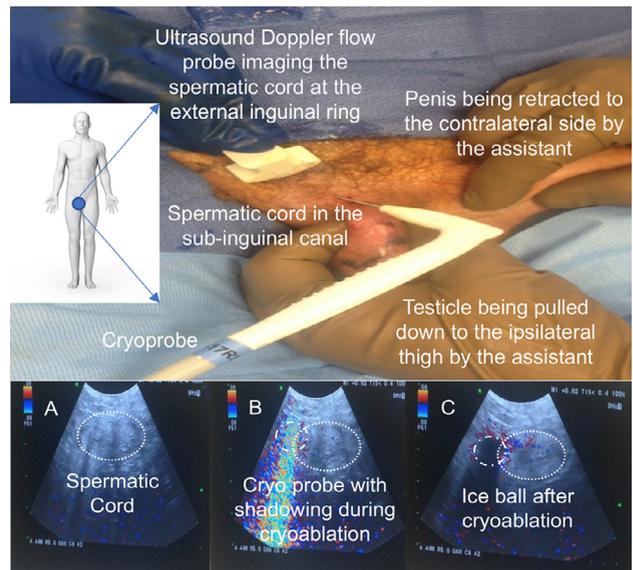
Cryoablation was not used for any patients in lieu of MDSC. MDSC was first attempted since we are ligating fewer nerves and get a higher success rate prior to ablating more external nerves in the UTC approach. Performing UTC prior to MDSC may create more scarring in the perispermatic cord areas making MDSC technically more challenging. Our center utilizes a targeted MDSC technique.<sup>26</sup>

The authors have not changed the surgical technique for MDSC based on the failures. We have had good published outcomes with targeted MDSC and feel that ligating as few nerves as possible and preserving the spermatic cord as much as possible is beneficial to the patients in terms of decreasing complications from MDSC such as testicular atrophy, hydrocele, and seroma formation. Cryoablation then becomes a good more aggressive ablation of nerves in select patient cases who fail MDSC.

The level of pain participants experienced was assessed preoperatively and postoperatively using 2 assessment tools: the subjective visual analog scale and a quantitative, objective, standardized, and externally validated pain assessment tool (PIQ-6, QualityMetric Inc., Lincoln, RI).

## Procedure

All UTC procedures were performed under MAC anesthesia. Patients were placed in supine position. The inguinal and genital regions were prepped and draped. A 30 cc mixture of 1% lidocaine, 25% bupivacaine, and 4 mg dexamethasone was injected into the perispermatic cord areas (medial and lateral to the spermatic cord at the external inguinal ring). An ultrasound probe was then used to identify the spermatic cord at the external inguinal ring. The Endocare 1.7mm PerCryo cryoprobe was placed medial and then lateral to the spermatic cord at the level of external inguinal ring (Fig. 1 and 2). These 2 areas contain nerve branches of the ilioinguinal, genitofemoral, and inferior

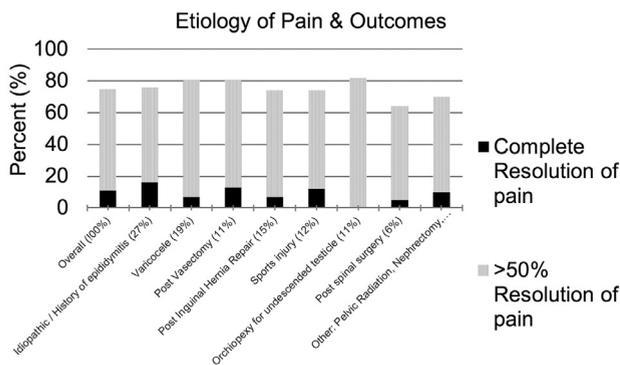


**Figure 2.** The cryo probe is placed lateral to the right spermatic cord as it exits from the external inguinal ring under real-time ultrasound guidance. Ultrasound's images during cryoablation: (A) right spermatic cord prior to cryoablation, (B) Image showing the ice ball forming lateral to the spermatic cord, and (C) Image of the spermatic cord just after cryoablation with the iceball still present medial to the cord. (Color version available online.)

hypogastric nerves based on work by Terkawi et al<sup>22</sup> and cadaver dissections we have performed previously.<sup>16</sup> Argon gas is used as the cooling agent to achieve -160 degree Fahrenheit temperatures at the probe tip. Two freeze cycles of 90 seconds each with a passive thaw cycle in between are used for the treatment. A 1.5 cm ice ball is created medial and lateral to the spermatic cord under real-time ultrasound (with doppler flow guidance) up to the edge of the cord, but not extending into the cord (Fig. 2). The ultrasound imaging is used to ensure that the vascular blood flow in the spermatic cord is not compromised in any way. A spacer agent (Allogen, Cygnex Inc., Orlando, FL) is injected in the area between the medial side of the spermatic cord and the penile corporal bodies to prevent any inadvertent injury to the penile nerves. We utilize 1 mL of Allogen in 3 cc of injectable normal saline. The surgical assistant pulls the penis away from the spermatic cord being treated and concomitantly pulls on the ipsilateral testicle to elevate the spermatic cord that is being targeted. This allows for better visualization of the spermatic cord and ensures that the cryo probes are away from the penis. The iceball is formed at the tip of the cryo probe. Thus pannus size only affects the depth that the needle has to be inserted for the procedure. In obese patients, the needle is advanced greater than 4 cm depth till the needle tip is 1 cm lateral or medial to the spermatic cord.

## RESULTS

The median operative duration was 20 minutes. Median duration of pain prior to the procedure was 6 years (range 1-52). Follow-up was performed at 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 4 years, and 5 years postoperatively. Median follow-up was 36 months (24-60 months). Etiology of pain in this cohort and outcomes are illustrated in Figure 3.



**Figure 3.** Etiology of pain and outcomes based on etiology.

Subjective visual analog scale patient pain outcomes were 75% of patients reported a significant reduction in pain (> 50% improvement). Of the 75% reporting a reduction, 11% reported a complete resolution of pain. There were no significant differences in outcome based on etiology.

Objective Pain Index Questionnaire (PIQ-6) outcomes: 53% significant reduction at 1 month (279 cases), 55% at 3 month (279 cases), 60% at 6 month (279 cases), 63% at 1 year (279 cases), 65% at 2 years (275 cases), 64% at 3 years (232 cases), 59% at 4 years (128 cases) and 64% at 5 years (53 cases) post-op. The data collected were analyzed using analysis of variance (ANOVA) for pairwise comparisons (paired samples) of each patient's reported pain levels as indicated by the PIQ-6 before the procedure, to the patient's reported pain levels as indicated by a readministration of the PIQ-6 measure at the 1 month, 6 month, 1 year, 2 year, 3 year, 4 year, and 5 year postoperative time marks (Supplementary Tables 1 and 2). With a total of 279 total cases included in the analyses, results indicate a statistically significant decrease in pain between preintervention and 1 month postintervention ( $P \leq .000$ ), as well as between preintervention and 3 month postintervention ( $P \leq .000$ ), 6 month postintervention ( $P \leq .000$ ), 1 year postintervention ( $P \leq .000$ ), 2 year postintervention ( $P \leq .000$ ), 3 year postintervention ( $P \leq .000$ ), 4 year postintervention ( $P \leq .000$ ), and 5 year postintervention ( $P \leq .000$ ).

These results indicate a profound decrease in the amount of pain reported between the preintervention mark and all postintervention marks up to and including the fifth year. This demonstrates that patients outcomes of this procedure are highly significant both statistically, as well as to the reported quality of life of the individual patients. While there is an indisputable link between the cryoablation procedure and mitigating patient's reported pain levels, it should be noted that after a period of 3 years, the data suggests that there is, on average, an increase in reported pain levels. However, the level of pain reported never nears preoperative levels and is only slightly higher at the 5-year postintervention period. Supplementary Table 1 also shows that there was some drop off in the sample size beyond 3 years, but this was primarily due to the fact that these were patients that had their procedure done more recently and we do not have follow-up of that duration on these patients. Extensive follow-up using email, spouse email, phone, work phone, spouse phone and mailing address was utilized to obtain as complete data as possible.

### Complications

Complications included 2 patients who developed a wound infection which responded to antibiotics. Four patients

developed penile pain (1 resolved with nonsteroidal anti-inflammatory drugs, 2 patients had persistent pain for a few months and 1 patient did not have follow-up). Initially we had 4 patients in our first 20 cases that developed some penile pain. After our first 20 cases, all the following patients received the spacer and we have not had any further incidence of penile pain.

## DISCUSSION

CSP continues to be a management dilemma for urologists with scant options for effective treatment or surgical intervention. CSP is described as intermittent or continuous testicular and/or groin pain of variable intensity, of at least 3 months duration, in the absence of objective organic findings, that interferes with the patient's quality of life.<sup>23</sup> Current treatment algorithms are limited to options of conservative management, diagnostic cord blocks, pulsed radiofrequency, vasectomy reversal for those with postvasectomy pain, MDSC, epididymectomy, and orchiectomy. MDSC is one treatment option for patients with CSP refractory to medical management. Marconi et al achieved a 92% significant reduction in pain in 50 patients with MDSC.<sup>24</sup> Other groups have also found similar findings; however, a small percentage of patient's report experiencing persistent pain after MDSC. Strom et al<sup>1</sup> reported a 12% failure rate in their cohort receiving this treatment, and Oliveria et al<sup>25</sup> reported a 10% failure rate in a multi-institutional study. These patients currently have limited treatment options such as epididymectomy or orchiectomy. Costabile et al observed that 80% of their patients continued to have significant CSP after orchiectomy indicating that the radical procedure may or may not be effective in a large number of cases. The goal of the current research was to evaluate an alternative treatment for this group of patients using cryoablation of the perispermatic cord tissues.

As the etiology of CO is not well understood, and hypersensitivity or irritation of the nerves that innervate the spermatic cord is the leading contemporary theory as to the origin of CSP, a common sense approach to treatment includes denervation of the spermatic cord. Any type of injury including infection, trauma, torsion, varicocele, hydrocele, scrotal surgery, or inguinal surgery can trigger an inflammatory response in the peripheral nerve fibers in this area.<sup>18</sup> Parekattil et al<sup>16</sup> found through tissue biopsy, that a large percentage of cases of CSP present with significant Wallerian degeneration in specific nerve fibers within the spermatic cord. There were 3 primary areas for these abnormal levels of Wallerian degeneration including (1) the cremasteric muscle fibers, (2) the perivascular tissues and vasal sheath, (3) the posterior lipomatous tissues.<sup>16</sup> The transection of these nerve fibers could be the anatomic basis for the success of MDSC in treatment of CO. Further, there may be persistent nerves with abnormal Wallerian degeneration around the spermatic cord in cases where MDSC provides less than ideal reported levels of pain relief. If this assertion is accurate,

cryoablation of these tissues may provide an effective surgical intervention for these patients.

The data generated by the current study demonstrates promising results suggesting that cryoablation of the perispermatic cord tissues may provide high levels of pain relief in patients with persistent CSP after MDSC. Further, UTC appears to demonstrate increased efficacy over time. Given the other alternative options which consist predominantly of extirpative surgery (epididymectomy or orchiectomy) for managing these patients, cryoablation should be considered a viable and effective treatment for CSP prior to implementation of more aggressive approaches.

We perform a cord block prior to the cryo to ensure that these patients still respond to some local nerve deactivation. This would indicate that these patients likely still have some sort of local nerve problem. We have had success with this technique in MDSC cases that were performed by various surgeons with different techniques. The outcomes did not seem to differ based on the technique of MDSC that was utilized.

## LIMITATIONS

Limitations of our study include the fact that the study design is retrospective as opposed to prospective. Many of our patients are referred to our center from a long distance for chronic pain and may have developed pain from a prior procedure (such as vasectomy, hernia repair, abdominal surgery, etc.). Most of these patients are very reluctant to enroll in control trials. We are in the process of trying to setup such trials as this would be very useful. However, patient compliance and enrollment are a real issue in this patient population.

## CONCLUSION

Ultrasound-guided targeted microcryoablation of the perispermatic cord is a safe and potentially viable treatment option for the salvage management of persistent chronic scrotal content pain in patients after MDSC.

## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.urology.2019.04.027>.

## References

1. Strom KH, Levine LA. Microsurgical denervation of the spermatic cord for chronic orchialgia: long-term results from a single center. *J Urol*. 2008;180:949–953.
2. Walz J, Perrotte P, Hutterer G, et al. Impact of chronic prostatitis-like symptoms on the quality of life in a large group of men. *BJU Int*. 2007;100:1307–1311.
3. Davis BE, Noble MJ, Weigel JW, Foret JD, Mebust WK. Analysis and management of chronic testicular pain. *J Urol*. 1990;143:936–939.

4. DeMello W, Desai PR. Use of lidocaine plaster for testicular pain. *Clin J Pain*. 2009;25:445.
5. Devine Jr. CJ, Schellhammer PF. The use of microsurgical denervation of the spermatic cord for orchialgia. *Trans Am Assoc Genitourin Surg*. 1978;70:149–151.
6. Engeler DS, Baranowski AP, Dinis-Oliveira P, et al. The 2013 EAU guidelines on chronic pelvic pain: is management of chronic pelvic pain a habit, a philosophy, or a science? 10 years of development. *Eur Urol*. 2013;64:431–439.
7. Morris C, Mishra K, Kirkman RJ. A study to assess the prevalence of chronic testicular pain in post-vasectomy men compared to non-vasectomised men. *J Fam Plann Reprod Health Care*. 2002;28:142–144.
8. Nangia AK, Myles JL, Thomas AJ. Vasectomy reversal for the post-vasectomy pain syndrome: a clinical and histological evaluation. *J Urol*. 2000;164:1939–1942.
9. Chen TF, Ball RY. Epididymectomy for post-vasectomy pain: histological review. *Br J Urol*. 1991;68:407–413.
10. Massaron S, Bona S, Fumagalli U, Battafarano F, Elmore U, Rosati R. Analysis of post-surgical pain after inguinal hernia repair: a prospective study of 1,440 operations. *Hernia*. 2007;11:517–525.
11. Loos MJ, Roumen RM, Scheltinga MR. Classifying post-herniorrhaphy pain syndromes following elective inguinal hernia repair. *World J Surg*. 2007;31:1760–1765. discussion 6-7.
12. Parekattil SJ, Cohen MS. Robotic surgery in male infertility and chronic orchialgia. *Curr Opin Urol*. 2010;20:75–79.
13. Levine LA. Microsurgical denervation of the spermatic cord. *J Sex Med*. 2008;5:526–529.
14. Heidenreich A, Olbert P, Engelmann UH. Management of chronic testalgia by microsurgical testicular denervation. *Eur Urol*. 2002;41:392–397.
15. Masarani M, Cox R. The aetiology, pathophysiology and management of chronic orchialgia. *BJU Int*. 2003;91:435–437.
16. Parekattil SJ, Gudeloglu A, Brahmhatt JV, Priola KB, Vieweg J, Allan RW. Trifecta nerve complex: potential anatomical basis for microsurgical denervation of the spermatic cord for chronic orchialgia. *J Urol*. 2013;190:265–270.
17. Oka S, Shiraishi K, Matsuyama H. Microsurgical anatomy of the spermatic cord and spermatic fascia: distribution of lymphatics, and sensory and autonomic nerves. *J Urol*. 2016;195:1841–1847.
18. Parekattil SJ, Gudeloglu A. Robotic assisted andrological surgery. *Asian J Androl*. 2013;15:67–74.
19. Puhse G, Wachsmuth JU, Kemper S, Husstedt IW, Kliesch S, Evers S. Phantom testis syndrome: prevalence, phenomenology and putative mechanisms. *Int J Androl*. 2010;33:e216–e220.
20. Beazley RM, Bagley DH, Ketcham AS. The effect of cryosurgery on peripheral nerves. *J Surg Res*. 1974;16:231–234.
21. Ilfeld BM, Preciado J, Trescot AM. Novel cryoneurolysis device for the treatment of sensory and motor peripheral nerves. *Expert Rev Med Devices*. 2016;13:713–725.
22. Terkawi AS, Romdhane K. Ultrasound-guided pulsed radiofrequency ablation of the genital branch of the genitofemoral nerve for treatment of intractable orchialgia. *Saudi J Anaesth*. 2014;8:294–298.
23. Qualllich SA, Arslanian-Engoren C. Chronic unexplained orchialgia: a concept analysis. *J Adv Nurs*. 2014;70:1717–1726.
24. Marconi M, Palma C, Troncoso P, Dell Oro A, Diemer T, Weidner W. Microsurgical spermatic cord denervation as a treatment for chronic scrotal content pain: a multicenter open label trial. *J Urol*. 2015;194:1323–1327.
25. Oliveira RG, Camara C, Alves Jde M, Coelho RF, Lucon AM, Srougi M. Microsurgical testicular denervation for the treatment of chronic testicular pain initial results. *Clinics*. 2009;64:393–396.
26. Calixte N, Tojuola B, Kartal I, et al. Targeted robotic assisted microsurgical denervation of the spermatic cord for the treatment of chronic orchialgia or groin pain: a single center, large series review. *J Urol*. 2018;199:1015–1022.