Invited Review Article

Review of various surgical approaches for varicocele management

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Abstract

Varicocele is one of the most common correctable causes of male infertility. Varicocele can also cause scrotal pain or discomfort. Treatment of varicocele is proved to have benefits in terms of fertility and pain. There are many treatment options for varicocele. This review aims to describe the treatment procedures and determine the outcomes, advantages and disadvantages for each treatment option.

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Introduction

Varicocele refers to the abnormal dilatation of the pampiniform plexus[1] which has been associated with scrotal pain, male-factor infertility, and hypogonadism. Nagler et al.[2] reported a 37% incidence of varicocele in infertile men compared to 13% in the general population. Another report by Clavijo et al.[3] found an average 15% prevalence of varicocele in healthy men compared to 45% of men presenting with primary infertility. Furthermore, up to 80% of men seeking care for secondary infertility have a varicocele.[3] Therefore, the treatment of a varicocele should be considered for men attempting to conceive who have palpable varicocele (s), infertility, and abnormal semen parameters, except for azoospermic men.[4] Other proposed indications for varicocele treatment include men with clinical varicocele, testosterone deficiency, chronic persistent and refractory testicular pain associated with the varicocele.[5]

There are many accepted treatment options for varicocele management including retroperitoneal, inguinal, or subinguinal varicocelectomy. Microscopic assistance is often used for the inguinal and subinguinal approaches. Laparoscopic varicocelectomy and the embolization of the spermatic vein are also accepted treatment options. We aim to review the current treatment options for varicocele and to determine the outcomes, advantages, and disadvantages of each treatment option.

Methods

We conducted a narrative review of operative procedures for varicocele treatment options and outcomes. We searched for standard textbooks and previous articles to describe these procedures. To extract the outcomes of these operative procedures, we conducted a literature search using PubMed and Google Scholar using combinations of the search terms "varicocele", "treatment", and "outcomes."

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Selection of articles

We selected articles based on the following criteria:

- They were written in English.
- They reported the outcomes of varicocele treatment options.
- They were published between 1990 and 2022.

We excluded studies that were not relevant to our review, including studies on non-surgical treatments and studies that did not report outcomes.

Data extraction

We extracted data from the selected articles using a standardized data extraction form. We extracted the following information from each article:

- Study design
- Sample size
- Age and sex of participants
- Intervention type
- Follow-up period
- Outcome measures
- Results

We also extracted information on any adverse events reported in the studies. We included the selected references in the narrative review for additional information. We also checked the reference lists of these articles for additional relevant studies.

Surgical techniques

Microsurgical subinguinal varicocelectomy

Subinguinal varicocelectomy is currently one of the most popular techniques used to treat varicocele. An approximately three cm transverse skin incision is made just below the superficial inguinal ring. The subcutaneous tissue, Camper, and Scarpa's fascia are dissected. The spermatic cord is grasped with a Babcock clamp and delivered out to the level of the wound. The external and internal spermatic fascia are divided and a Penrose drain can be passed around the remaining cord structures to help lift up the cord into the operative field. An operating microscope with 8x to 25x magnification can be used[6] to obtain better visualization and identification of the fine vascular and lymphatic structures. A Micro-Doppler ultrasound can be used to identify and preserve the arterial anatomy. Papaverine irrigation is beneficial to induce vasodilation and further aid in arterial identification. The goal of the operation is to ligate all dilated veins while preserving the arterial and lymphatic anatomy. The veins can be ligated with silk ties or small clips.

An inguinal varicocelectomy can be performed using a similar technique; however, the incision is higher over the inguinal canal. The external oblique must be divided, thus creating greater morbidity with the operation. Lee et al. found men undergoing inguinal varicocelectomy had more postoperative pain compared to the subinguinal approach.[7] The main benefit of the inguinal approach compared to the subinguinal approach lies in the anatomy of the pampiniform plexus, as there are fewer branches of the external spermatic vein in the inguinal canal. Having fewer vessels to ligate may be preferable to many surgeons. Studies of varicocele anatomy suggest that access to and ligation of low inguinal and gubernacular veins may cause fewer varicocele recurrences[8] but encountering more veins may result in a more difficult procedure and longer operative time.[9]

A microsurgical subinguinal varicocelectomy offers good outcomes in terms of sperm parameters. The highest pregnancy rate (44.75%) was achieved from this approach.[10] The overall complication rates are lowest with microscopic varicocelectomy (< 5%) compared to laparoscopic (8-12%) and open retroperitoneal (5-30%) varicocelectomy.[11] Microscopic dissection and identification of lymphatic vessels lead to a lower hydrocele rate which is reported to be lowest (0.72%) with microscopic surgery compared to other conventional techniques (7.47%-7.58%).[10,12]

Wu et al. developed a modification of the subinguinal varicocelectomy where the spermatic cord is mobilized and gently 'pulled' distally.[13] This technique affords the convalescent benefit of a subinguinal approach, but also a more proximal dissection on the spermatic cord where there is less branching of the veins. The study enrolled 52 male patients with varicocele, with 26 patients undergoing the conventional microscopic subinguinal varicocelectomy and the other 26 patients undergoing the novel approach of treatment. The results showed that the novel approach had a shorter operative time and required the ligation of fewer vein branches compared to the conventional method. There was no significant difference

in the number of testicular arteries or lymphatic ducts between the two groups. The incidence of postoperative complications was similar for both groups. The authors concluded that the novel approach is a safe and effective method of varicocele treatment and can significantly reduce the number of internal veins to ligate and shorten the operating time without increasing complications.

Laparoscopic spermatic vein ligation

Laparoscopic management of varicocele has gained increasing acceptance over the last few decades.[14] The laparoscopic view offers great exposure to the posterior abdominal wall, particularly at the deep inguinal ring. The procedure is performed under general anesthesia with the patient placed in a supine position. One camera port and two instrument ports are usually sufficient. There are several locations of port placement, but the main objective is to have a clear vision and triangulate the internal inguinal ring. Port sizes can vary depending on surgeon preference and the size of the available equipment. However, a 5 mm trocar usually allows testicular vein clipping. The patient is then placed in a slight reverse Trendelenburg position. The internal inguinal ring and internal spermatic vessels are identified. The overlying peritoneum is opened to clearly expose the spermatic vessels. The pulsating artery is separated from the darker testicular vein[15] and the vein is ligated with Hem-o-lok or metallic clip and can then be divided.

The testicular vein in this part tends to be larger than the inguinal or subinguinal area, and the magnification from laparoscopic equipment contributes to the advantages of this procedure. The ability to perform bilateral varicocelectomy simultaneously compared to separate incisions with an open approach is also a benefit of the laparoscopic approach. A potentially longer hospital stay and treatment costs are drawbacks of this approach.[11]

The laparoscopic approach offers a lower pregnancy rate (27.5%) compared to other treatment methods (44.8% for microscopic subinguinal, 41.8% for microscopic inguinal, 31.9% for embolization and 30% for non-microscopic inguinal approach).[10] The recurrence rate (3%-15%) is lower than in a conventional open approach (9%-45%) but higher than in microscopic approaches (0%-2%).[11] Hydrocele formation is greater than with microscopic surgery (7.57 vs 0.72%).[10,16] Rizkala et al. demonstrated that the use of lymphatic sparing laparoscopic varicocelectomy had a lower hydrocele formation rate compared to plain laparoscopic varicocelectomy (4.5% vs 43.3%).[17]

Traditional open approaches

In 1949, Palomo described the open retroperitoneal approach for the treatment of varicocele.[18] The procedure involves an en-bloc section of the testicular vascular bundle. The modification of arterial and lymphatic sparing techniques has followed since then.

The concept of the procedure is to enter the retroperitoneal space by incision at the area of the internal inguinal ring, then split abdominal muscle to identify the internal spermatic vein and artery near the ureter. The advantages of this procedure are that only one or two large veins can be found at this level, also the artery has not branched yet and often separates from the vein. These anatomic features make it technically an easier procedure. Disadvantages are higher recurrence rate and hydrocele formation.[19]

The benefits of the traditional open Palomo procedure are the low cost, and that the ligation is high enough to avoid multiple branching veins but the collateral veins that branch out of the bundle inferior to the operating field in the procedure cannot be carried out, which can lead to a higher recurrence rate. Testicular atrophy after ligation of the testicular artery was rarely described. It also has a higher incidence of varicocele recurrence and hydrocele formation than any other treatment method.[11]

The inguinal approach procedure is easier than the retroperitoneal approach in obese patients and the ability to ligate more collateral external spermatic veins are the advantages of this procedure in terms of varicocele recurrence but the Ilioinguinal nerve should be identified and carefully preserve as the inguinal canal has to be open in this method.

Traditional open approaches offer a lower pregnancy rate than microscopic approaches (30% vs 41.8%-44.8%).[10,11] They also cause a higher recurrence rate and hydrocele formation.[12]

Embolization

Endovascular approaches for the treatment of varicocele involve venography to identify the internal spermatic and collateral veins with subse-

quent venous occlusion by various occlusion and embolization techniques.[20] For a left-sided varicocele, the right common femoral vein approach is technically easier to access the left internal spermatic vein. The endovascular catheter is passed through the inferior vena cava into the left renal vein and the gonadal vein. However, an internal jugular or basilic vein approach is preferable for right internal spermatic vein access because the acute angle of the gonadal vein and the inferior vena cava is difficult to navigate.[20] The catheter tip is placed at the junction of the internal spermatic vein and the pampiniform plexus and a venogram is performed to identify the collateral pattern. The choices of embolizing agents include solid embolics such as coils and vascular plugs. Liquid embolics such as sclerosant sodium tetradecyl sulfate and glue are also used.[20]

Technical successful embolization is defined as cessation of blood flow as demonstrated by intraoperative imaging. The treatment of right-sided varicocele has a technical failure rate as high as 49% in some reports[21,22] with an overall treatment failure of 13%.[23] Hydroceles are not typically seen in this approach while recurrence rates are low (1.9%-9.3%) comparable to the microsurgical technique (2.07%-9.47%).[10] Pregnancy rates (31.93%) are inferior to other microscopic approaches (41.78%-44.75%).[11]

Discussion

Varicocele is a common condition that can result in infertility and testicular pain. There are several treatment options available, and each technique has its own advantages and disadvantages. In determining the best option, surgeons must consider operative time and cost, pain resolution, fertility/pregnancy/semen parameters, and complications.

Surgery time and cost

A randomized trial comparing open, laparoscopic, and microsurgical varicocele treatment found that the operation time is usually longer in the microscopic group compared to laparoscopic and open surgery groups.[12] The laparoscopic approach had the highest treatment cost followed by microscopic and open approaches. Al-Kandari et al. reported the treatment cost of unilateral and bilateral varicocelectomy for 1) inguinal approach; $1800 and $2100 2) microscopic subinguinal approach; $2400 and $3000 3) laparoscopic approach; $2700 and $3600, respectively.[12] Based on pregnancy outcome, percutaneous embolization was the least cost-effective method (approximately 7300 Canadian dollars per pregnancy) compared to microsurgical varicocelectomy, the most cost-effective method (approximately 5402 Canadian dollars per pregnancy).[24]

Fertility and semen parameters

There was significant improvement of semen parameters in all open, laparoscopic, and microsurgical groups but no differences in degree among them.[12] A review article from Diegidio et al. concluded that microsurgical subinguinal or inguinal techniques offer the best outcomes since pregnancy rates were highest.[10] Most of the articles in this review report improved sperm parameters. Bebar et al.[25] found 43% compared to 51% improvement of sperm parameters by using Palamo and laparoscopic techniques respectively. Zampieri et al. reported 40.6% and 58.3% of patients had normalization of semen parameters by treatment of varicocele laparoscopically without and with the arterial preserving procedure, respectively.[26] Improvement in testosterone level and testicular size were seen but no comparison between each technique was shown. Meta-analysis in 2015 reported significant improvement in pregnancy rate with inguinal microsurgery, subinguinal microsurgery, open inguinal, and laparoscopic technique compared to expectant treatment (Odds ratio 3.48, 2.68, 2.92 and 2.90, respectively).[27] Inguinal microsurgery showed improvement in sperm density and motility compared with retroperitoneal open surgery.[27] A systematic review and meta-analysis in 2020 concluded that microsurgical varicocelectomy provides the greatest benefit to most patients in terms of higher spontaneous pregnancy rate and improvement of sperm parameters compared to laparoscopic or open varicocelectomy.[28] Percutaneous embolization had lower pregnancy rates than microsurgical varicocelectomy and there was a recommendation against it as a first-line treatment for varicocele in men with infertility.[20]

Complications

The microscopic group also had lower postoperative hydrocele and recurrent varicocele compared to the laparoscopic and open groups.[12]

A review from Diegidio et al. found that both microscopic inguinal and subinguinal techniques had lower hydrocele formation rates compared to open and laparoscopic approaches.[10] While the laparoscopic technique had the highest surgical complications.

Subinguinal and inguinal microsurgery outperformed retroperitoneal open surgery and lower than laparoscopic approach in terms of recurrence.[10,27] Inguinal microsurgery and subinguinal microsurgery also had lower overall complication rates compared with retroperitoneal open surgery while laparoscopic approach had more reported complications than other techniques.[10,27]

Diamond et al.[29] reported 10 years of varicocele treatment experience in children and adolescents. Although the laparoscopic approach had the highest success rate (100%) compared to Palamo (93%), Ivanissevich (69%) and subinguinal approach (69%), a higher hydrocele rate was seen in the laparoscopic approach. Artery sparing procedure decreased hydrocele formation.

For the embolization technique, technical failures are rare for left-sided varicocele but can be as high as 49% for right-sided varicocele. A meta-analysis from Cayan et al. reported an overall technical failure rate of 13%.[23] Theoretically, intra-operative venography during embolization can identify venous anastomosis variants, which thought to be the cause of recurrence in other surgical treatments but the literature reveals a wider range of recurrence rates (0%-24%) compared to 0%-3% for microsurgical varicocelectomy.[20]

Lurvey et al.[30] reported incidences of hydrocele to be 4.9%, 8.1%, and 5%; retreatment rates of 1.5%, 3.4%, and 9.9% when treated by open, laparoscopic, and percutaneous embolization techniques, respectively in varicocele patients under 19 years. The outcomes may be slightly different from the adult population since pediatric urologists may not be familiar with microscopic approaches, which makes microsurgical approaches account for only 2% of open varicocelectomy.[31]

Pain resolution

Approximately 2-10% of patients with varicocele complain about testicular pain. Al-Gadheeb et al. report 83.3% pain relief after microscopic subinguinal varicocelectomy. A significantly better pain relief is seen in patients with unilateral symptoms.[32] A systematic review and meta-analysis from Lundy et al. found that 75%, 76%, 85%, and 90% of patients had partial or complete improvement of pain after undergoing varicocelectomy by inguinal, retroperitoneal, laparoscopic, and microsurgical approaches respectively.[33] Sheehan et al. reported 50% and 89% complete pain resolution at 1-month and 1-year post varicocele treatment by embolization.[34]

Conclusions

The principle of varicocele treatment remains unchanged for several decades. Previous reports that showed better outcomes of microsurgical treatment were based on several small studies. Larger studies should be conducted to confirm those advantages. More studies about the technique modification or additional maneuvers to enhance outcomes and reduce complications should also be conducted.

Conflict of Interest

The authors declare no conflict of interest.

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