

## An Updates on Techniques of Microsurgical Vasectomy Reversal- A Mini Review

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### Abstract

Following sterilization by vasectomy, men may need future fertility, either due to the loss of a child or a new marriage. Following vasectomy reversal there have been a lot of advances in the field to improve the patency and pregnancy rates, although in the modern era of assisted reproductive technology they are usually not counseled with the ease of sperm retrieval and IVF/ICSI. Here we carried out a systematic analysis using the MeSH terms on the search engine Pubmed, like "vasectomy reversal", "vasovasostomy'(VV)', "vasoepididymostomy"(VE), "optimizing success", "different sutures" to be used, "most modern techniques" like robotic assisted VV or VE, Video microscopy, analysis of vasal fluid". We found a total of 1200 articles, out of which we selected 75 articles for this review. No meta-analysis was carried out. Further emphasis has been laid on the training of new urologists to learn this complicated technique so that natural conception can be sought for. Further techniques of some complicated cases are described.

**Keywords:** VV; VE; Vasectomy reversal; IVF/ICSI/Vasal fluid

### INTRODUCTION

Vasectomy reversal is the recommended method of reversing sterilization in men desiring fertility subsequently. With marked improvements in techniques in the last 4 decades, high patency rates and favourable pregnancy outcomes following reconstruction can be expected. Though there are other treatment options that are available for these patients with post vasectomy obstructive azoospermia (OA) meaning different kinds of sperm retrieval techniques, vasectomy reversal is the only method which allows natural conception. Further Vasectomy reversal has also been found to be more cost effective in contrast to sperm retrieval to be used for IVF (in vitro fertilization)/ICSI (Intracytoplasmic injection). Still the success of Vasectomy reversal is based on good clinical judgement, efficient microsurgical skills and proper selection of subjects. The aim of this review is to highlight the treatment approach for vasectomy

reversal in length, based on the recent evidence. The advances made recently in surgical technique and how they contribute to this surgery are to be critically analyzed. Since they are technically problematic stress is put on role of microsurgical training, that includes the current knowledge which are improving the education in this field.

### EVALUATION TO BE DONE PREOPERATIVELY

Preoperative examination of men with suspected OA starts with a proper history taking and thorough examination physically. Main idea of this is to find the cause of azoospermia whether obstructive (OA) or non obstructive azoospermia (NOA). Specially on examination of the spermatic cord, a heating blanket or hot pack is placed with the idea of warming the scrotum, thus relaxing the scrotal dartos muscle. Still no sign or symptom is 100% sensitive or specific and this early examination can be further increased in case of borderline cases.

In case of a clear causative factor identification, laboratory examination is usually not needed, like an early history of vasectomy. But in absence of vasectomy, or if patient had difficulty in getting a pregnancy, prior to sterilization, it is better to get an FSH and morning time testosterone (T) level. This discrimination of OA vs NOA was carried out by Schoor et al. [1]. A length of testis of a minimum 4.6cm, in combination with an FSH level <7.6mIU/ml, identifies subjects having OA in 96% of the patients. With this the preoperative testicular biopsy has got practically removed for diagnosing. Though useful, the Schoor criteria will wrongly diagnose obstruction in roughly 1 in 20 men. Subjects with NOA, having an appropriate testicular size, and a FSH value <7.6mIU/ml, usually have some form of maturation arrest on histology. Hung et al. [2] examined a cohort of 600 men who presented with NOA where services were provided by a single unit. 4.3% of the subjects had a testicular length >4.6cm and a normal FSH level, with maturation arrest on biopsy. Even Tsai et al. [3] on examination of men presenting with maturation arrest, observed both testis volume and a FSH level below the threshold in 38% of the cohort they studied. Because of this any reproductive urologist who asks the patient for reconstructive surgery needs to know the limitations of the basic laboratory tests, since operative plan may change dramatically in the possible misdiagnosis. Serum antisperm antibodies assessment is useful for confirming spermatogenesis; A high positive assay confirms the diagnosis in case of OA [4].

Mostly imaging studies don't give much information, but for suspected ejaculatory duct obstruction, where a transrectal ultrasound shows dilated seminal vesicles and/or ejaculatory ducts or midline cysts might be diagnostic. Ultrasonography (USG) doesn't provide any additional data over physical examination in case of vasal gaps, presence or absence of a sperm granuloma, or testicular size (if an orchid meter is utilized). Only way USG might be helpful is in getting the diameter of caput epidymis, which will differentiate OA/NOA, but not for a specific patient having maturation arrest—all these are the most important points regarding preoperative examination [5]. Further fullness of the epididymis might not be present in men having OA, where obstruction is at the level of rete testis, which may be present in 15% of men with OA [6].

On confirming obstruction, further patient counseling should include anticipated reconstructive outcomes.

In the work done by the Vaso-vasostomy Study Group, best chances of success get obtained when the interval of obstruction was under 3 years (patency rate 97%, pregnancy rate 76% [7]). With increasing duration of vasal encounters the outcomes kept on worsening, with 15 plus years of obstruction leading to patency and pregnancy rates of 71% and 30% respectively. Once obstructive interval rises chances of secondary epididymal increase occurs and thus the patient requires both vasoepididymostomy (VE). Technically VE is more difficult, with greater likelihood of early and late failures, besides reduced pregnancy rates, in spite of patency getting demonstrated [8, 9]. Fuch's et al. showed a 50% increase in the probability of needing a VE for every 3 year period following vasectomy in one of the biggest published series. Performance rate of VE falls once the level of obstruction reaches the efferent ducts, secondary to inadequate epididymal exposure following spermatogenesis [11, 12]. Since the prognosis is based largely on if bilateral VE will be needed, many groups have chalked out extra preoperative predictors for this setting. McCammack et al. [13] tried to use magnetic resonance imaging for laying down the prognosis of requirement of IVF in OA. They had a small cohort of 10 subjects with known OA, a 19.4% increase in epididymal T1 intensity predicted the need for VE in 90% of subjects. Follow up studies are required to confirm these findings which are consisting of large cohorts. Once McCammack's finding get confirmed, magnetic resonance imaging (MRI) might prove a useful tool for prediction of epididymal obstruction and the subsequent requirement of VE instead of vasovasostomy (VV). Patients need to understand prior to the surgery that bilateral VE is needed as patency and pregnancy rates are typically reduced in such circumstances [7].

In terms of importance this impact of interval since obstruction has not been clear in contemporary series [14, 15]. Still most of literature implicates that the interval of obstruction remains one of the most important factor regarding preoperative counseling [16]. Other important factor in preoperative counseling is whether sperm granuloma is present. It is considered that a sperm granuloma provides a passage to relieve vasal pressure, thus decreasing the risk of secondary epididymal obstruction by "blowout" [17]. In contrast to obstruction interval, sperm granuloma was considered favourable in older series, having more studies recently showing little or no predictive

value [7, 14, 15, 18]. Boorjian et al. presented a large experience of a single surgeon, finding more chance of statistical significance ( $p=0.07$ ) regarding difference in patency rates following a vasectomy reversal (95% vis a vis 78% for subjects without a palpable sperm granuloma). Despite that some examine for sperm granuloma, since a granuloma might be pointing to a greater -quality intravasal fluid during the reconstruction and hence imply a greater chance that one can perform a VV procedure that is lesser tough [7, 18].

Other aspects on history/general physical examination (GPE), include history of previous vasectomy reversal, big vas al gaps, if any iatrogenic vasal injury is reflected by another procedure carried out earlier like herniorrhaphy. A lot of small series presented success following previous failed reversal, found moderately decreased success rates. The Vasovasostomy Study Group presented a series of 199 subjects in which a repeat procedure was done, and found a patency rate in 75% of subjects, with a pregnancy rate of 43% [7]. A cohort done following that consisted of 41 patient who had at least 1 previous attempt at vasal reconstruction reported by Hernandez et al. [19] Found a patency rate and pregnancy rate of 79% and 31% respectively. They showed that 39% of their subjects needed bilateral VE that gives importance of preoperative knowledge. Once large vasal gaps or iatrogenic injury to vas is present, it points to the inability of vas to get a tension-free anastomosis. Which should be discussed with the patient prior to the intervention [20]. Although such settings are rare, surgical approach varies markedly from the traditional VV and VE and may even need specialized equipment [21]. No long term outcomes are available regarding these reconstructions which are full of complexity. Patient attempting these need to be aware of lack of information as regards patency and pregnancy rate anticipated.

### Female Factor

Clinical characteristics of the female partner must be considered while making the decision on treatment plan for OA, Since these factors will affect prognosis as significantly as the males preoperative evaluation. Current reproductive urologist has different procedures to offer men following vasectomy that range from definitive reconstruction to the different kinds of sperm retrieval techniques. In some cases like tubal factor, the couples are forced to have IVF and hence

sperm retrieval is the best option. However except for these cases where IVF is unavoidable, utilization of vasectomy reversal has decreased markedly in the post -ICSI era. Although many cases of increased use of ART, exist, one major cause is that women delay the family building [23]. It is clear that with increasing maternal age there is an inverse relation to chances of natural conception and ART outcomes. Further, men wanting fertility following vasectomy tend to be older and might have partners who are of high age as well.

Following vasectomy reversal main factor which predicts pregnancy, besides re-establishment of patency, is the age of the female partner. According to Megheli et al. [14], who described a cohort of 334 subjects who underwent reconstruction and found that female age was the only independent predictor of pregnancy, that outperformed obstructive interval and sperm granuloma status. Just like that on examination of 173 men undergoing vasectomy reversal for obstructive intervals of at least 15 years Fuchs et al. [8] found that pregnancy rates of 64% and 32% according to partners, having <30 year age vis a vis 36-40 years respectively. Thus the overall pregnancy rate was 43%, that was similar to the contemporary IVF/ICSI results. Since it can sometimes take >6mths for sperms to return to the ejaculate, and hence successful pregnancy might even take longer, some consider that vasectomy reversal is not the choice of treatment for couples that have partner of advanced maternal age [9, 24, 25]. Stratification was attempted in a better way by Kapadia et al. [26] as per womans age. They analyzed 136 men who chose to undergo vasectomy reversal even if their partners were 35 years or older and compared the result they obtained with the ART results that had been documented. They found that live birth rates were comparable between per cycle IVF data and vasectomy reversal. For subjects with partners over 40 years, the vasectomy reversal group got a birth rate of 15.4%, while one cycle of ART gave a birth rate of 14.2%, when selecting for couples who did not have any separate female infertility factors.

Still whether vasectomy reversal is proper when the woman is >35 years remains unanswered since Kapadia et al. [26] just compared per cycle outcome while many vasectomy reversal couples in the long run will undergo multiple cycles. Still all subjects seeking vasectomy reversal it is worth offering that vasectomy reversal is more cost effective than ART. Lee et al. [27] utilized a constructive and analytical

model for comparison of vasectomy reversal with sperm retrieval along with IVF/ICSI, which included indirect costs [27]. In terms of dollars the calculated cost in 2005 for vasectomy reversal, microsurgical epididymal sperm with IVF/ICSI, and testicular sperm aspiration with IVF/ICSI were, 25321\$, 58528\$ and 61, 977% respectively. This was similar to the cost factor analysis by Heidenreich et al. [28], that further adds to much less morbidity with complications if vasectomy reversal was opted for.

Finally history of proven fertility in the partner in the couples who present is another important preoperative factor. In the earlier studies that contained small cohorts found high pregnancy rates when the male partner was seeking pregnancy with the same female partner prior to vasectomy. The study carried out by the Vasovasostomy Study Group, subjects that underwent reconstruction secondary to death of a child, got a pregnancy rate of 76% (n=21), while in subjects having a new partner got a pregnancy rate of 50% (n=612) [7]. On the same lines subjects with the same partner, Kolettis et al. [29] and Chan et al. [30] Obtained pregnancy rates of 60% and 86% respectively. Ostrowsky et al. [31], conducted a comparison of 258 couples where partner was same with the rest of vasectomy reversal cohort. A pregnancy rate of 83% were obtained when vasectomy reversal was done in a couple with proven fertility in contrast to 60% in the other cohort giving an odds ratio of 2.0 (P<0.01). For reasons not very clear prognosis when partner is same is markedly greater, which should be emphasized in preoperative counseling.

Thus the criteria combining both male and his wife will update regarding the prognosis for any attempt carried out at vasectomy reversal. Thus the reproductive urologist has to make a decision along with the male partner weighing all pros and cons. Though vasectomy reversal is the gold standard and is most cost effective for all patient reporting, sperm retrieval might prove the most effective choice in certain situations [32]

### Vasectomy Reversal: Techniques

The techniques of vasectomy reversal got optimized in 1980s and further in 1990s with marked work of the Vasovasostomy Study Group [7, 33]. The basics of either VV or VE depend on a good quality anastomosis which is a tension free, mucosa to mucosa connection that maintains adequate blood supply, The anastomosis has to be water tight for maximizing the chances of

patency. In view of crossover recombination, sperm will produce an inflammatory response when presented outside of the immune privileged space of the testis [34]. If leakage of sperm occurs from a reconstruction side will result in a granuloma development, that might distract the anastomosis, causing failure [35, 36]. Further to achieve a high quality anastomosis in the male reproductive tract, where the vasal lumen is as small as 0.3mm and epididymal tubules as small as 0.15mm, proper visualization with an operating microscope is pivotal [37, ]. Though reasonable patency can be obtained using loupes and prolene stent, expected results are still lesser than the traditional microsurgical reconstruction that maintains the option of doing V E if required [37].

Both types of vasectomy reversal, VV or VE, can be done using a high bilateral scrotal incision. Some workers have retried a modified technique utilizing a small midline incision via no scalpel vasectomy maneuvers [38]. Although patency and pain outcomes were favourable, the limited surgical exposure VE and can be rather hindering for large vasal gaps or significant granulomas. The group of Hayden prefers the traditional high scrotal exposure since it is generally well tolerated and gives marked flexibility for an unexpected different reconstruction. Further high bilateral scrotal incisions can be used even in awake procedures, although most surgeons prefer anaesthesia should VE gets indicated [36, 39].

Decision making following an intraoperative approach Irrespective of the incision opted for, the vasectomy reversal begins with the idea of notification of the vssal gap and resection of nonviable vas deferens with the help of a slotted nerve clamps provide comparable outcomes [40]. Distal patency must be ensured to confirm practicality of reconstruction, that might be obtained through a saline or water soluble contrast vasogram [35]. If obstruction of the abdominal vas remnant might occur due to inadequate resection of the vasectomy site, or due to unrecognized iatrogenic injuries from procedures that occurred after sterilization (e.g herniorrhaphy) [41]. In the rare scenario of inguinal and abdominal obstruction (usually from previous hernia repair) crossed VV might be of use in case the contralateral testis has a patent epididymis (as confirmed by the presence of sperm in testicular and vasal fluid, while the ipsilateral epididymis is blocked [42].

For particular cases, assessing the vasal end might be the first decision point for the surgeon. The vasal ends should be patent, having proper blood supply as assessed by bleeding from the final mucosal vessels. What is of importance is that mucosal vessels will usually bleed following a short delay, while adventitial vessels will bleed briskly following transection. Usually the testicular remnant will determine better perfusion. The surgeon should be able to see 4 layers: mucosa, two layers of muscle (subtle), and the adventitia. If 2 muscular layers are not seen, it might indicate residual scar from the vasectomy. More resection for optimizing the vasal ends must be weighed against the criterion of a larger vasal gap, a choice that can be helped by experience via adequate microsurgical training.

On obtaining homeostasis for the testicular vasal remnant with the use of a low-power bipolar cautery, intravasal fluid can be examined following that without obscuring contamination with red blood cells. Macro and microscopic appearance of the vasal efflux tells the surgeon whether secondary epididymal obstruction has occurred, thus obliterating VE. One can anticipate, finding of motile sperm within vas deferens rules out the possibility of epididymal obstruction, with post VV patency rates nearing 100% for some series [43]. The presence of non motile but intact sperms also predicts high patency rates. For this latter case, the Vasovasostomy Study Group showed a patency rate of 91% to 96% [7]. On visualizing only sperm parts (i. e sperm heads), the Vasovasostomy Study Group showed a patency rate of 75%. Subsequent smaller studies found similar results, on the basis of which many providers carried out a VE in such a setting [44]. Scovell et al. [45] Carried out a contemporary meta-analysis that included 1239 subjects across 6 studies, re-examined the role of intravasal fluid assessment that neared statistical significance during vasectomy reversal. Observation of sperm parts or sperms with short tails positively correlated with pregnancy, rendering the recommendations for VV in such a case. Subsequently a retrospective review was carried out in 902 subjects, where finding of only sperm parts in intravasal fluid assessment neared statistical significance for worse post reversal pregnancy outcomes ( $p=0.05$ ) [46]. Still most providers now go on with VV when only sperm parts are found, since the expected patency rates are greater than for VE. Presence of intravasal azoospermia might indicate

VE; yet the surgeon must interpret the macroscopic findings of the vasal efflux to make sure the operative plan that is going to be.

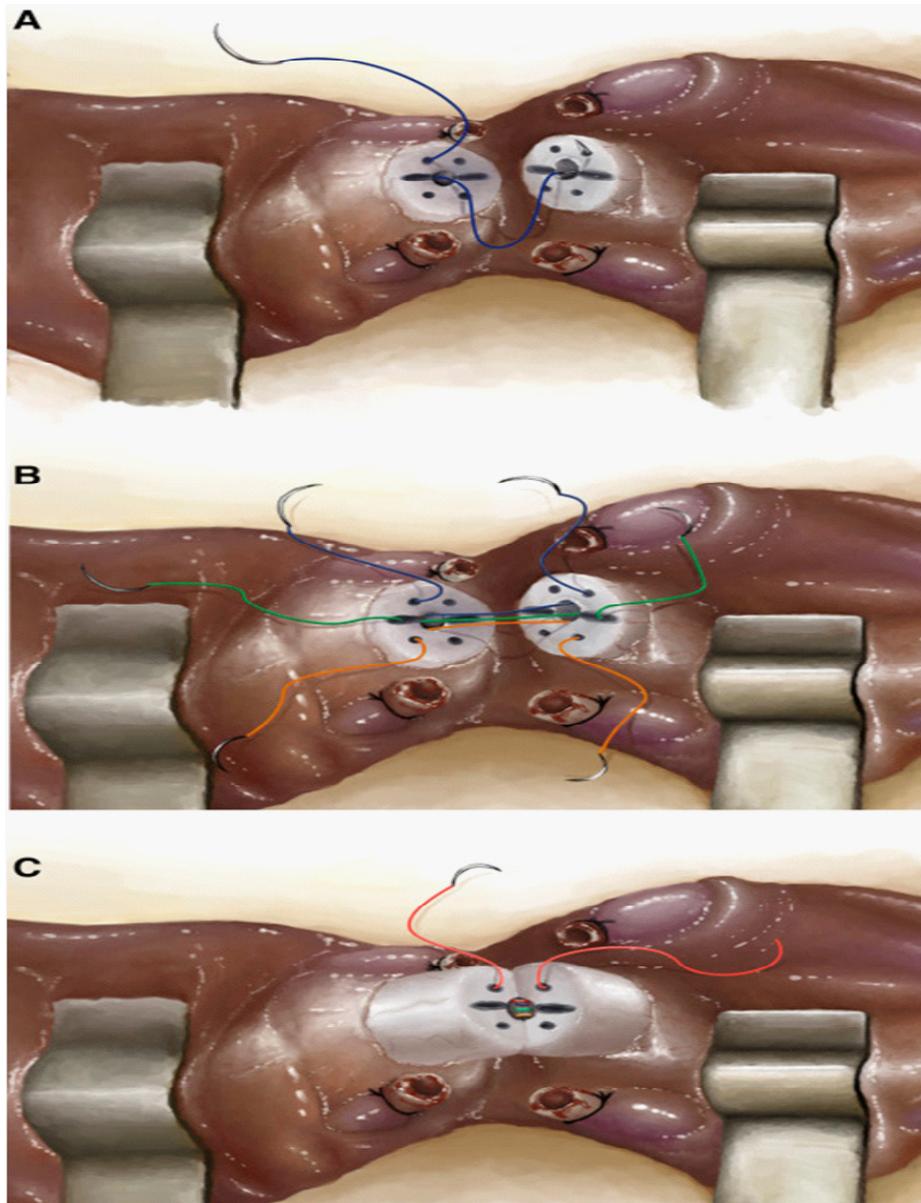
Overall, the vasal efflux can be differentiated on the basis of its colour, consistency and volume. If there is "toothpaste" like fluid, that is a part of the vassal epithelium, and in the absence of sperm, it warrants VE [47, 48]. But plenty of clear fluid following transaction of vas deferens generally indicates a patent epididymis, even in the absence of sperm [7, 48]. Problem exists if there is intravasal azoospermia, with a low efflux volume, or if the colour/consistency is different from clear and thin. In this context Hayden et al. advocate opening the tunica vaginalis [49]. A transition point of dilated to nondilated epididymal tubules is a clear sign of secondary obstruction. Though a transition point is specific, it is not very sensitive, and its absence does not rule out epididymal blockade [50]. Other strategies are barbotage of the testicular vassal remnant in hopes of discovering sperm or waiting a short period of time, (i.e. while the contralateral side is examined), that sometimes might result in return of very few sperms. Because of this it is always important to evaluate both sides prior to finalizing which technique is to be used.

An important factor that can complicate the assessment of intravasal fluid is the commonly used T replacement therapy (or less common, anabolic steroids). Exogenous androgens suppress the release of gonadotropins centrally. Although systemic T levels might reach therapeutic levels, spermatogenesis needs intratesticular concentrations to be higher in quantity [51]. In the absence of intratesticular T synthesis that is stimulated by LH, there will be impaired sperm production because of inadequacy of exogenous hormone replacement therapy. So much so that azoospermia was induced in 95% of subjects in a study with the use of high dose T undecanoate [52]. Thus the subjects presenting for vasectomy reversal with recent use of androgens might present with intravasal azoospermia because of poor synthesis rather than due to epididymal blockade. Recently Coward et al. [53] treated 6 patient with clomiphene and /or HCG prior to vasectomy reversal. They showed expected rates of intravasal sperm during surgery. Bigger studies are required for confirming these early results especially with the testis recovery is complex following exogenous androgen exposure [54].

**Vasovasostomy**

Following assessment of vasogram and intravasal fluid if VV is needed one must assess the resulting vasal gap by freeing both vasal remnants to make sure that there is a tension free anastomosis. One must take care that vasal vasculature is preserved, for preventing failure because of ischemia. Better mobility and length can be obtained usually from the testicular remnant, especially when the convoluted vas is freed. In case of

large vassal gaps, more advanced procedures might be required like inverting the test is to add to the supplied length [42]. On bringing both ends of the vas together without tension, microspike approximator use helps in exposure along with fixation [42]. Importance has to be given to see that vas deferens does not twist while setting up the reconstruction. Hayden et al. utilize the microdot technique as well for preplanning placement of every suture, which is very helpful if luminal discrepancy exists [43] (fig 1).

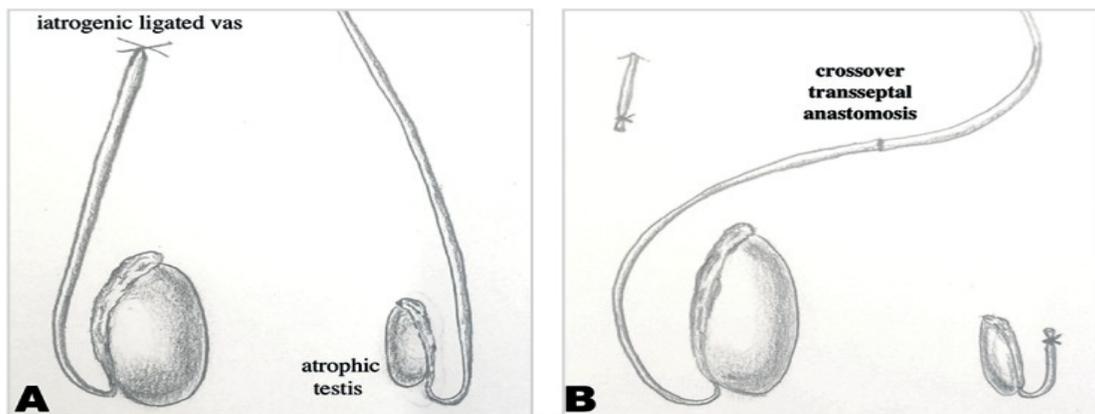


**Fig 1.** Courtesy ref no 49. (A) Setup and placement of the mucosal sutures for VV. (B) Note that the initial three sutures must form a “three-string guitar” before tying, a heuristic that helps ensure no sutures inadvertently crossed each other. (C) Flipping of the microspike approximator facilitates the remaining mucosal sutures. With this exposure the initial three ties should be visible and checked for inadvertent back-walling during initial suture placement.

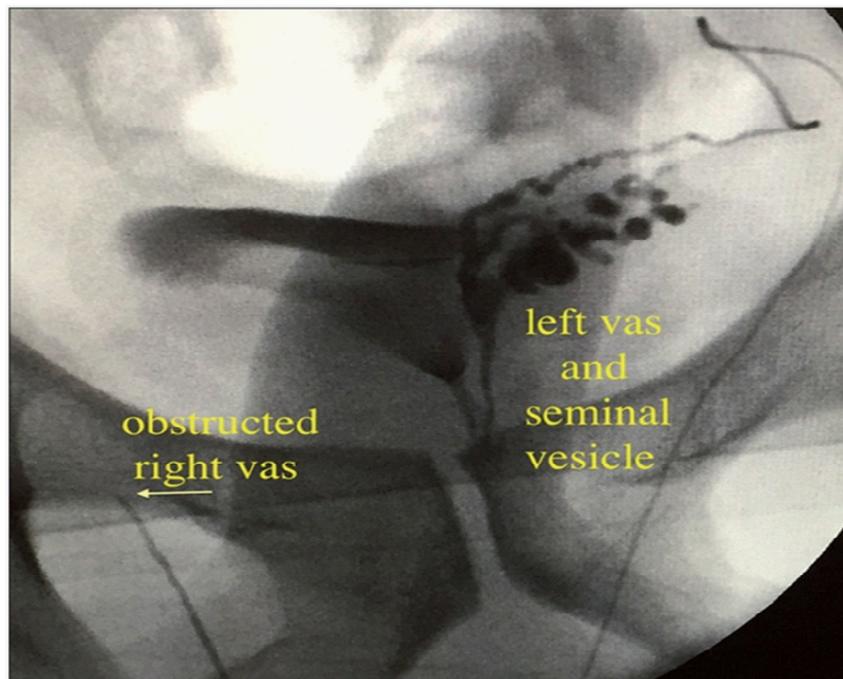
## An Updates on Techniques of Microsurgical Vasectomy Reversal- A Mini Review

The Vasovasostomy Study Group did not find any statistical difference in patency or pregnancy outcomes for two layer and single layer VVs [7]. Following that a meta-analysis confirmed these results where 6,633 patients were involved [16]. Possibly, a high quality single layer anastomosis might prevent extravasation and thus reduce the accompanying risk of granuloma. But Hayden et al. continue to use the two layer technique, since that it has been associated with greater patency rate that has been published [43, 49]. For highlighting the mucosa indigo carmine can be used prior to placing the sutures. A total of six 10-0 sutures get used for approximating the mucosa, with additional six 9-0 sutures placed to approximate

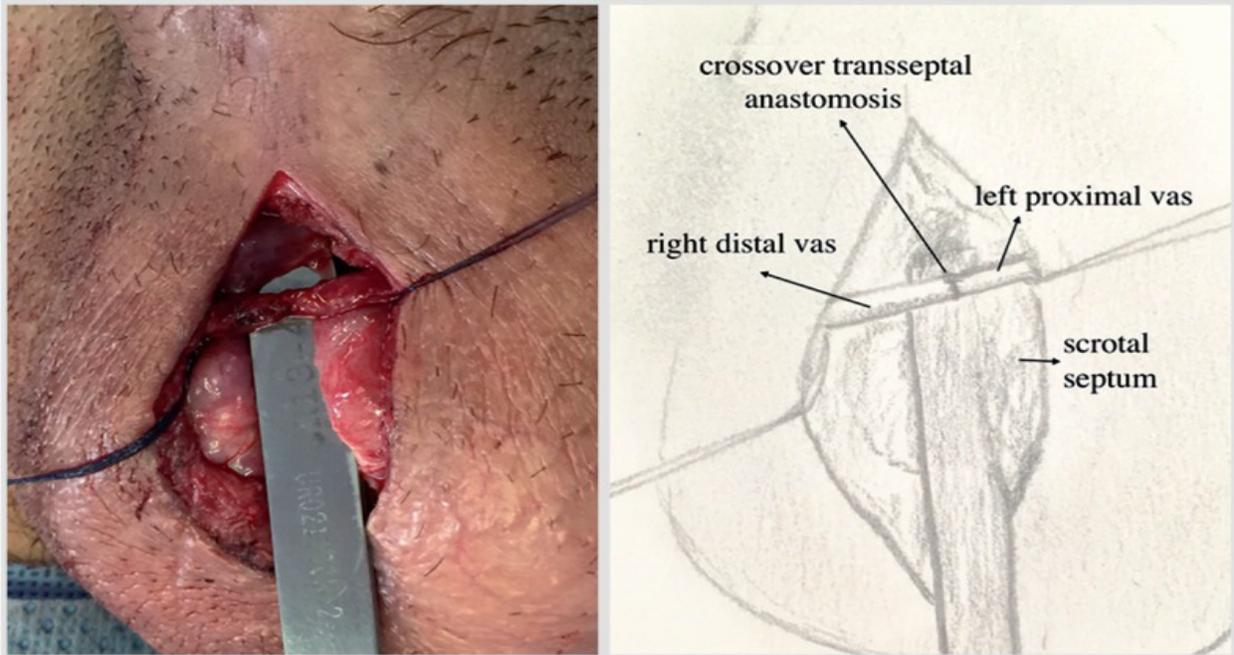
the muscularis. Adventitia is further brought together with at least six 9-0 sutures. Ultimately the adventitia is brought together with 7-0 polydioxanone sutures, that give additional tensile strength to the repair. Animal studies have indicated noninferiority of nylon sutures for the 10-0 and 9-0 layers [55]. To prevent back walling double-armed sutures are a must since all sutures are put inside out [49]. In some challenging cases cross microsurgical atypical vasovas ostomy in scrotum of atypical OA [56]. (FIG 2, 3, 4). Similarly crossover transseptal vasovas ostomy has been considered as an alternative for very selected cases of iatrogenic injury to vas deferens. [57] (fig 5, 6).



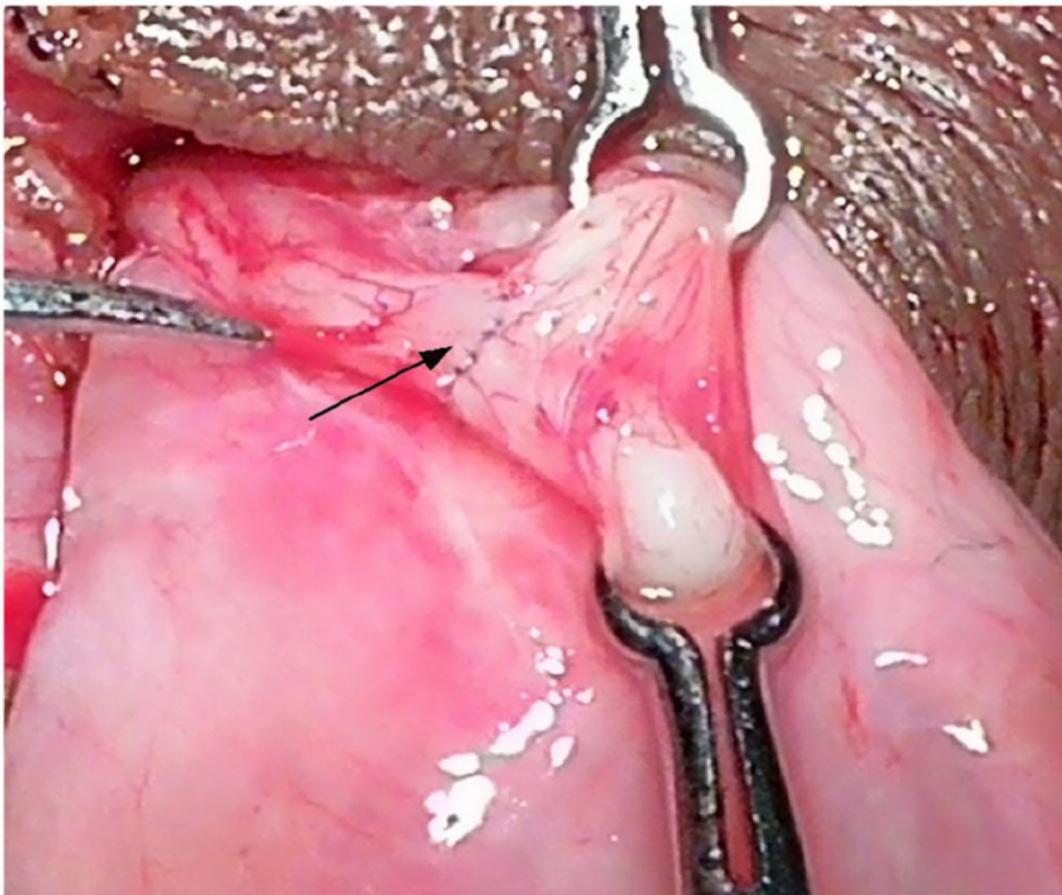
**Fig 2.** Courtesy ref no 49.-Steps for successful LIVE. See text ("Vasoepididymostomy" section) for a written description.



**Fig 3.** Courtesy ref no. 56 Intraoperative deferentography demonstrating obstructed right vas deferens and normal left vas and seminal vesicle.



**Fig 4.** Courtesy ref no 56. A) Schematic view of iatrogenic injury to right vas deferens with hypotrophic left testis. B) Schematic view of surgical procedure for microsurgical crossover transseptal vasovasostomy



**Fig 5.** Courtesy ref no 56. Final aspect of the microsurgical crossover transseptal vasovasostomy.

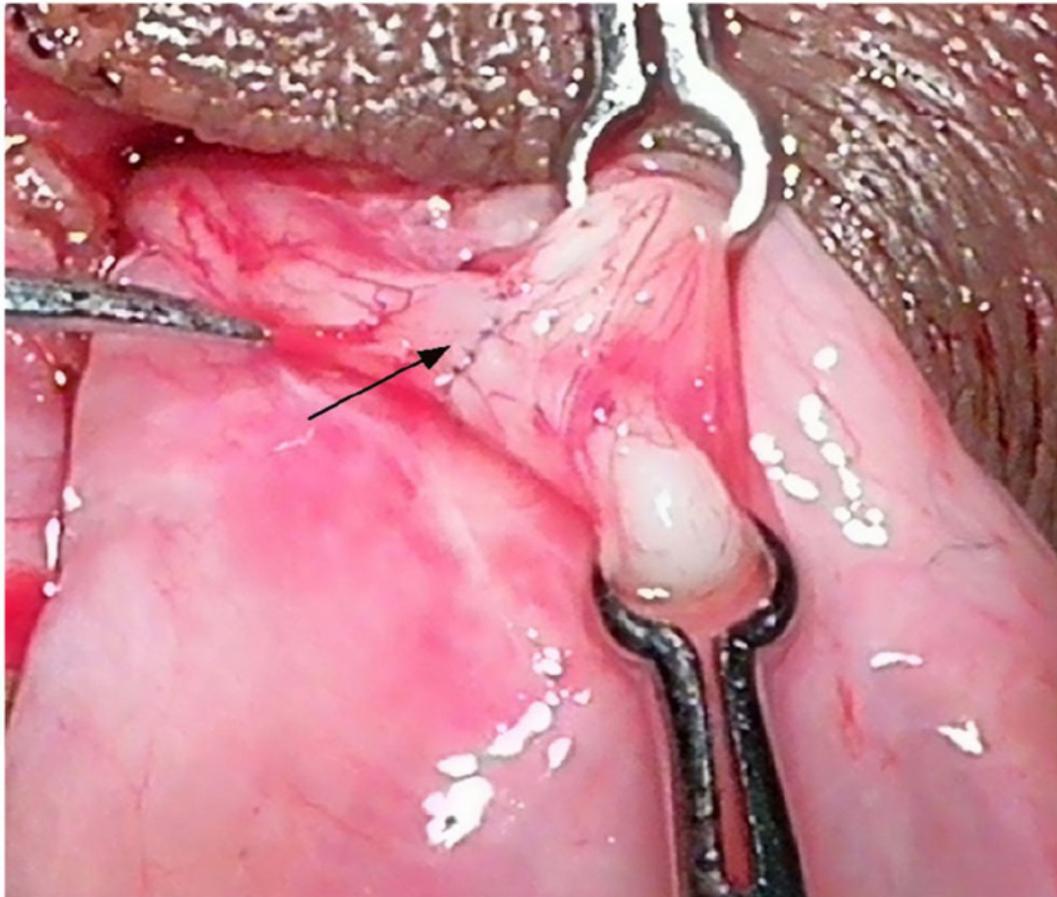


Fig 6. Courtesy ref no 57-Cross vasovasostomy in the scrotum The arrow refers to the anastomosis site

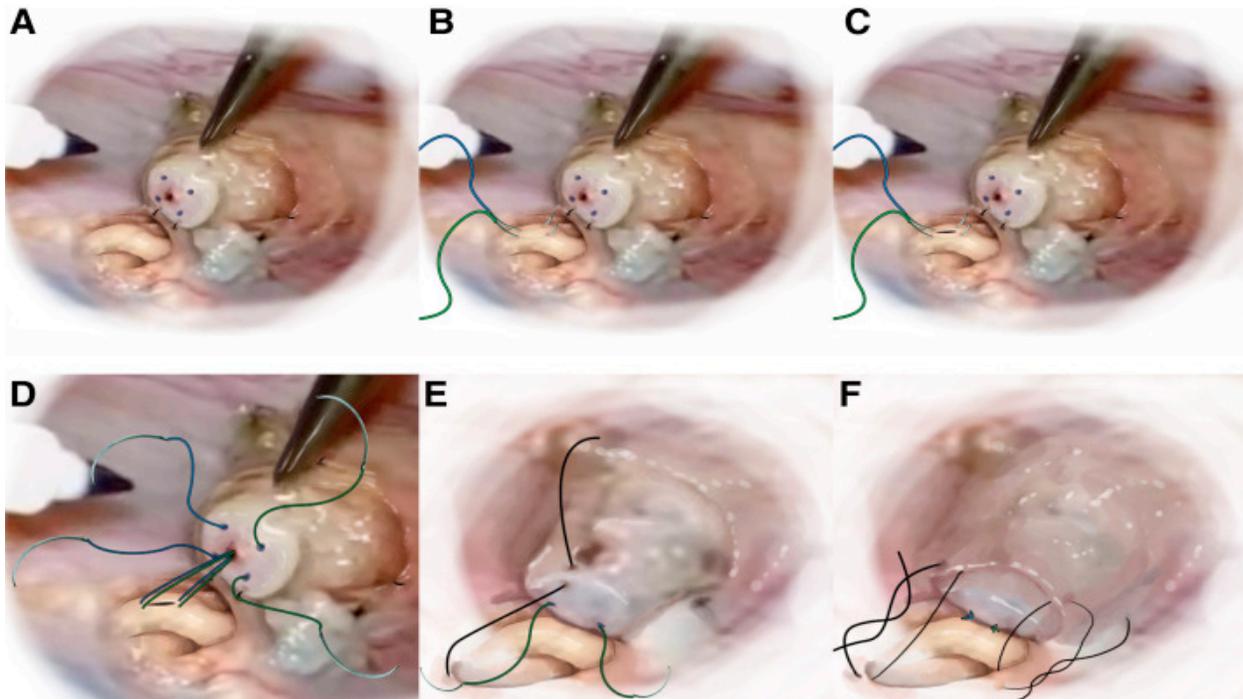


Fig 7. Courtesy ref no-Cross vasovasostomy in the scrotum The arrow refers to the anastomosis site

### Vasoepididymostomy

VE is much more difficult as compared to VV in view of the size and fragility of epididymal tubules. Still the technique needs to be mastered by any surgeon attempting vasectomy reversal as the presence or absence of epididymal obstruction can be judged only intraoperatively. [58] Just like VV, a sufficient length of the abdominal vasal remnant is essential to be obtained so that tension free anastomosis can be performed. Since the abdominal vas gives less ability to free more length, occasionally testis might have to be pexed superiorly for avoiding undue stress on the resulting reconstruction [42]. Following that a small window is made in the tunica vaginalis, and the abdominal remnant is drawn through to facilitate the reversal.

How to select the epididymal tubule is guided by the tubule size, its orientation, and the natural lay of the vas deferens. Since patency outcomes tend to drop as more epididymal length is excluded, the initial tubule which is selected should be as distal as is possible, but above any transition points which might be present [12]. Small window of epididymal tunic is then excised by gently raising the tissue with jeweler forceps and transected with the help of microscissors. Inadvertent entry into an epididymal tubule means to repeat attempt upstream within the epididymis. Then the vas is anchored to the edge of the tunical window with 9-0 nylon sutures (fig 7A). This might be helped with the use of approximator clamp, since any tension might tear these delicate tissues.

There are multiple techniques for VE, although the Longitudinal Intussusception vasoepididymostomy (LIVE) procedure has been found to be better in animal studies and now is the one considered as the standard of care [59]. The selected epididymal tubule is 1<sup>st</sup> linked with indigo carmine for helping watch the lumen once a tubulotomy is made. Two 10-0 double armed nylon sutures are then put longitudinally along the tubule in a parallel fashion. It is crucial that the needles are left in situ for preventing deflation of the epididymal tubule, that will make the tubulotomy overly traumatic otherwise (fig 7B and 7C). Further placing the needles in the beginning, would allow enough space for making a tubulotomy. Then with the help of ophthalmic knife the tubules between the needle then incises the tubules between the needles. Then the effluxed fluid needs to be examined for the presence/

absence of sperms. Once no sperms are found, this site needs to be given up and look for a new tubule upstream. If sperms are present, the already placed double armed sutures are then placed through the mucosa of the vassal end (fig 7D). Just as in VV, Hayden et al. mark the vas with microdots for simplifying the suture passage. Following that 9-0 stay suture for bringing the vas lumen down into the tubulotomy by securing the vasal adventitia to the tunical window, directly opposite to the initial anchoring stitch (fig 7E). Prior to tying the 10-0 sutures, careful tension should be applied till all slack has been removed (as indicated by subsequent movement of the opposite side of the stitch). This step also makes sure that proper identification of both legs of the same suture, which need to be tied together at that time. Finally step of VE is to secure the rest of the vas circumference to the tunical window with multiple interrupted 9-0 Nylons (fig 7F). Spacing of sutures will ensure a watertight seal.

Little modifications of this LIVE technique have been described in the different publications. Various trials have examined, the use of single armed 10-0 sutures [60]. The patency which results following use of single armed 10-0 sutures tend to be lesser than with the use of traditional double-armed sutures. To reduce back walling Hayden et al. use only double-armed sutures. Zhang et al [61]. Made another modification, a vessel sparing VE, that was meant for pts with a long history of varicocele repair. Larger series that corroborate this have not been published. Still the improved success of LIVE technique and its simplicity decrease the chances of errors.

### New Tools

Advances in surgical tools have given more chances for improving microsurgical reconstruction. The biggest is robotic surgery, since it offers high resolution, three dimensional magnification, with tremor-reduced fine manipulation by different surgical graspers. Earliest publications regarding possibility and effectivity of robotic-assisted VV on fresh human vas deferens specimens was given by Kuang et al. [62]. Different animal studies were subsequently carried out for assessing patency outcomes. The only randomized controlled trial was conducted by Schiff et al. [63] where they compared robotic VV and VE with the operating microscope done in a rat model. Following 9 weeks of recovery these rats were killed and examined

for patency and granuloma formation. The time taken for surgery for VV were considerably lower in the robotic group, while no difference in operating time was noted in VE. No statistical difference in patency rates were observed between the 2 instruments. Sperm granuloma formation was higher significantly in the microscopic VV, with no difference in rates of VV.

So far various small studies have reported noninferior outcomes of robotic vasectomy reversal in humans [64]. Yet the uptake of robotic vasectomy reversal has been infrequent, probably due to cost factor and the traditionally trained microsurgeons being more comfortable with the operating microscope. Though cost –efficacy of robotic –assisted vasectomy reversal is debatable, it may be excellent in difficult cases where intracorporeal vasal reconstruction has to be done [65]. Larger series are needed to corroborate this approach and verify the durability of patency following extended follow up.

Video microsurgery is another technology, which is coming up and might be used for vasectomy reversal. Here instead of the operating microscope, a high resolution camera which transmits to monitors that are capable of producing three-dimensional images with accompanying eye wear gets utilized [66]. Till now, the technology for obtaining the needed resolution for facilitating safe visualization using this procedure was limited. Recently, both Olympus and Zeiss are manufacturing products which surpass the imaging limits needed for surgery. Video microscopy has promise for a longer working focal length, wider field of view, along with minimal surgeon strain due to posture [67]. More studies are needed for confirming the projected performance of video microscopes vis a vis the traditional operating microscope.

### Post Operative Manipulation

In many Western countries vasectomy reversal is conducted as a day procedure. Convalescence of patient is similar to that for minor scrotal surgeries, that are well tolerated. Complications are haematoma, and infrequently infection. These patients are followed up by most reproductive urologists with serial semen analysis. Farber et al. [9] conducted a meta-analysis, analyzing the kinetics and later failure rates were delineated for the pooled data of 24 studies. Sperm return to the ejaculate happened between a mean range of 1.7 -4.3 mths for VV and upto 6.6mths for

VE. Late failures, by definition is a return of seminal azoospermia, that occurred in upto 12% and 50% for VV and VE, respectively. In view of high rates of the anastomosis getting shut down it is better to counsel the patient for sperm cryofreezing once patency has been confirmed.

The reference values for semen analysis following vasectomy reversal had not been clear till now. A cohort of 139 subjects were examined following vasectomy reversal by Majzoub et al. [68]. They found that men who were able to achieve a pregnancy had much lower semen parameters in contrast to WHO referral values [69]. A sperm concentration of  $<5 \times 10^6$ /ml, motility  $<10\%$  and morphology  $<1\%$  a pregnancy rate observed were 15%, 21.3%, and 14% respectively [68]. Though the studies cohort was small, there initial data give an early means of interpreting the postreversal semen analysis beyond the WHO, 5<sup>th</sup> edition criteria and the binary outcome of patency [69].

### Training of the Surgeons

Since vasectomy reversal is a procedure which requires adequate attention it needs dedicated microsurgical training to make sure optimum results are achieved for the patients. Tissue handling technique, needle control of 10-0 sutures, intraoperative assessment of vasal stumps, tension, and epididymal tubule selection can only be acquired via experience rather than from published literature. With male infertility fellowships quiet common, this field will continue to further superspecialize and thus there will be condensation into centres of excellence. In other urologic subspecialities, learning curve s for common surgeries are being defined for allowing quality control of the practitioners. For this the best example comes from oncology field, where minimal case load to carry out a robotic –assisted prostatectomy is being described [70].

Need for standardization and quality control of reproductive urologists has been noticed for a long time. Wood et al. [71] surveyed both urologists along with general surgeons who were practicing vasectomy reversal to assess the volume and outcomes. Those who submitted high volumes ( $>15$ /year) obtained a patency rate of 87% in contrast to those practitioners having lesser volume ( $<6$ /year), having a patency rate of 56%. Nagler et al. [72] observed similar results, i. e. patency rates of 89% and 53% respectively, for those who did and did not practice the skills in a

microsurgical lab. A rat model is used accurately to simulate both the VV and VE techniques in Hayden et al. Centre [73]. Just like that the Toronto group also gave promising results from their training curriculum [74].

Description of learning curve for the traditional microsurgical vasectomy reversal is a goal that has not been reached till now. Kavoussi et al [75]. Described the learning curve for the transition of a skilled microsurgeon to robotic-assisted vasectomy reversal for a single high volume reproductive urologist. It was found patency rates remained consistent and within acceptable limits over time, but operative times significantly reduced following the 1<sup>st</sup> 50 cases. Thus a continuous work is required to mature reproductive urology for standardizing and optimizing training of future guidelines.

### CONCLUSIONS

Techniques of microsurgical vasectomy reversal keep on evolving continuously for improving outcomes for males who want fertility following elective sterilization. Success begins with proper pinpointing of proper candidates for this surgery preoperatively. Need for assessing both partners is a must and very important for postoperative OA, and proper preop examination and counseling can help in choosing the proper treatment plan. Even after choosing vasectomy reversal the surgeon might face various intraoperative decisions making on the basis of remaining healthy anatomy along with examination of intravasal fluid. In view of the great amount of work by the Vasovasostomy Study Group, most treatment algorithm is known, despite some occasional questions regarding if only sperm parts are found. High rates of patency with favourable pregnancy outcomes can be ensured to the pts. For continuous delivery of quality care, reproductive urologists need to standardize fellowship education, and pass it on to the next generation of subspecialists.

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