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Introduction

A varicocele is a pathologic dilation of the gonadal veins within the spermatic cord. Varicoceles are found in 15% of the adult male population and in 35% of men presenting for infertility evaluation. Varicoceles can also contribute to low testosterone, orchalgia, and testicular atrophy.

Numerous studies have shown the benefits from varicocele ligation. Improvements in semen analyses with male factor infertility, improvements in orchalgia, increasing testosterone levels and growth in testicular size have all been reported. Recent meta analyses have confirmed that subinguinal traditional microscopic varicocele repair (TMV) have the highest success rate and lowest complication rate as compared to inguinal or laparoscopic abdominal approaches. This approach has become the gold standard for varicocelectomy.

More recently, the Da Vinci Robot (DR) has been used to successfully perform microscopic varicocelectomy surgery. Advantages to robotics include elimination of tremor, retraction with third arm, and stable immersive 3D microscopic vision, all contributing to precision of surgery. One of the earliest experiences by Shu et al demonstrated successful robotic assisted microscopic varicocelectomy (RAMV) without complications in eight men. In a review of his robotic microsurgical experience Parekattil demonstrated low failure and low complication rates in 181 RAMV. Comprehensive outcome data was not presented in the review.

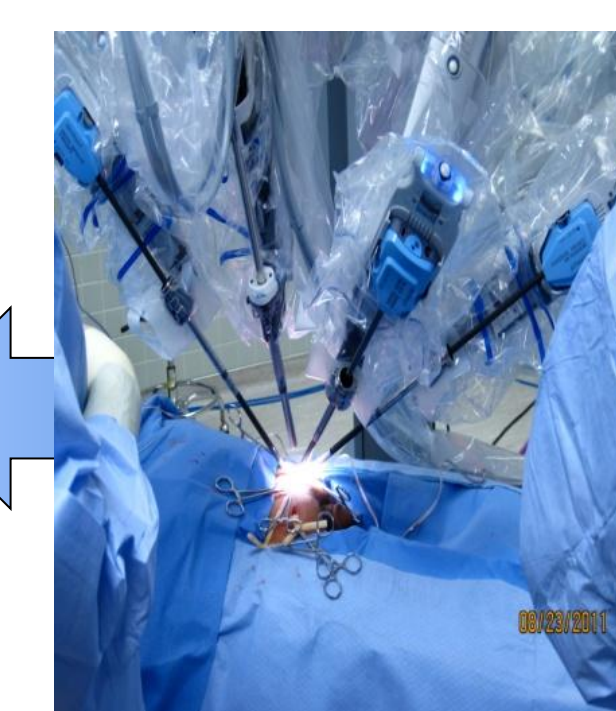
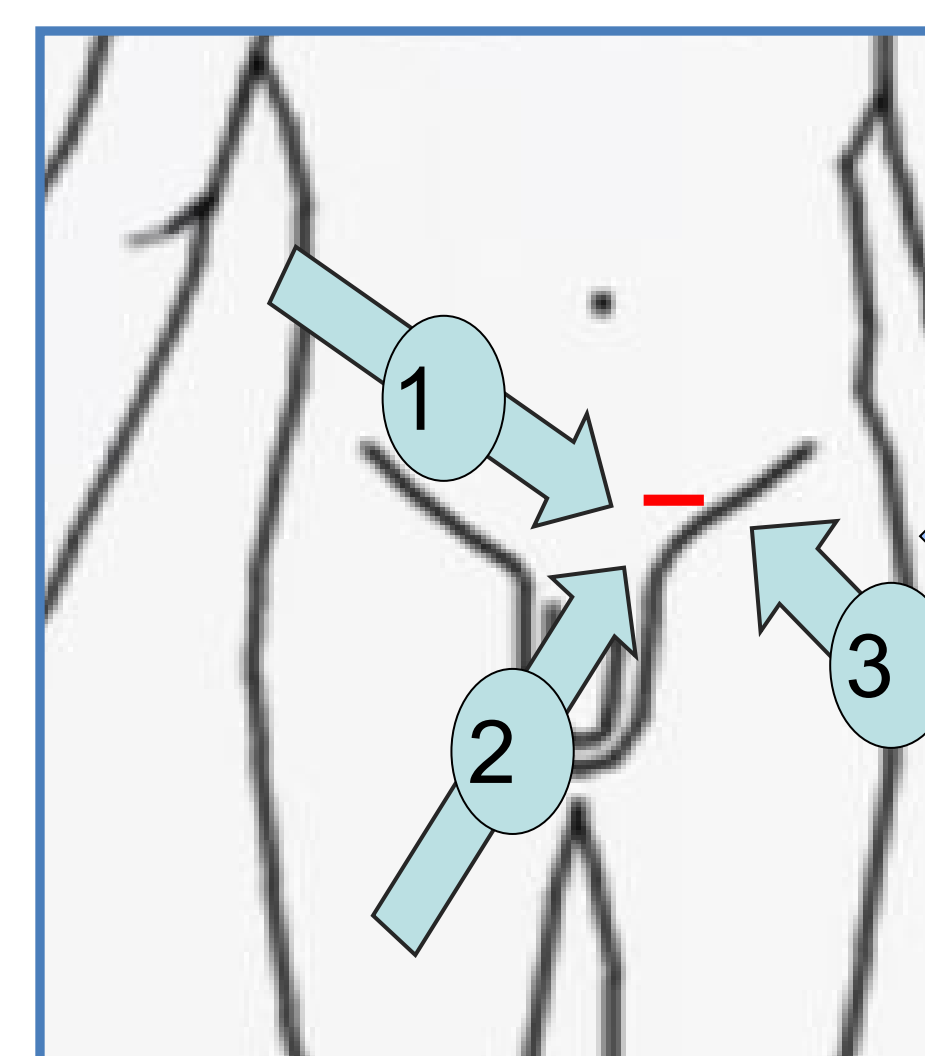
In this study we aim to comprehensively describe our experience with RAMV in 391 consecutive RAMV. To date, this is the largest reported series for RAMV.

Methods

We reviewed charts in all men who underwent RAMV (213) from March 2012 to Dec 2014 presenting with symptomatic hypogonadism, infertility, or orchalgia. Pre operatively we obtained baseline hormone panel including testosterone, free testosterone, estradiol, follicle stimulating hormone (FSH), luteinizing hormone (LH), dihydroepiandrosterone (DHEA), sex hormone binding globulin (SHBG). Preoperative scrotal Doppler ultrasound performed by a single ultrasonographer was used to confirm presence and laterality of the varicoceles, diameter, retrograde blood flow velocity with valsalva, and testicular size. Pre operative semen analysis was obtained on infertility patients. Post operatively, ultrasound was repeated at three months to assess change from baseline. Patients who presented with low testosterone and/or infertility, hormone panel and semen analysis was repeated 3 months post operatively. Complications as well as analgesic use was recorded.

Men with varicoceles present on physical exam and not found on ultrasound were not offered surgery. The spermatic cord was isolated and elevated from the incision using a penrose drain as in a standard TMV. The robot was then docked perpendicular to the patient's left side and a RAMV was performed with identical steps as TMV.

Methods



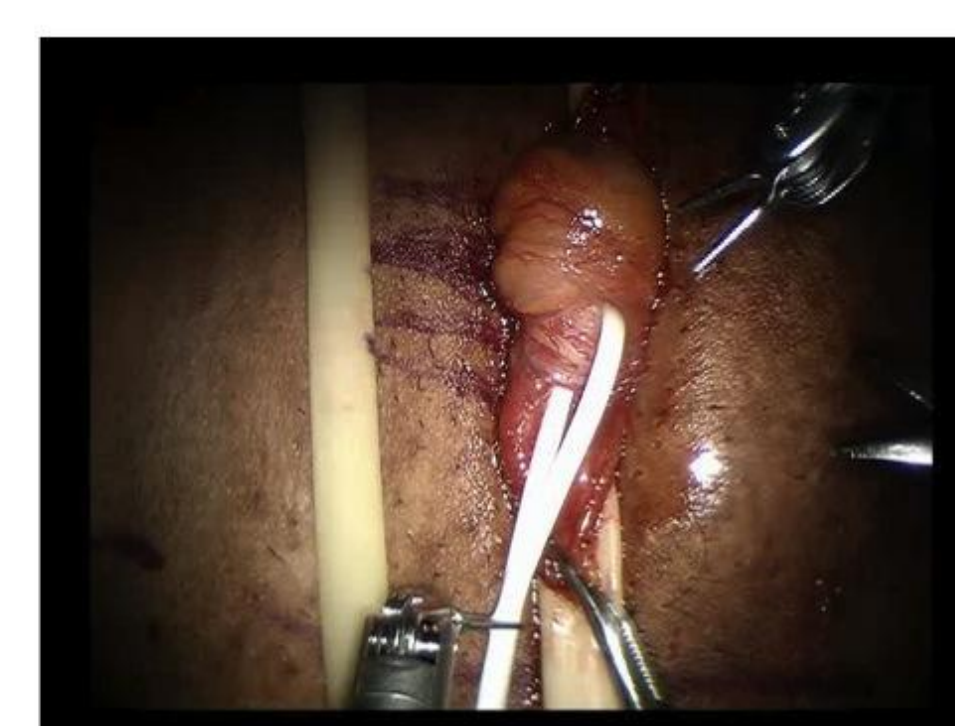
Instruments/Suture:
Small and Medium clip applicator
8-0 Prolene suture x2 (4in)
Blue and white vessel loop
4-0 vicryl
4-0 moncryl
Hictacryl
Local (50/50 1% lidocaine/0.25% bupivacaine)

Arm 1: Black diamond forceps
Arm 2: Monopolar scissors 90° from Arm 1
Arm 3: Black Diamond Opposite Arm 1,
Camera: Directly over Incision with Zero degree lens

Exposing the Spermaticcord



Isolating Vas Deferens



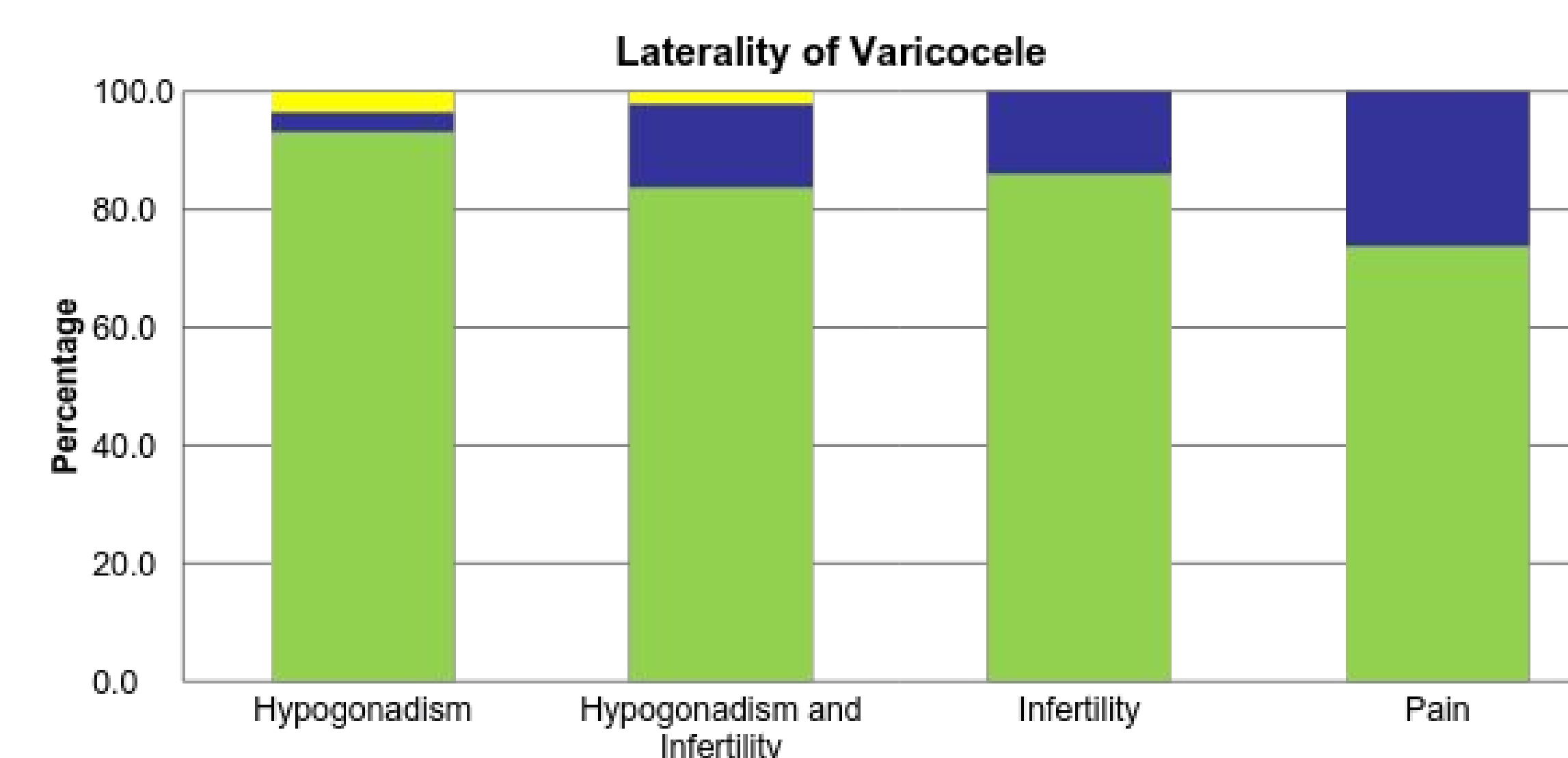
Opening the Cremasteric Fascia



Isolating Arteries with Vessel Loops



Results



Baseline Hormone Semen Profile

	Pre op value (SE)	Post op value (SE)	P value
Hormone Panel			
Testosterone (ng/dL)	338.9 (12)	466.7 (16)	<0.0001
Free Testosterone (pg/mL)	18.9 (2.0)	30.5 (3.7)	0.004
Estradiol (pg/mL)	25.4 (1.2)	23.7 (2.7)	0.5
Free estradiol (pg/mL)	0.43 (0.08)	0.40 (0.21)	0.9
LH (mIU/mL)	4.7 (0.3)	6.3 (0.3)	<0.0001
FSH (mIU/mL)	6.8 (0.6)	9.1 (0.7)	<0.0001
DHEA (ug/dL)	265 (19)	275 (19)	0.4
Testis Doppler			
Left testicle vol. (mL)	18.6 (0.6)	21.5 (0.6)	<0.0001
Right testicle vol. (mL)	18.8 (0.7)	21.6 (0.7)	<0.0001
Semen Analysis			
Volume (mL)	3.1 (0.2)	2.7 (0.2)	0.08
Concentration (M/mL)	13.2 (2.5)	24.8 (5.2)	< 0.002
Motility (%)	34 (3.3)	32 (3.1)	0.4
Morphology WHO (%)	18.3 (2.8)	21.5 (3.2)	0.2

	% Δ in T	% Δ in SC	% Δ in Mot	% Δ in Morp	% Δ in RTV	% Δ in LTV
Hypogonadism	53 (18)	-	-	-	12 (4)	8 (5)
Hypogonadism Inf	58 (10)	280 (186)	20 (17)	49 (39)	14 (2)	16 (3)
Infertility	60 (17)	730 (354)	63 (32)	39 (48)	13 (4)	6 (5)
Pain	34 (19)	-	-	-	15 (4)	9 (6)

Comparison of Robotic Microsurgical Varicocelectomy (RAMV) with Subinguinal Traditional Microscopic Varicocelectomy (TMV)

	RAMV	Subinguinal TMV
Clinical Outcomes		
Increase in T (ng/dL)	Our series: 128	Large cohort or meta-analysis: 97, 131, 122
Increase in sperm concentration (mill/mL)	11.6	14.1, 7.4, 12.3
Increase in adult left testis vol in adults (mL)	2.8	1.5
Patients requiring pain med	37%	37.5%
Complications		
Injury to testicular artery	0	0.9%
Hydrocele	0.5%	0.4%
Failure/ Persistence	7.4%	1.0%
Hematoma	2.4%	-

Discussion

We describe our series of RAMV. Complications using our approach were low without any injury to testicular arteries. We had 7% of failure of surgical repair measured by any persistent flow on duplex doppler. Serum testosterone and seminal sperm concentration significantly improved. These results from our series suggest the safety and efficacy of the robotic approach for varicocele repair.

The DR is expensive technology. We are not suggesting that RAMV is superior to the TMV in outcomes and do not advocate the purchase of a DR to perform varicocelectomies. On the other hand, virtually all institutions currently own at least one robot. The capital cost of the robot and its use is divided amongst all the surgical specialties that utilize the DR. Operating microscopes (OM) are frequently jealously guarded by the service to which they belong, lest they be damaged by "another service".

The robot specific "disposables" consist of three multi-use instruments (two black diamond forceps and one monopolar scissors) that total approximately \$600 per case.

As a training tool for future urologic surgeons, the use of the Davinci robot for RAMV is far more practical than the operating microscope. Virtually all graduating residents will be using the DR for prostatectomies, nephrectomies, cystectomies and uro-gynecologic procedures. The DR is a common platform. Few graduating residents will ever utilize the OM after graduation. With the DR, the resident becomes facile with dissecting out structures such as the vas deferens, 1 mm gonadal arteries, 3mm veins and suturing with 8-0 sutures (the cremasteric layer). All these skills are transferable to the other DR procedures. The ability to "freeze" action during the case and the dual console is optimal for teaching and training.

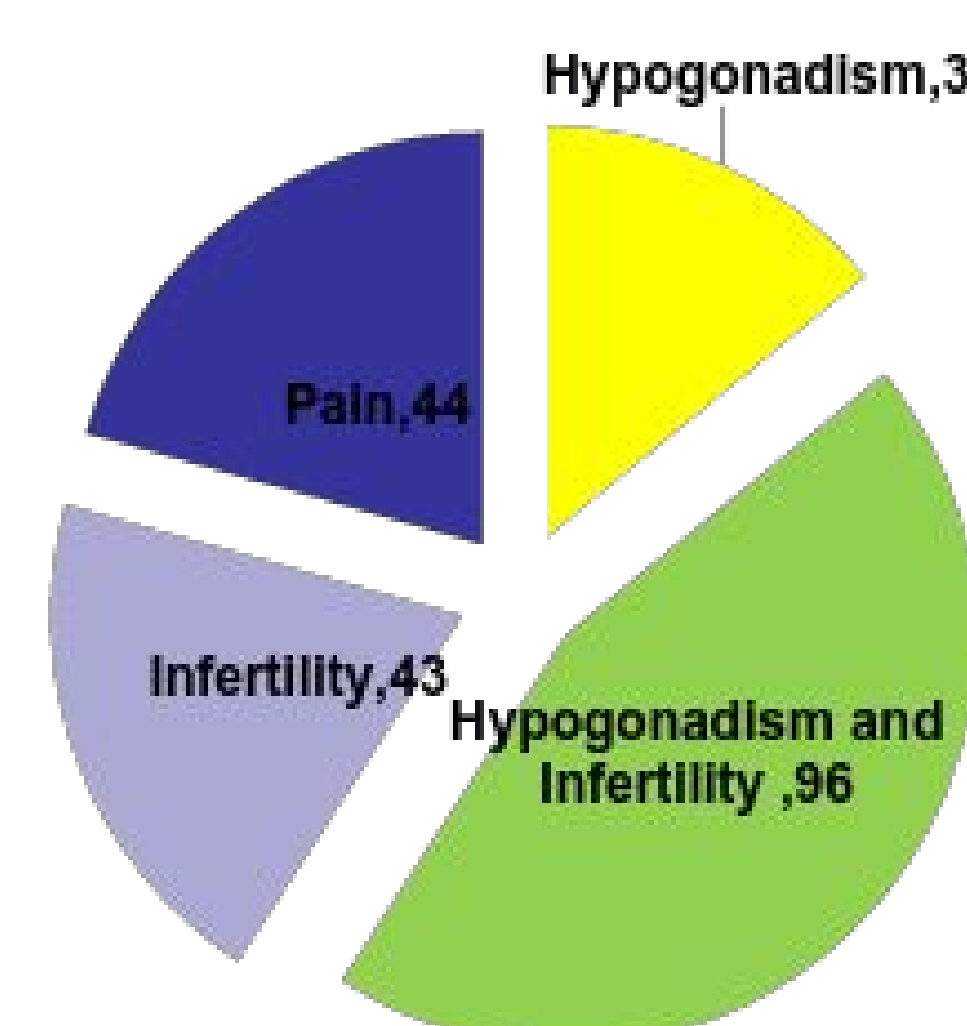
For the surgeon, a trained assistant or resident is not necessary, as the "bedside" duties can be performed by a surgical scrub technician. Specialized microsurgical instruments, many of which get damaged between cases, are not needed. No special table or patient position is necessary and the ergonomics of the DR are much kinder to the surgeon, decreasing "surgeon wear".

A major drawback of the DR is availability for the surgeon. The DR is shared by all services. With the addition of the new generation of DR (Xi), many institutions have increasing time available on the "old" machines. Hopefully introduction of competitive products will decrease costs and increase availability for the robotic platform.

Conclusions

- Results with the DR are comparable to OM in microsurgical varicocelectomy.
- Resident training is enhanced on a common platform
 - Isolating 1 mm arteries
 - Tying 8-0 sutures
- The dual console and ability to freeze action optimizes teaching
- The DR is universal to all the surgical services, decreasing its per use cost for the hospital.

Results



	Age	% Prev Preg	Duration of Sx (mo)
Hypogonadism	35 (2)	50	29 (6)
Hypogonadism/Infertility	36 (1)	36	35 (3)
Infertility	36 (1)	45	33 (5)
Pain	28 (1)	19	23 (6)

	Test Total	Test Free	E-2	LH	FSH	SHBG	Sperm Concen	% Motil	K Morph
Hypogonadism	383 (27)	10.5 (0.85)	18.9 (2)	6 (0.5)	6 (1)	29 (2)	-	-	-
Hypogonadism/Infertility	343 (15)	9.6 (46)	25.1 (2)	5 (0.3)	8 (0.5)	25 (1)	17 (3)	30 (2)	1 (0.29)
Infertility	391 (22.5)	10.2 (0.71)	20 (2)	6 (0.4)	8 (1)	29 (2)	19 (5.7)	35 (5)	2 (0.5)
Pain	412 (24)	11.1 (0.75)	20 (2)	5 (0.4)	3 (1)	31 (2)	-	-	-