Review Article

Robot-assisted microsurgery for chronic orchialgia

Parviz Kavoussi[1], Nahomy Calixte[2], Jamin Brahmbhatt[2], Sijo Parekattil[2]

[1]Austin Fertility & Reproductive Medicine, Austin, TX, USA; [2]South Lake Hospital, Clermont, FL, USA

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Correspondence to: Parviz Kavoussi. Austin Fertility & Reproductive Medicine, Austin, TX, USA. Email: pkavoussi@hotmail.com.

Abstract: Chronic orchialgia is one of the most common complaints seen in the urologists office and has traditionally been considered a very difficult diagnostic and therapeutic challenge for the clinician. First line management of chronic orchialgia is conservative treatment; however, in men who fail conservative therapy, surgical intervention may be indicated. Microsurgery has been the mainstay for surgical treatment of chronic orchialgia, but the implementation of robotics to microsurgery lends itself particularly to surgical treatment of chronic orchialgia. PubMed was used to perform a current literature search on chronic orchialgia with robotic microsurgery, robotic spermatic cord denervation, robotic varicocelectomy, and robotic vasectomy reversal. Although conservative therapy is considered the first line treatment for chronic orchialgia, reported outcomes are moderate to poor, with the need to proceed to surgical intervention in select cases. Current surgical therapies in which robot assistance have been applied to microsurgery include microsurgical denervation of the spermatic cord, varicocelectomy, and vasectomy reversal. As further studies have assisted in the understanding of surgical treatment of chronic orchialgia, the application of robot assistance to this level of microsurgery has been shown to be feasible and safe with comparable outcomes to traditional microsurgery and may provide potential advantages.

Keywords: Robot assisted microsurgery; chronic orchialgia; spermatic cord denervation; varicocelectomy; vasectomy reversal

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Introduction

Chronic orchialgia, defined as unilateral or bilateral scrotal pain lasting at least three months in duration, continues to be a challenging entity to diagnose and treat (1,2). Conservative treatment is first line therapy, but when it fails surgical intervention may be warranted. Surgical intervention for chronic orchialgia was advanced with use of the operative microscope for andrological surgery in the 1970s to include microsurgical spermatic cord denervation (MSCD), varicocele repair, and vasectomy reversal in select patients. The application of the da Vinci® robotic platform to microsurgery lends itself as a particularly useful tool for MSCD, varicocele repair, and vasectomy reversal for chronic orchialgia.

Methods

A review of the current literature using PubMed to search for publications regarding robotic assisted microsurgery for chronic orchialgia, robot assisted MSCD, robot assisted microsurgical varicocelectomy (RAVx), and robot assisted microsurgical vasectomy reversal (RAVR) was performed.

Results

For select patients who fail conservative therapy for chronic orchialgia, surgical therapy should be considered. Microsurgical procedures used to treat chronic orchialgia in which the robotic platform can be applied include MSCD, RAVx, and RAVR.

Robot assisted MSCD

Men who have idiopathic chronic orchialgia with no identifiable anatomic etiology, or who have failed other surgical treatments for chronic orchialgia, should be considered for MSCD, which has resulted in reasonably effective response rates. MSCD was first reported in 1978 and multiple follow-up studies have shown favorable outcomes with microsurgical techniques (3-6). Historically, MSCD has been performed with the use of the operative microscope. The robotic system has been applied to MSCD with similar results to the classic microsurgical outcomes. The concept of applying the operative robot to MSCD was first introduced in 2010 (7). There are significant data showing similar outcomes with robot assisted MSCD (RMDSC) in comparison to traditional MSCD. In one series of a cohort of 401 patients undergoing RMSCD for chronic orchialgia, 72% of patients had complete resolution of pain, while 14% had a greater than 50% improvement in pain. Mean operative times for RMSCD were 41 minutes (8,9).

A recent retrospective review of 772 patients who underwent RMSCD by two fellowship trained microsurgeons from October 2008 to July 2016 (Parekattil & Brahmbhatt *et al.*) was performed. Selection criteria were as follows: chronic testicular pain (>3 months), failed standard pain management treatments and negative urologic workup. Targeted ligation of tissues containing the trifecta location of nerves with Wallerian degeneration was performed: the cremasteric muscle fibers, the peri-vasal sheath and the posterior spermatic cord lipomatous tissues. The primary outcome measure was level of pain. Pain was assessed preoperatively and postoperatively using two assessment tools: (I) the subjective visual analog scale (VAS) and (II) an objective standardized externally validated pain assessment tool (PIQ-6, QualityMetric Inc., Lincoln, RI, USA). The Median age was 41 years. Median operative duration (robot console time) was 20 minutes (range, 15–80 minutes). Median follow-up was 2 years. Subjective VAS patient pain outcomes: 84% significant reduction in pain (50% complete resolution—425 patients, 34% reported a greater than 50% reduction in pain—291 patients). Objective PIQ-6 outcomes: significant reduction in pain in 67% of patients at 6 months and 68% at 1-year post-op.

RAVx

Varicoceles are present in 2–10% of men with orchialgia and varicocelectomy should be considered when other etiologies are not identified for chronic orchialgia and a palpable varicocele is present (10). RAVx performed subinguinally, was first introduced in 2005. Shu *et al.*, reported elimination of physiologic tremor and the stable, ergonomic platform as advantages of the robotic approach (11,12). Parekattil *et al.*, performed a prospective randomized control trial exploring RAVx in a canine spermatic cord model and reported significantly faster operative time compared to the traditional microsurgical approach (9). Another report on RAVx found no difference in operative time when transitioning from standard microsurgical varicocelectomy to RAVx, and found robotic time decreasing with more cases and advancement on the learning curve (13).

RAVR

In men who have undergone vasectomy and the etiology of their chronic orchialgia is thought to be due to post-vasectomy pain syndrome with a physical examination suggestive of congestion associated pain with fullness of the epididymis and pain with intercourse, vasectomy reversal may be considered (14,15). Although the majority of data on RAVR is not specifically for chronic orchialgia, a number of studies have evaluated the use of the operative robot to perform RAVR for fertility restoration, and patency rates can be assessed to extrapolate to the ability to perform this operation for chronic orchialgia, with expected similar responses to microsurgical vasectomy reversal for chronic orchialgia, as it is essentially performing the same operation with a different tool. A number of studies have investigated the feasibility and outcomes of RAVR. In 2004, Kuang *et al.*, performed *ex-vivo* robot assisted vasovasostomies on fresh human vas deferens specimens and found elimination of tremor and comparable patency rates (16). In the same year, robot assisted microsurgical vasovasostomy and vasoepididymostomy was performed in a rat model and revealed improved stability and motion during suturing (17). Fleming *et al.*, first reported robot assisted bilateral vasovasostomies on two patients with excellent patency results (18). In 2005, multilayered RAVR was performed in a rabbit model (19). In 2010, the first comparative human study was published between RAVR and traditional microsurgical vasectomy reversal and showed shorter operative times and improvement in early semen analysis measurements in the RAVR group compared to microsurgical vasectomy reversal group, by a single surgeon (20). The RAVR technique was validated in 2014 showing equivalent operative times, patency rates, sperm concentration, and total motile sperm count in

comparison to traditional microsurgical cases performed by a different single surgeon. There was also a faster mean time to pregnancy by four months in the robot assisted group in this series (21). Brahmbhatt *et al.*, has reported the use of RAVR specifically for chronic orchialgia secondary to post-vasectomy pain syndrome. Twenty-four men in this cohort underwent RAVR and at the 6-month follow-up, the mean visual pain score improved from 6.9 to 1.8. There was an improvement in the standardized pain impact questionnaire score in 85% of these men (22).

Discussion

The role of robot assistance with microsurgical procedures in urology has been expanding, and it particularly lends itself to microsurgical procedures for chronic orchialgia, with potential advantages. Although no microsurgeon likes to admit it, we all have a physiological tremor under the magnification of an operative microscope, to varying individual degrees. The robotic platform provides elimination of tremor, along with improved stability, instrumentation with 7 degrees of freedom, and improved surgeon ergonomics with the potential for decreasing surgeon fatigue when multiple microsurgical procedures are performed consecutively. Other potential advantages include scalability of motion for precision, the 3-dimensional high-definition visualization with the magnifying camera, and the ability to manipulate three surgical instruments and the camera simultaneously giving the primary surgeon control of every aspect of the operation and de-emphasizing the need for a specialty skilled microsurgical assistant who can work competently under the operative microscope. Currently, there is also the ability to utilize multi-input visual interfaces with up to three simultaneous visual views and the possibilities to advance the technology to meet the microsurgeons needs are expanding.

That being said, the use of the operative robot does not replace the importance of meticulous microsurgical techniques with the robotic device or the need for high levels of microsurgical training and skill for robotic microsurgeons. Whether using the traditional operative microscope or the robotic platform to assist with microsurgery, surgeons must still rely on the microsurgical principles of meticulous surgical technique, minimal touch techniques with as little manipulation of critical tissues as possible, maintaining microvascular supply, and preserving microanatomical structures that do not need to be taken in bulk. Application of such principles to robotic microsurgery will help this technique to advance as a potentially advantageous tool for the microsurgeon and for patients requiring such procedures for chronic orchialgia. As we have evolved in our techniques for treating men surgically for chronic orchialgia by operating using the naked eye, to using optical loupes, to the operative microscope, and now to the operative robot, the future surely holds more opportunities for progress.

One of the potential caveats to robotic assisted microsurgery is the formidable cost of the da Vinci robotic platform itself. The current Xi system is approximately $2 million with an annual maintenance fee of approximately $100,000 per year. This makes it impractical for most ambulatory surgery centers and office based practices to purchase. However, there are several thousand robotic systems spread widely across many hospitals in the US currently. Many of these systems are under-utilized and many hospitals are eager to have increased utilization since there is an added redundancy cost to the hospital if they underutilize their system. In our setup (SP), we were able to come to an understanding with our community based hospital to utilize the robot in slots when there is less utilization (late afternoons & early evenings). We decided not to purchase a new operating microscope, but rather use our existing robotic platform to improve utilization of the robotic system. The average per case added cost for a robotic microsurgical case over a standard microsurgical case is $350 (assuming the hospital has already purchased a robot). There are advantages to the surgeon with robotic assisted microsurgery in terms of surgical ergonomics and less fatigue. It has allowed increased throughput of the volume of cases that we can perform in our practice in a given amount of time. In our practice, we felt that this added cost should come out of the surgeon/hospital profit margin and not be borne by the patient. So for example, let's look at pricing for a robotic assisted microsurgical vasectomy reversal. Our total out of pocket charge to the patient is under $7,000 (includes surgeon fee, hospital fee & anesthesia fee—we perform these under anesthesia in the hospital as an outpatient procedure). A market analysis of vasectomy reversal pricing on the internet ranges from $3,000 to $25,000 for microsurgical vasectomy reversals ranging in settings from an office based (no anesthesia) to hospital based anesthesia procedure. As can be seen, the pricing can vary a lot based on profit margins that are set by the surgeon/hospital setup. A regional analysis in our immediate vicinity in Florida shows pricing for a hospital based (with anesthesia) microsurgical vasectomy reversal pricing in the $10,000 to $12,000 range. Thus, our pricing is actually significantly less than what most pure

microsurgeons charge for a vasectomy reversal. This is an example of how we have actually reduced patient costs for microsurgical reversal using a robotics program. As robotic platforms become more widespread and available, it is likely that microsurgical applications and utilization will likely rise. In fact, recently there are a few ambulatory surgery centers that are beginning to purchase robotic platforms, this trend is likely to continue and will likely further reduce overhead costs compared to the hospital setting.

Conclusions

As surgical treatment of chronic orchialgia has advanced, the application of robot assistance to this level of microsurgery has been shown to be feasible and safe with comparable outcomes to traditional microsurgery and may provide potential advantages.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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