INTRODUCTION

Varicoceles have been recognized as clinical entities for more than a century but, in the early years, the treatment was exclusively for the management of pain. After 1952, these lesions were viewed differently because Tulloch reported that varicoceles may affect male fertility. He performed a varicocelectomy on a man with azoospermia, sperm appeared in the ejaculate over time, and the patient achieved a pregnancy. In 1955, Tulloch reported his series of varicocelectomies on 30 infertile men. Three had azoospermia, but the others had varying sperm densities. Although the study design was crude evaluated by today’s standards, the author concluded, “From the results obtained, it seems justifiable where a varicocele is associated with subfertility, the varicocele should be cured.”

From 1970 to 2000, varicocelectomies gained worldwide interest for the treatment of male infertility. Several innovative procedures to correct varicoceles began to appear in the world’s literature, and comprehensive review articles were published on the subject of varicocelectomies. As a result of the growing worldwide interest, the number of varicocelectomies was increased in clinical practice, and the data of the National Survey of Ambulatory Surgery estimated that 67% of the patients undergoing ambulatory surgery for male infertility had a diagnosis of varicocele. The number of procedures were increased further when the interventional radiologists began to treat varicoceles.

Controversy stimulates varicocele research

This clinical activity was not without controversy. Statisticians and reproductive endocrinologists were skeptical of the use of varicocelectomies for the treatment of male infertility for several reasons. They noted that the entry criteria for surgery varied among centers, the analysis of semen and pregnancy data often used inappropriate statistical methods, and almost all of the studies were retrospective. Since there were few prospective randomized trials, the Cochrane Collaborative presented negative reviews and, in 2009, they concluded, "Insufficient evidence exists that treatment of varicocele in men from couples with otherwise unexplained subfertility does improve the couple's spontaneous pregnancy chances." The Reproductive Endocrinologists (REs) also weighed in on the role of varicocelectomies for the treatment of male infertility because they cited better results with IVF.

Nevertheless, reproductive scientists continued to study the pathophysiology of varicoceles as source material for the investigation of male infertility. The early studies focused on the role of retrograde venous blood flow because of the increased heat that it produced within the testes which may affect developing sperm and Leydig cells. Others suggested that there was a retrograde accumulation of adrenal metabolites in the testes, as well. In time, the varicocele research evolved to the study of molecular and genetic information in both animal models and humans. Although informative, these reports did not completely explain the basis for the clinical diversity that was associated with varicoceles. For example, why did some men with varicoceles remain fertile? How could a left-sided varicocele cause bilateral effects to both testes? However, new information has become available and helped explain these puzzling issues.

These new data identified molecular markers in men with varicoceles that were similar to responses that occurred in all cases of varicose veins. Recent articles suggest that the retrograde flow may transmit pressure to the walls of varicose veins which release products associated with oxidative stress. In a study among adolescents with varicoceles, Romeo and Santoro were the first to document that Reactive Oxygen Species (ROS) and Nitrous Oxide (N₂O) were released into the spermatic veins. Since these products in excess may damage sperm mitochondria, sperm cytology, and DNA, some
investigators suggested that these products may represent the basis for the cause of infertility among men with varicoceles. Other investigators demonstrated that repeated measurements of the markers for oxidative stress were less variable than values noted on repeat semen analyses, and still others have suggested that these markers should be considered in the work up of all infertile men.

**The new data**

Following varicocele correction, Gabriel et al. reported that sperm DNA damage may decrease significantly as the sperm concentrations and pregnancy rates increased. In the same time, an increase in the publications of prospective randomized trials appeared in the worldwide literature. Collectively, these data began to challenge the critics of varicocelectomies, and the Cochrane Collaborative re-evaluated its position. In 2012, they reviewed 10 prospective randomized trials including 894 men and, based on these new data, they concluded, “Treatment of varicocele in infertile men with a clinically manifest varicocele and poor semen quality may be of benefit.” In addition, they reported that the Number Needed to Treat (NNT) indicated that for every 7 men treated by varicocelectomy, there was 1 additional pregnancy. Independently, Comhaire and Declerq provided data from a multi-center study. They reported that following varicocelectomy repair the NNT was 6.3, and when antioxidants were provided after a varicocelectomy, the NNT was reduced even further. In addition, other publications have proposed a role for varicocelectomies in the treatment several other clinical situations such as low testosterone, nonobstructive azoospermia, and IVF/ICSI outcomes, but these matters will be considered elsewhere within this special issue of the journal. Therefore, it is an exciting time to be discussing surgeries and procedures for the correction of varicoceles, and the present manuscript will focus on the evolution of these techniques and consider some refinements.

**IN THE BEGINNING**

**The pain era**

Rothman presented a concise historical manuscript on varicocele management. He noted that the early investigators reported that about 16% of the male population had varicoceles which are similar to the incidence today, but the treatments at that time were for the management of scrotal pain. The therapies included scrotal support, acupuncture, application of a seton (direct puncture of the veins and placement of a nonabsorbable thread into the veins until the veins dried up), application of an external clamp to compress the veins over a few weeks and ligation with a suture that was passed percutaneously by a needle behind the compression clamp, and then tied anteriorly above the skin to obstruct the veins for up to 2 weeks. Although this latter approach seemed crude, it was the forerunner of techniques that would be reported for the correction of varicoceles.

**The early 20th century**

Ivanissevich developed conventional surgery for the management of varicoceles based on anatomical studies of cadavers, and this surgery was still used for the treatment of scrotal pain. He evaluated the anatomy of the spermatic cords, status of blood flow, and musculature of the anterior abdominal wall and stated that a varicocele was caused by venous reflux due to inefficient venous valves. He proposed a simple way to access to the spermatic cord and stated, “For the surgeon who is just beginning, it is undoubtedly easier to open the canal.” He identified the contents of the spermatic cord in the inguinal canal and ligated the large varicose veins as a group after excluding the testicular artery and vas. Although he recognized the importance of excluding the testicular artery from the ligature, there were some cases of testicular ischemia, hydrocele formation, and recurrences. Nevertheless, he utilized this procedure on 4955 patients over 40 years of practice.

**1949**

Another surgical procedure was reported by Palomo and was called the “Radical Cure of a Varicocele by a New Technique.” He studied a small series of 40 men and noted that three arteries supplied the testis. He concluded that as long as only two arteries were ligated, the flow from the remaining artery would serve as a sufficient blood supply for the testis. The procedure was done under local anesthesia; the incision for this procedure was 4 cm long and it was 3 cm above the internal ring. The dissection was just above the internal inguinal ring where the large spermatic veins were easily visible. Although the artery and veins were ligated together, Palomo excluded the deferential and cremasteric arteries which he believed provided sufficient blood supply to the testis. Among his first 40 cases, there were no relapses or evidence of atrophy but the matter of hydrocele formation was not discussed.

**VARICOCELE SURGERY FOR INFERTILE MEN**

**After 1952**

Tulloch was the first surgeon to repair a varicocele for the treatment of infertility. Tulloch was influenced by the comments of noted colleagues. For example, Russell stated that there was no doubt that the incidence of varicocele is higher in men with poor quality seminal fluid and the varicocele may have an effect on infertility, and Hotchkiss stated that the temperature effect of the varicocele may influence the nutrition of the germinal epithelium and upset maturation of spermatozoa. He recommended varicocelectomy for prophylactic therapy.

Tulloch’s initial report described an infertile man with a varicocele and azoospermia who achieved return of sperm to the ejaculate after a varicocelectomy. Tulloch utilized the Robb procedure which approached the spermatic veins 5 cm above the inguinal ring. At this site, the dilated veins were fewer in number and the arterial blood supply to the testis was avoidable. In addition, Robb demonstrated that secondary venous drainage was preserved after the repair because he observed some venous flow by means of the direct injection of dye into the remaining veins. These observations provided anatomical proof that reasonable arterial flow and venous drainage were preserved which encouraged others to consider the development of newer surgical methods for the treatment of varicoceles.

**After 1970**

Both Dubin and Amelar were the students of Robert Hotchkiss, and they authored several manuscripts related to varicoceles and male infertility. Among their manuscripts, they proposed a diagnostic grading system for clinical practice. The patients were examined upright, and a Grade III varicocele was visible and palpable, Grade II was palpable, and Grade I was palpable with a concurrent Valsalva maneuver. They commented that all infertile men should be examined in this way, because a small palpable varicocele was as damaging as a large one.

In 1975, Dubin and Amelar published their experience with varicocele surgery on 504 men who had not produced a pregnancy for at least 1 year. Before the surgery, all men had at least two semen analyses and those with azoospermia were excluded. The surgery was a modification of the Ivanissevich procedure (Figure 1).

In addition, Dubin and Amelar were the first to recognize the importance of lymphatic preservation. When they summarized their 25-year experience on 986 men, 30 had postoperative hydroceles (3.0%)
but only five required hydrocelectomies. At the same time, Szabo and Kessler\textsuperscript{25} reported results on 111 internal spermatic ligation with the Palomo procedure and there were eight hydroceles (7.2%). Since the occurrence of hydroceles were not uncommon after the surgical techniques that were popular at that time, some surgical refinements seemed necessary.

**INTERVENTIONAL RADIOLOGY**

1966

The phenomenon of retrograde blood flow was permanently recorded preoperatively when Ahlberg \textit{et al.}\textsuperscript{30} used selective venography for diagnostic purposes and accurately documented the retrograde flow associated with varicoceles. In 1976, Comhaire and Kunnen\textsuperscript{31} suggested that venography was not only available for the diagnosis of disturbed venous flow but also could be used therapeutically.

1978

Lima \textit{et al.}\textsuperscript{32} performed catheterization of the internal spermatic veins and then produced sclerosis of these structures with 5–10 ml of 75% hypertonic glucose solution. They repeated the glucose injection until the vein caliber was markedly reduced, and then they completed the procedure by adding 2 ml of monoethylamine oleate. Although they were concerned about possible thrombus migration into the lung, this complication did not occur in their series. As an alternative, Kunnen\textsuperscript{33} introduced percutaneous embolization with a tissue adhesive, 2-isobutyl-cyano acrylate (Bucrylate). The refluxing veins were identified by venography and then they were filled with Bucrylate that hardened in place to eliminate the retrograde flow. Comhaire and Kunnen\textsuperscript{34} reported data on 97 infertile men with varicoceles who were treated with Bucrylate embolization. They noted that the varicocele size was not predictive of outcome, but the successes were greater among the men with the better preoperative semen data, and their overall pregnancy rate was 50.5%. However, this technique lost popularity when Fernandez Aparicio \textit{et al.}\textsuperscript{35} reported that the percutaneous delivery tube could become adherent to the hardened material within the vein which required immediate open surgery to correct the problem.

1981

Varicoceles were predominantly on the left side but, in 25% of the cases, there may be a varicocele on the right, as well. In the early days of percutaneous catheterization, it was often difficult to catheterize the right side but Gonzales \textit{et al.}\textsuperscript{36} introduced trans-jugular catheterization to embolize the right internal spermatic vein more efficiently. In a separate report, Formanek \textit{et al.}\textsuperscript{37} was successful with catheterization of the right spermatic vein in 17 of 24 patients but, over time, the technology improved for percutaneous embolization and it became un-necessary to use the trans-jugular approach. For example, Marshman\textsuperscript{38} described a delivery guide wire for entry into the internal spermatic veins followed by embolization with small steel coils. The wire was an improvement because it could be steered into the veins under fluoroscopy, but these coils were of concern because some migrated into the lung.

Percutaneous venography was also used to diagnose and manage varicocelectomy failures. For example, Morag \textit{et al.}\textsuperscript{39} demonstrated persistent refluxing veins in 21 of 40 patients who had high surgical ligations, and they occluded the persistently refluxing veins with steel coils. As an alternative, Walsh and White\textsuperscript{40} performed percutaneous renal vein catheterization and occlusion with balloons of various sizes that could be deflated and repositioned. White \textit{et al.}\textsuperscript{41} reported successful balloon occlusions of 52 varicoceles among 50 outpatients with only one recurrence at 8 months, but Kaufman \textit{et al.}\textsuperscript{42} studied recurrences in cases after both balloon and surgical occlusions. Among the failed balloon cases, recurrences occurred because parallel collaterals were not occluded whereas among the surgical failures some deep pelvic veins were untied. In a separate publication, Murray \textit{et al.}\textsuperscript{43} diagnosed and treated 44 recurrent varicoceles in 37 patients. Among 18 failed balloon occlusion procedures, the recurrences were treated with surgery. After 26 failed surgical procedures, 10 (38.5%) were high or mid-level, 15 (57.7%) were low inguinal, but none were trans-scrotal. These cases were corrected by balloon occlusion. None required repeat inguinal or scrotal surgery.

**MICROSURGERY**

1979

Modern microsurgery was introduced in 1970’s primarily to improve the outcome of vasectomy reversals, but it was suggested that this equipment may benefit for varicocele surgery, as well. Silber\textsuperscript{44} reported a patient who sustained ligation of the internal spermatic arteries during a varicocelectomy, and he recommended the use of ocular loupes when dissecting the cord structures. In a separate review, Woznitzer and Roth\textsuperscript{45} reported a surprising number of arteries within the specimens removed at the time of varicocele repair. They suggested that an operating microscope, microsurgical instruments, and a Doppler ultrasound probe could be used for a varicocelectomy to observe lymphatics and avoid injury to the internal spermatic arteries.

1985

Marmar \textit{et al.}\textsuperscript{46} presented the first microsurgical varicocelectomy with an operating microscope and microsurgical instruments. Based on the experience gained from performing vasectomy reversals, the operating room staff was familiar with the setup, and they were able to rapidly prepare the room for the varicocelectomy. With the availability of the microsurgical equipment, Marmar introduced several innovations (Figure 2).

1992

Goldstein \textit{et al.}\textsuperscript{47} modified the microsurgical, sub-inguinal varicocelectomy in several ways. They performed 640 varicocelectomies in 429 men. These surgeons had proven skills with microsurgery, and they used the sub-inguinal approach, but they took a more aggressive approach with arterial dissection and venous ligation, and they delivered the testis as part of the procedure (Figure 3). Their failure rate was 0.6% of all procedures, and the pregnancy rate per couple was 43% within 6 months. Although other surgeons delivered the testis during a varicocelectomy, Ramasamy and Schlegel\textsuperscript{48} compared
the results of microsurgical inguinal varicocelectomy with testis delivery (55 patients) and without testis delivery (110 patients). At 1 year, the pregnancy rate was 40.0% for those with delivery and 55.0% for those without delivery. The differences were not statistically significant, but anecdotally they observed that delivering the testis resulted in more trauma, a longer operating time and inflammatory changes in the scrotum.

1994

Marmar and Kim49 updated their series that included 606 procedures on 466 patients. There was only one permanent hydrocele. The recurrence of a palpable varicocele was 0.82% based on the total number procedures that were performed on these men. The 1-year pregnancy rate for 186 postvaricocelectomy patients was 35.6% versus 15.8% for 19 men with varicoceles who were treated medically, and these differences were statistically significant. The readers are encouraged to read this report for the discussion on the statistical methods that were used for analysis of the semen data. One other fact to note is that none of the steps of the original procedure have changed since it was introduced in 1985.

When microsurgery is contemplated on either inguinal or subinguinal spermatic cord, the surgeon should become familiar with the specific anatomy. For example, Hopps et al.50 reported the vascular anatomy on 48 consecutive patients who had subinguinal cord surgery and compared their findings to those of Jarow et al.51 who reported the anatomy of the cord in the inguinal canal. During the subinguinal surgery, there is no need to open the inguinal canal, and Gontero et al.52 reported statistically significant lower intraoperative visual analog pain scores (VAS) with the subinguinal approach. However, Hopps et al.50 stated that the subinguinal approach more difficult because the primary branch point for the testicular artery occurs in the inguinal canal and, as a result, there are more arterial branches covered by more small veins. Marmar and Kim49 did not expose the arterial branches because they occluded the smaller remaining venous branches by controlled sclerosis. Pasqualotto et al.53 dissected the small venous breaches and reported better outcomes for sperm densities and pregnancies based on the number of ligations of adherent veins. In either case, the surgeons must fully understand the anatomy to avoid vascular injuries.

1997 - microsurgery for adolescents with varicoceles

Lipshultz and Corriere54 suggested that varicocele ligations at an early age may prevent a progressive decline in testicular size, and Kass et al.55 examined testicular biopsies among adolescent boys with varicoceles to confirm retarded testicular growth. Therefore, the presence of testicular hypotrophy and varicocele has become the basis for varicocelectomy in adolescents. In a prospective study on adolescents, Paduch and Niedzielski56 reported a 26% increase in volume of the left testicle after a modified Palomo procedure which supports the role for this surgical repair among adolescents. However, Kass and Marcol57 reported an overall 11.0% failure rate after the nonarterial sparing Palomo procedure, and 16% failure rate among adolescents with the a modified Ivanissevich inguinal procedure. In addition, Ferber and Kass58 reported a 29% rate for hydroceles with the Palomo procedure among adolescents. Therefore, other surgical methods were considered for adolescents.

Lemack et al.59 utilized a microsurgical repair on 30 adolescents with varicoceles, and they had no failures. In addition, it is interesting to note that this group included five boys who had failed with a
nonmicrosurgical varicocelectomy. In a separate report, Schiff et al.\textsuperscript{60} performed 97 sub-inguinal microsurgical varicocelectomies on 74 adolescents and they reported 1 hydrocele. Although these techniques require microsurgical skills, Mirilas and Mentessidou\textsuperscript{61} reported that they offered good results with low morbidity, but all surgeons are advised to carefully study the complex vasculature of the spermatic cord and testis to obtain favorable results.

**ANTEGRADE SCLEROSIS**

When considering the evolution of varicocele surgery, the Tauber procedure deserves a detailed discussion. This technique was first described in 1988, but Tauber and Johnsen\textsuperscript{62} did not report the technique in the English version until 1994 when it became known as “antegrade scrotal sclerotherapy.” They performed open surgery to expose the spermatic cord and select a single vein for sclerosis in an antegrade manner, and the steps of the procedure are shown in Figure 4. Their study group included 218 patients with varicoceles and the reasons for surgery included scrotal pain, poor semen analyses, and varicoceles progression. The follow-up revealed no postoperative varicocele in 91% of the cases and, among the infertile group, 42% of the cases conceived within 6–30 months.

Despite these favorable results, there have been a few notable complications associated with these procedures. For example, Goll et al.\textsuperscript{63} reported the loss of a testicle due to a hemorrhagic infarct after antegrade sclerotherapy. In a separate study, Salerno et al.\textsuperscript{64} documented that an anomalous anastomoses may occur between the left internal spermatic and visceral veins, and they suggested venographic studies before sclerosis to minimize recurrences, but there were other implications. In a patient with a venous anomaly, Vincini et al.\textsuperscript{65} reported a large bowel infarct following antegrade sclerotherapy that required colonic resection and a colostomy. As a result, in a review of 5254 cases, Tauber et al.\textsuperscript{66} recommended preliminary phlebography to identify venous anomalies before antegrade sclerosis.

**Antegrade scrotal sclerotherapy for adolescents with varicoceles**

In 2001, Mazzoni et al.\textsuperscript{67} reported sclerotherapy for adolescents because of its simplicity, low cost, and lack of hydrocele formation. They compared 45 adolescent varicocelectomies done with the Palomo procedure versus 44 Tauber procedures. The Palomo procedures had two failures (4.4%) and two postoperative hydroceles (4.4%). In contrast, the Tauber procedures had two failures (4.5%) but no hydroceles. However, Zaupa et al.\textsuperscript{68} followed 84 children after antegrade scrotal sclerotherapy, 6 (7.0%) had recurrences, no hydroceles, but 3 (3.0%) had more serious complications including two with wound infections, one with a scrotal hematoma and focal testicular necrosis. Therefore, the parents of the children with varicoceles must be informed of these complications before consenting to these procedures. The reality of these complications has stimulated other investigators to seek modifications.

Colpi et al.\textsuperscript{69} utilized a sub-inguinal approach combined with sclerotherapy alone for occlusion of the venous vessels by a modification of the Marmar and Kim\textsuperscript{49} (Figure 5). The study group consisted of 307 men aged 17–51 years. Therefore, this modification was applicable to adolescents as well as adults. There were some cases of postoperative penile swelling, but there were no hydroceles or atrophic testes. In a separate report, Carmignani et al.\textsuperscript{70} introduced sclerotherapy of the pampiniform plexus with a modified Marmar technique in children and adolescents. They evaluated 25 patients between 9 and 18 years (mean 14.4). There were no recurrences and only one hydrocele. The authors concluded that this modification was safe, easy to perform, and applicable to the treatment of children and adolescents. Further, their modification did not require extensive venous dissection, and the modification was less invasive than the laparoscopic procedures that have been popularized for young patients, which will be the topic of the next section.

**LAPAROSCOPIC VARICOCELECTOMY**

Laparoscopies were first used for the diagnosis of intra-abdominal pathology but, over time, most hospital had laparoscopic instruments that were used for a variety of procedures. In the beginning, some complications had been reported during laparoscopic procedures. For example, Soulie et al.\textsuperscript{71} reported the complications with 350 laparoscopic procedures related to urologic diagnoses. These included 0.3% mortality rate, a 1.1% conversion rate to an open case, and a...
2.6% injury rate to the vasculature or visceral organs. There was a 2.8% postoperative complication rate including thromboembolism and wound infections at the trocar sites. However, the complication rate decreased from 9.0% for the first 100 cases to 4.0% for the next 250 procedures.

As the complication rate for laparoscopy decreased over time, it was not un-expected that clinicians would perform laparoscopic varicocelectomies. Hagood et al.\(^\text{22}\) reported laparoscopic varicocelectomies on 10 patients. The operative repairs were proximal to the internal ring and four were bilateral. They reported that the laparoscopic camera provided a microscopic view, the arteries were easily observed after a papaverine drip, and the internal spermatic veins were not difficult to clip and divide. Postoperatively, one patient had shoulder pain and three had a pneumoscutrot that resolved in 1 day, but overall patients had less pain than other procedures and they were managed by acetaminophen with codeine for 2 days. Donavan and Winfield\(^\text{73}\) had a similar experience with 14 laparoscopic varicocelectomies and, in addition, they reported improvement in the pain associated with varicocelectomies on 10 patients. The operative repairs were proximal to the internal ring and four were bilateral. They reported that the laparoscopic camera provided a microscopic view, the arteries were easily observed after a papaverine drip, and the internal spermatic veins were not difficult to clip and divide. Postoperatively, one patient had shoulder pain and three had a pneumoscutrot that resolved in 1 day, but overall patients had less pain than other procedures and they were managed by acetaminophen with codeine for 2 days. Donavan and Winfield\(^\text{73}\) had a similar experience with 14 laparoscopic varicocelectomies and, in addition, they reported improvement in the pain associated with varicocelectomies, but Friedersdorff\(^\text{79}\) had a different experience with 14 laparoscopic varicocelectomies and, in addition, they reported improvement in the pain associated with varicocelectomies. Oswald et al.\(^\text{81}\) introduced the idea of preoperative dye injections into the subdartos space before 28 Palomo procedures in adolescents. They injected 2 ml of isosulphan blue, and the lymphatics were clearly stained in 24 of 28 patients. There were no hydroceles or recurrences among those who were stained successfully. Methylene blue was avoided because this dye may cause local tissue reactions. Ishibashi et al.\(^\text{82}\) used Indigo carmine because there has been extensive experience with this dye in cases of lymphatic mapping and sentinel node identification in cases of breast cancer. If 1–2 lymphatic channels were preserved during a varicocelectomy, there were no postoperative hydroceles.

**Ways to repair hydroceles**

Since hydroceles require management when they occur after some varicocelectomies, new minimally invasive hydrocelectomies may be applicable. For example, Onol et al.\(^\text{83}\) reported that after a 15 mm transverse scrotal incision, the tunica vaginalis could be grasped and dissected without delivery of the testis. By means of traction on the tunica, the sac was dissected from the subcutaneous scrotal tissue and delivered sufficiently so that the base could be opened and drained of fluid. The edges of the sac were cauterized and dropped back into the scrotum followed by skin closure. Saber\(^\text{84}\) presented a slight modification whereby a disc of the tunica was excised and over sewn before skin closure.

**Dissection and ligation of the deep veins within the pampiniform plexus**

Some reports suggested that the number of veins ligated may influence the outcome of varicocelectomies, but these extensive dissections and ligations may be risky. Shindel et al.\(^\text{85}\) questioned whether the number of veins ligated truly affected semen outcomes. Nevertheless, for those who choose to perform these extensive dissections, Zhang et al.\(^\text{86}\) introduced the use of transfixing microsutures for difficult to isolate periarticular veins.

**Immediate repair of arterial injury during a varicocelectomy**

Even with the aid of an operating microscope, Chan et al.\(^\text{87}\) reported that arterial injuries may occur in about 0.9% of microsurgical varicocelectomies. However, Kumar et al.\(^\text{88}\) noted that the torn artery may be repaired immediately by observing the bleeding during arterial pulsations and closure with three #11-0 nylon sutures.

**Simplification of laparoscopic varicocelectomies**

The conventional approach for laparoscopic varicocelectomies utilized several ports, but recent modifications were introduced to simplify the procedure, especially for children. Kaouk and Palmer\(^\text{89}\) reported the use of a single umbilical port in three children with no complications, failures, and postoperative hydroceles. Youssef and Abdalla\(^\text{90}\) presented an expanded randomized trial that included 80 patients, and they compared the single incision trans-umbilical laparoscopic varicocelectomy (SIL-V) to the conventional laparoscopic technique (CLT-V). Following the SIL-V, there was a high rate of cosmetic satisfaction and significantly lower visual analog pain scores (VASs).

**New device for percutaneous occlusion of varicoceles**

A newly patented vascular occlusive devise was introduced and known as the Endo-luminal Occlusive System (EOS). It consisted of a Nitinol base attached an open sleeve of PTFE, and the system was reported to be rapid, more controllable, and less expensive than other systems. Although this devise is applicable to both arteries and veins, the first clinical trial after FDA approval was on six men with varicoceles (Venbrux et al.\(^\text{91}\)) and they reported that the product provided 100% occlusion in the vessels that were studied.
Robotic-assisted varicocelectomy

In 2008, Corcione et al. performed the first 8 robotic-assisted subinguinal varicocelectomies and compared these data to eight patients who had conventional microsurgical procedures. The operating times were the same, and neither group had complications. Recently, Parkkattil and Gudeloglu published a comprehensive review of robotic assistance for andrology. They commented that the operative microscope revolutionized microsurgery in 1970’s whereas robotic assistance may represent the start of the second revolution. However, they pointed out that the growth of robotic assistance has been limited by high equipment and insurance costs. Therefore, the question remains whether robotic-assisted varicocelectomies can compete with standard microsurgical procedures, especially with the introduction of new magnification systems that could provide surgeons the ability to work at variable focal lengths and with high-definition television screens for operative clarity. Parekattil and Gudeloglu incorporated such an imaging system (VITCOM) onto the 5th arm of their robotic platform, but others have used this equipment alone for various microsurgical procedures. No doubt, improved technology will continue to advance microsurgery, but the costs and outcome data will determine the eventual role for robotic surgery versus conventional microsurgery for the management of varicoceles.

CONCLUSIONS

The diagnosis and treatment of varicoceles have come a long way since the time they were corrected for the management of pain, alone. Over many decades, men and animal models with varicoceles have been a major resource for the study of male infertility. Now, the studies of varicoceles have entered the molecular era, and new data based on these molecular findings have led the way toward a better understanding of the pathophysiology of these venous lesions. The evolution of varicocele surgery and the refinements have been creative, effective, and rewarding, as well. In conclusion, it is hoped that the material in this special issue (including the present manuscript) will stimulate even more research that will lead to fresh ideas in future regarding the management of male infertility and other conditions related to varicoceles.

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