The value of percutaneous coil embolization in the treatment of varicocele compared with laparoscopic varicocelectomy: a prospective study

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Background
This study was done to evaluate the efficacy, feasibility, safety, and postoperative outcomes of radiological percutaneous embolization compared with laparoscopic technique in the treatment of primary varicocele.

Patients and methods
The authors evaluated 60 patients who presented with clinically and radiologically evident varicoceles proved by testicular duplex studies and experienced infertility or subfertility confirmed by semen analysis together with chronic testicular pain attributed to varicocele. A total of 30 patients (50%) were operated via laparoscopic varicocelectomy (group A) and the other 30 patients were selected for percutaneous varicocele embolization with coiling of the testicular (spermatic) veins (group B).

Results
In all cases, patient complaints, clinical examination, and radiological studies were performed, supported with semen analysis in patients with subfertility.
In group A patients, the mean age was 23 years, whereas it was 28 years for the group B patients. The average procedural time was 34 min for the group A patients and 45 min for group B. Of patients in group A, one had a small port site hematoma and two patients had secondary hydrocele formation, whereas 1 of the group B patients had minor puncture site hematoma and 3 patients had transient postcoiling mild pain. Semen analysis improved in 93.3% of the group A patients and 83.3% of the group B patients.

Conclusion
Laparoscopic varicocelectomy is safe and effective, causing minimal discomfort and early return to activity with a low recurrence rate. Percutaneous varicocele embolization is a minimally invasive technique that has a high success rate in experienced hands, has low morbidity with real-time delineation, and can be done under local anesthesia as an outpatient procedure with minimal risk of radiation exposure.

Keywords:
coil embolization, laparoscopic varicocelectomy, varicocele

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Background

Varicocele is the most common correctable cause of male factor infertility. It is defined as varicosity and tortuosity of the pampiniform plexus, caused by retrograde blood flow through the internal spermatic vein owing to incompetent valves. Most varicoceles are left sided, only 1% are on the right side, and up to 30% are bilateral. Its prevalence rate ranges from 25.4 to 81% in infertile men [1].

The indication of varicocele treatment includes infertility, impaired testicular growth, and chronic scrotal pain. The recurrence rates range from 14.9% for high inguinal approaches to 1% for microscopic varicocele repair [2].

Testicular pain is the presenting symptoms in 2–10% of patients with varicocele, which is described as dull aching pain or heaviness. The ideal technique for varicocele treatment is controversial; these techniques include microsurgery, laparoscopy, percutaneous embolization, open surgical ligation of spermatic veins, and retrograde and antegrade sclerotherapy. All of the aforementioned techniques have their own advantages and disadvantages [3,4].

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Percutaneous embolization is a safe and efficient minimally invasive procedure that necessitates selective catheterization of the internal spermatic vein, followed by occlusion with a sclerosant or solid embolic devices. Complications are infrequent and include thrombophlebitis of the pampiniform plexus, coil migration, allergic reaction to contrast media, and mild low back pain [5].

Improvements in semen parameters and pregnancy outcomes are the same in patients undergoing percutaneous embolization and surgical ligation. Percutaneous embolization has low morbidity and complications with high long-term success rate adding its cost effectiveness compared with surgery, which has led some authors to recommend percutaneous embolization technique as the first treatment approach for varicocele [6].

Laparoscopic varicocelectomy was first described in the early 1990s, and then, it gained wide success and was accepted as a simple, safe, and minimally invasive procedure in adults and children. It has several advantages over other nonmicrosurgical inguinal approach, such as excellent visualization of the spermatic vessels, especially helpful in obese patients, and also allows separate ligation of the spermatic veins with preservation of arteries. In a bilateral varicocele, it allows treatment of both sides during the same session, but the risk of hydrocele is reported in up to 25% of patients [7].

Regarding percutaneous varicocele embolization, it can be done under local anesthesia to avoid complications of general anesthesia. It can be done without perivascular tissue damage. as it is purely an endovascular technique. Another advantage to the embolization is in bilateral cases, where it can be done in a single setting with the same venous access [8].

Patients and methods

Demographic, clinical, and surgical data of the 30 patients who had laparoscopic varicocelectomy are obtained from the General Surgery Department. Approval of the ethical committee was obtained before starting the study and all patients signed written consent after describing the procedure and the possible complication. Moreover, the data of the 30 patients who were subjected to percutaneous embolization in the Interventional Radiology Department were reviewed. This study was performed between April 2018 and April 2020 in Ain Shams University hospitals.

Patients were divided randomly into two groups: group A (patients who had laparoscopic repair) and group B (patients who had percutaneous embolization varicocelectomy).

All patients had a full description and discussions of the procedure, and a written consent was obtained.

All patients had routine preoperative investigations in the form of complete blood count, prothrombin time, partial thromboplastin time, clotting time, full chemistry including renal function, scrotal duplex scan criteria to assess venous reflux, and semen analysis.

The techniques were adequately explained to all patients included in the study, and written consent was obtained from all patients before performing the procedures.

Regarding patient complaints, most patients experienced chronic scrotal dragging or dull aching pain, and other patients had subfertility or infertility regarding sperm count, motility, and abnormal forms.

Exclusion criteria

The following were the exclusion criteria:

(1) Nonrefluxing varicocele by duplex study.
(2) Asymptomatic varicocele.
(3) Abnormal renal function.
(4) Patients with bleeding diathesis.
(5) History of sexually transmitted disease or previous lower genitourinary tract infection

All patients underwent follow-up by scrotal Duplex and semen analysis every 3 months.

Operative technique

Technique of laparoscopic varicocelectomy

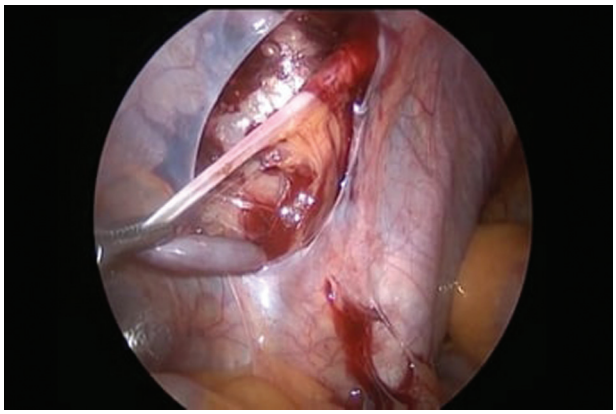
All the patients included in this study underwent laparoscopic varicocelectomy under general anesthesia.

The patient was laid supine in Trendelenburg position, and a Foley's catheter is inserted to empty the bladder (removed at the end of the procedure). A Veress needle is inserted through an infraumbilical 1-cm incision for CO_2 gas inflation with a pressure of 15 mmHg being preferred.

A 10-mm trocar is inserted into the abdomen for the camera. Two additional trocars are required: one 5 mm in the right lower abdomen and the other in the opposite lower quadrant for passage of the clip applier.

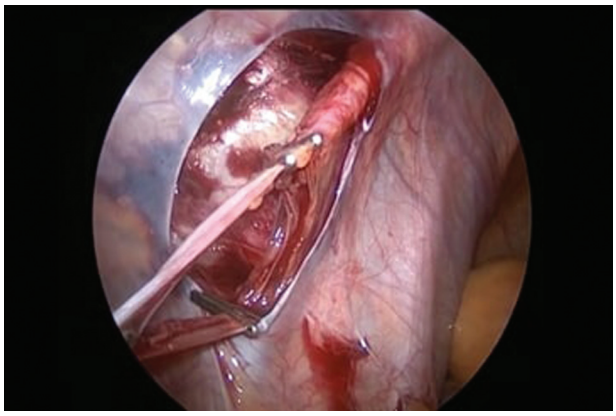
The internal inguinal ring and the testicular vessels are identified. Peritoneum over these spermatic vessels is

Figure 1



Dissection of the spermatic vein.

Figure 2



Clipping of the spermatic vein and then division.

incised using monopolar diathermy. Using a dissector with a fine tip, we dissected the artery free from the veins.

Once the testicular vein is identified, it can be clipped and then divided. Reperitonealization of the small window is not necessary. Ports are removed under vision to make sure that there is no port site bleeding (Fig. 1).

Technique of percutaneous varicocele embolization

The patients were asked to fast 4 h before the procedure, and the procedure was simply explained to them.

Sterilization of the puncture site was done by tincture iodine (we preferred to use the right internal jugular vein (IJV) as an entry site rather than the femoral vein to gain better access to the testicular veins), and then a local anesthetic agent (10 ml Xylocaine 2%) was injected at the site of entry over the right IJV after its localization by ultrasound.

Right IJV puncturing using a Seldinger needle under ultrasound guidance was done followed by placement of 6 F vascular sheath. Then, a 4-F vertebral or cobra catheter was introduced through the vascular sheath into the IVC over a 0.035' Terumo hydrophilic guidewire.

Contrast media was injected into the IVC to assess the origin of left renal vein, and the catheter was introduced into the left renal vein as distal as possible followed by manual injection of contrast while the patient underwent Valsalva to visualize the origin of left the internal spermatic vein (left testicular vein), which was catheterized by moving the catheter tip into the ostium of the left testicular vein, and then the catheter was advanced through the testicular vein over the guidewire followed by injection of contrast agent while the patient strained to assess the termination of the testicular vein, incompetence of valves, and collateralizations. Embolization was done using coils (fibered platinum coils 8–12 mm in diameter according to the degree of dilatation of the testicular vein).

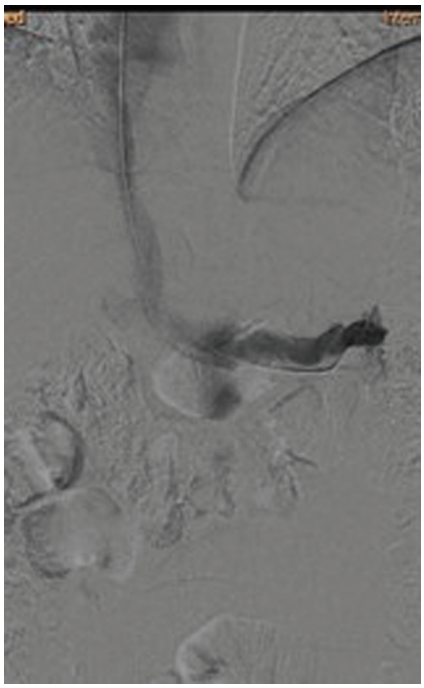
The coils should be placed distally at the level of the internal ring or distal to the lowermost collateral to avoid recurrence of reflux through these collaterals. Gonadal venography should be repeated after 5–10 min with the patient straining to confirm occlusion of the testicular vein and collaterals (Fig. 2).

Catheterization of the right testicular vein is more difficult than the left one due to its acute angle with the IVC; so, the vertebral or cobra catheter was placed in the IVC at the level of renal veins, and contrast was injected forcefully while the patient underwent Valsalva to localize the ostium of the right testicular vein which lies in the anterolateral aspect of the IVC just below the right renal vein. Then catheterization of the right testicular vein was done to assess reflux during straining, and if present, coiling of the vein was done in the same manner applied to the left side (Figs 3–9).

Our patients were clinically examined postoperatively for complications and were followed up every 3–6 months through clinical examination, colored-Doppler ultrasonography, semen analysis, and visual analog scale (VAS) scoring system to assess postoperative pain.

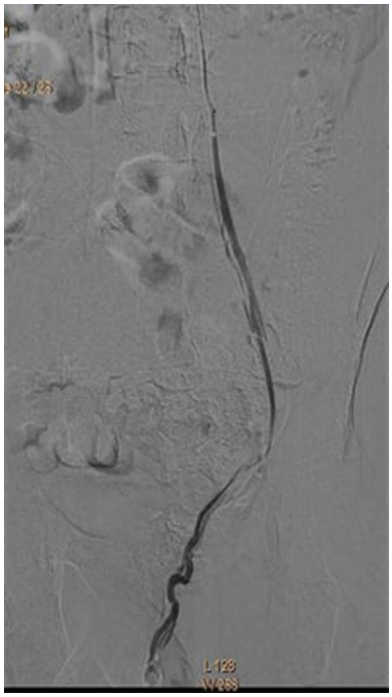
The VAS tool uses a progressive numerical scale ranging from 1 and 10, corresponding to different

Figure 3



DSA showing left renal venogram. DSA, digital subtraction angiography.

Figure 4



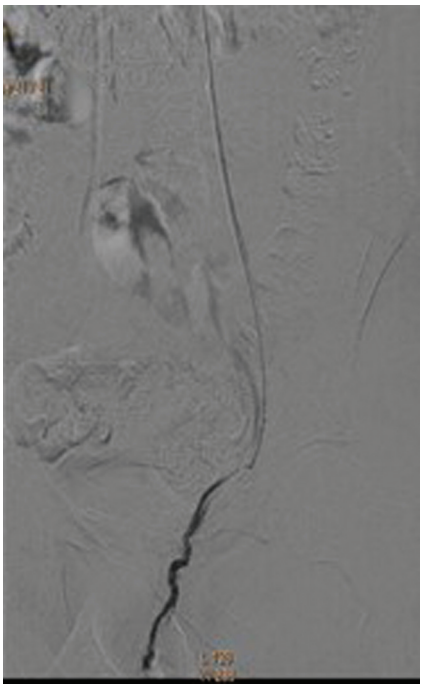
DSA showing left testicular venography with reflux during Valsalva into the pampiniform plexus of veins. DSA, digital subtraction angiography.

pain thresholds: mild pain for a score from 1 to 3, moderate pain for 4 to 7, and severe pain for 8 to 10.

Statistical analysis

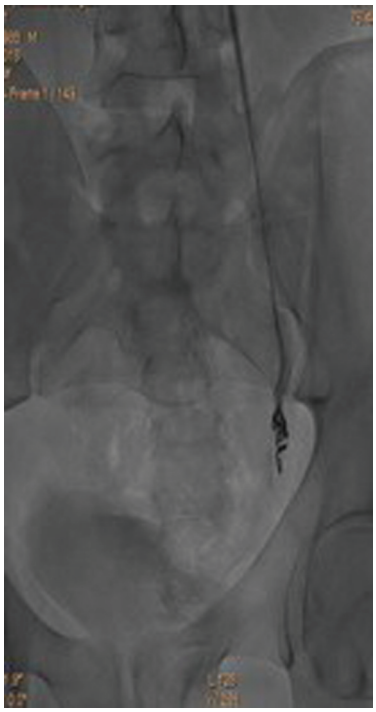
Data were collected, revised, coded, and entered to the Statistical Package for the Social Science (IBM SPSS) version 23 (Armonk, NY, USA). Data were presented as percentages. The differences in surgical outcomes between the two groups were compared using Pearson's χ^2 and Fisher's exact tests. P values were reported,

Figure 5



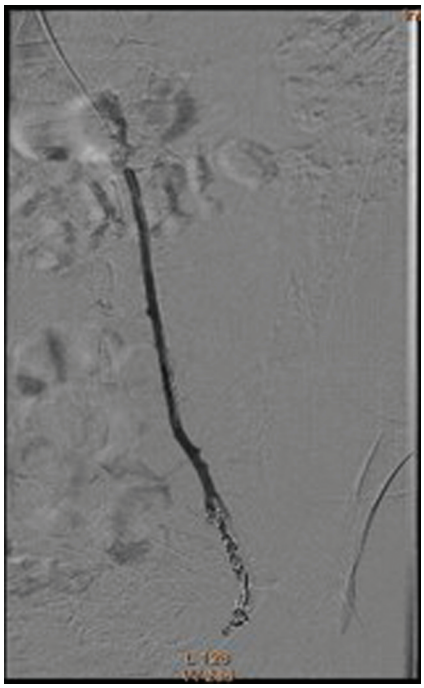
DSA showing left testicular venography with reflux during Valsalva into the pampiniform plexus of veins. DSA, digital subtraction angiography.

Figure 6



Coiling of the left testicular vein using a 10-mm coil at the level of the ischial spine.

Figure 7



DSA showing another coil (10 mm) placed superior to the first coil and venography revealed no distal reflux yet small collateral was seen arising from the testicular vein (arrow). DSA, digital subtraction angiography.

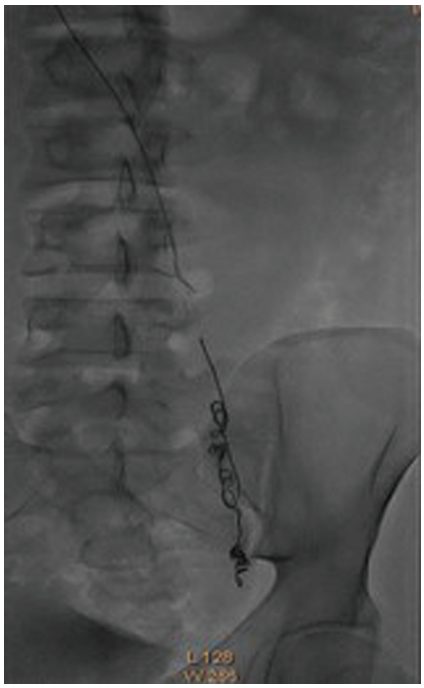
where the results were considered to be significant (S) with *P* less than 0.05, highly significant with *P* less than 0.01, and nonsignificant (NS) with *P* greater than 0.05.

Results

In group A, 30 patients were operated on via laparoscopic surgery, and their mean age was 23 years (15–47 years). The patients' complaints were chronic scrotal pain, which was dull aching or dragging in character in 25 patients (83.2%), and subfertility attributed to varicocele in five patients (16.6%). Among the 30 patients, 24 (80%) had left-sided varicocele, whereas six patients (20%) had bilateral varicoceles. The mean follow-up period was 16.6 months (range: 6–24 months). No cases were presented to the emergency department for an immediate postoperative complication between discharge and first follow-up visit (Tables 1 and 2).

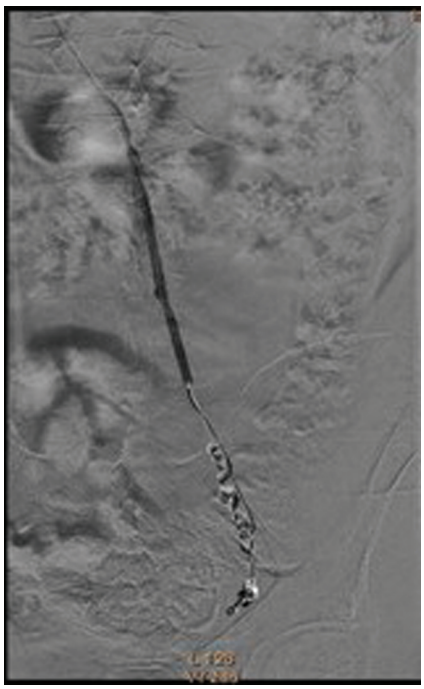
Patients in our study were classified clinically into three grades as follows (based on clinical criteria published by Dubin and Amelar) [9,10]: grade I, varicocele is palpable during/after Valsalva, representing 12 (40%) patients; grade II, varicocele is palpable on physical examination without Valsalva, representing 10 (33.3%) patients; and grade III, varicocele is visible on inspection and palpable on examination, representing eight (26.6%) patients (Table 3). Color flow Doppler

Figure 8



A third 10-mm coil was placed with its tip deployed into the origin of the collateral.

Figure 9



DSA showing venography of the left testicular vein after coiling with no residual reflux. DSA, digital subtraction angiography.

sonography had been used to confirm the varicocele degree (Table 4).

The mean duration of symptoms was 18 months (10–38 months), whereas the average operative time was 34 min (24–75 min).

Table 1 Patients' characteristics

	Group A (*n*=30)	Group B (*n*=30)	*P* value
Mean age (range) (years)	23 (15–47)	28 (18–40)	0.0486 (S)
Varicocele side [*n* (%)]			
Left sided	24 (80)	28 (93.3)	0.0435 (S)
Bilateral	6 (20)	2 (6.6)	0.00952 (HS)
Patient complaint [*n* (%)]			
Chronic pain	25 (83.3)	23 (76.6)	0.967 (NS)
Sub/infertility	5 (16.6)	7 (23.3)	0.0683 (NS)
Mean duration of symptoms (months)	18 (10–38)	15 (12–43)	0.00834 (HS)
Mean follow-up (months)	16.6	17.4	
Average procedure time (mm)	34 (24–75)	45 (38–84)	0.0357 (S)

HS, highly significance; S, significance.

Table 2 Postprocedural complications, recurrences, and follow-up

	Group A (*n*=30)	Group B (*n*=30)	*P* value
Port (puncture)site hematoma	1	1	NS
Hydrocele	2	0	0.0412 (S)
Postcoiling mild pain	0	3	0.0327 (S)
Failed catheterization	0	2	0.098 (NS)
Postprocedural residual grade I varicocele	2	2	NS
Postprocedural recurrent grade II varicocele	2	2	NS
Postprocedural Duplex normal	26 (86.6%)	26 (86.6%)	NS
Semen analysis improvement (sperm count, motility, and abnormal form)	28 (93.3%)	25 (83.3%)	0.0369 (S)

S, significance.

Table 3 Clinical grading of varicocele

	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]
Grade I: varicocele palpable during Valsalva	12 (40)	15 (50)
Grade II: palpable on physical examination	10 (33.3)	8 (26.6)
Grade III: visible on inspection, palpable on examination	8 (26)	7 (23.3)

Table 4 Color Doppler ultrasound classification of varicocele (10)

Grade	Features
1	Reflux in vessels of the inguinal canal only during the Valsalva maneuver, while scrotal varicosity is not evident in the US study
2	Small posterior varicosities that extend to the upper pole of the testis. and venous reflux is seen in the supratesticular region only during the Valsalva maneuver
3	Varicosities at the inferior pole of the testis and reflux observed only under during the Valsalva maneuver
4	Vessels appear enlarged even when the patient is studied in a supine position and during the Valsalva maneuver. Testicular hypotrophy is common at this stage
5	Venous ectasia is evident even in the prone and supine positions. Reflux is observed at rest and does not increase during the Valsalva maneuver

US, ultrasound.

Clinical examination and assessment were done for all patients in standing and supine positions by inspection and palpation of dilated pampiniform plexus of veins, testicle size, and consistency.

However, in group B, 30 patients had percutaneous varicocele embolization, and the average age at presentation was 28 years (18–40 years). All patients had refluxing varicocele diagnosed by scrotal duplex study. A total of 28 patients had left-sided refluxing varicocele, whereas two patients had a bilateral refluxing varicocele. The mean follow-up period was 17.4 months (range: 9–24 months).

Regarding patient complaints, 23 patients had annoying or dragging pain, especially with standing, and seven patients presented with infertility.

Our study population in group B was distributed regarding the clinical and Doppler grading of varicocele into three grades as follows: 15 patients had grade I varicocele, representing 50% of the patients; grade II included eight (26.6%) patients; and seven patients had grade III varicocele, representing 23.3%.

Mean duration of symptoms was 15 months (12–43 months), and the average procedure time was 45 min (38–84 min).

Regarding postoperative complications, in group A, one patient had a small port site hematoma that resolved spontaneously, and two patients had secondary hydrocele formation, whereas in group B, one patient had minor hematoma at the puncture site that resolved spontaneously, and three patients had postcoiling transient mild pain, which was relieved a few days later on via analgesics; the two patients with bilateral varicocele had successful left testicular vein catheterization, yet with failed catheterization of the right testicular vein owing to its acute angle with the IVC with concomitant right testicular vein ostial spasm owing to repeated trials of catheterization.

The follow-up of patients in both groups was done via scrotal duplex and semen analysis every 3 months.

In group A, two cases had recurrent grade II left-sided refluxing varicocele, resulting in a failure rate of about 6.6% and two cases had residual grade I nonrefluxing were observed, but the duplex scan was normal in 26 (86.6%) patients. Relief of pain occurred in all cases according to the VAS scoring system assessment. Semen analysis showed improved results in 28 cases (93.3%) regarding sperm count, motility, and abnormal forms.

In group B, a duplex study revealed that two patients had right-sided grade I and grade II refluxing varicocele (the two patients with failed catheterization of the right internal spermatic vein), making a failure rate of about 6.6%, and two patients had residual left-sided grade I nonrefluxing varicocele. The duplex scan was normal in 26 (86.6%) patients.

Semen analysis showed improved results in 25 (83.3%) cases regarding sperm count, motility, and abnormal forms. VAS scoring system was used in follow-up. Regarding the pain assessment using the VAS scoring system, the mean postprocedural VAS score at 3 months was 0.8 after the embolization, and 26 patients (87.5%) had a significant improvement in the VAS score ($P<0.001$).

Discussion

There are many options for the treatment of varicocele including surgical management either an open surgical approach or microsurgical approach, laparoscopy, or via radiological percutaneous embolization of the testicular veins.

Percutaneous varicocele embolization is the least invasive technique of all the treatment approaches with no need for surgical incisions and could be done under local anesthesia and could be done as an outpatient procedure with very short recovery time, and also it has the advantage of eliminating the potential risk of injury of the testicular artery as it is a purely endovascular approach [11].

Laparoscopic varicocelectomy is safe, effective, and minimally invasive. In addition to its better cosmetic results and advantage in case of bilateral disease, it allows excellent exposure and control of the affected vessels. Furthermore, the shorter hospital stays and the earlier return to normal activities are very important advantages in recommending this technique as an efficient alternative to the open surgical method [12].

Laparoscopic varicocelectomy was comparable to open technique, with minimum morbidity, shorter hospital stays, and with the advantage of treating bilateral varicoceles without any additional incisions. Moreover, laparoscopic varicocelectomy produces better overall patient satisfaction and hence can be considered as a preferred surgical technique, although sperm analysis results were the same in both methods [13].

This technique has more advantage than open surgery because it allows an excellent visualization of the spermatic vessels; the number of veins to be ligated and arteries to be preserved is smaller, and their caliber is larger. In 89–100% of patients, spermatic artery preservation is possible [14].

Both laparoscopic and percutaneous embolization techniques showed good amenability in terms of results; moreover, outcomes of this research have been in line with the recent literature ones [15].

This current study included 60 cases with primary varicocele divided into two groups: group A patients underwent laparoscopic repair, and group B patients had percutaneous embolization varicocelectomy.

The mean age in group A was 23 years and in group B was 28 years, which corresponds to the age of incidence of primary varicocele (young adults) in the literature.

In our study, the mean duration of the disease symptoms was 18 months (10–38 months) in group A and was 15 months (12–43 months) in group B, which coincides with a recent study that included 40 patients experiencing primary varicocele for laparoscopic varicocelectomy, where the mean duration of the disease was 18.6 months [16].

In this study, pain was found to be the most common presentation, with 25 patients (83.3%) in group A and 23 patients (76.6%) in group B, followed by infertility, with five patients (16.6%) in group A and seven patients (23.3%) in group B. This is in agreement with another study done by Kolon [17], which reported that pain represents the most common presentation of varicocele.

Primary varicocele is more common on the left side in about 90% of cases, is bilateral in 8–9%, and is right sided in 1–2%. The etiology is related to the anatomy of the left testicular vein, which is longer than the right and enters the left renal vein perpendicularly instead of the vena cava (in the right side) with acute angle [18]. Our study found the same patient characteristics, as among group A, 80% had left-sided varicocele, and 20% had bilateral varicocele, whereas in group B, 93.3% were left-sided and 6.3% were bilateral, and there were no cases that had isolated right varicocele.

When comparing the preoperative to postoperative status, it was found that laparoscopically treated patients had a failure rate of 6.6%, and in group B, the failure rate was 6.6% (technical failure to catheterize the right testicular vein). This result is approximately the same as that of a Jordanian retrospective study at prince Hussein Medical Center varicocele database on 265 patients, who had clinical varicoceles confirmed by scrotal Doppler examination. A total of 45 patients underwent unilateral varicocele embolization, and 220 patients underwent bilateral and unilateral varicocele surgery. The failure rate in patients who underwent varicocele embolization was 4%, and recurrence rate was 4%. On the contrary, in patients who underwent varicocele surgery, the recurrence rate was 7%, and sperm motility improved in all patients too. There were no complications in all patients [19].

These results enforce the fact that percutaneous embolization of varicocele is a safe procedure with equivalent efficacy to laparoscopic approach and an ideal choice especially for patients with a varicocele recurrence following initial surgical management with equivalent efficacy to the laparoscopic approach [20].

Varicocele embolization has been shown to pose no risk of postoperative hydrocele formation compared with the 8.24% rate for surgical approaches as proved by a Canadian study on 158 patients, which represent the largest contemporary series of varicocele embolization outcomes currently available in the literature. Our study agrees with these findings, as the incidence of hydrocele as a postoperative complication in group A was 6.6% versus no cases of hydrocele was found in group B [21].

In our study, we performed the artery and lymphatic sparing approach in the laparoscopic technique as it was observed that this technique has better outcomes as found by Misseri *et al*. [22] who observed noticeable favorable results after lymphatic sparing varicocelectomies; however, the varicocele embolization procedure is an endovascular approach with no risk to injure the arteries and lymphatics.

Regarding infertility, semen analysis had been improved in 28 (93.3%) cases after laparoscopic varicocelectomies. Semen analysis 6 months after surgery showed a significant improvement in concentration and quality of sperms in varicocele grades I and II. For varicocele grade III, only concentration improved. No significant improvement was observed in the second visit in sperm concentration and quality. Kang *et al*. [23] compared testicular artery and lymphatic preservation versus complete testicular vessel ligation in 80 patients; they found significant improvement in sperm parameters after both procedures.

In our study, regarding cases that had percutaneous embolization (group B), the improvement in semen analysis occurred in 25 (83.3%) of patients compared with 28 (93.3%) patients who underwent laparoscopic varicocelectomy (group A), with relative better response in semen analysis in the laparoscopically treated group.

Complications of percutaneous embolization are infrequent, and usually mild complication rates in recent literature have been reported from 0%, to 5%, and 11%. Thrombophlebitis of the pampiniform plexus is a potential complication with the use of sclerosants. Wunsch and colleagues reported its occurrence in 0.5% of cases; such use of sclerosant has not been done in our practice. Coil migration is a rare complication that could be prevented by accurately oversizing coils and low-level embolization [24]. In our series, four patients developed postprocedure minor complications: one patient had puncture site minor hematoma that resolved spontaneously and three patients had mild postcoiling pain that relieved few days on analgesics. Moreover, two patients had failed catheterization of their right internal spermatic veins owing to the very acute angle with IVC. Hydrocele and testicular atrophy are not potential complications of embolization techniques, and none of these complications have occurred in our series.

Exposure to ionizing radiation is a potential hazard. Studies have shown that with the use of appropriate techniques (shielding of the gonads, avoiding exposure of the scrotum to the primary beam, collimation of beam to the smallest practical area, and using pulsed fluoroscopy and image capture to minimize angiographic runs and spot images), it becomes within the range of other diagnostic procedures [25].

Our study is not without limitations. Our cohort is small with a medium-term follow-up. The use of the VAS as an assessment tool might be subjective to observational bias and contains a subjective element of interpretation. In future studies, a larger number of populations, longer follow-up period, as well as additional questionnaires about the effects on quality of life might be useful to achieve a more objective determination of the effects on testicular pain due to varicoceles.

Conclusion

Percutaneous embolization of varicocele is a safe and effective procedure using local anesthesia and could be done as an outpatient procedure with a very short recovery time. Embolization is an ideal choice for patients with recurrent varicocele following initial surgical management. However, embolization carries the risk of technical failure, especially for those with right-sided varicocele.

Laparoscopic surgery is better in bilateral or right-sided varicocele, to avoid technical difficulties occurred from embolization of the right-sided varicoceles.

Embolization has satisfying outcomes regarding the treatment of varicocele related to dull aching pain, back to a normal lifestyle, and cost effectiveness (in literature), but in our center, the surgical approach is less costly and equivalent regarding the improvement of pain symptom.

Laparoscopic varicocelectomy is a safe and effective procedure, causing minimal discomfort and short hospital stay, wide patient acceptance, with marked improvement in sperm morphology.

With careful patient selection and proper pretreatment assessment, varicocele embolization can be appropriately employed as a safe and effective treatment option for symptomatic varicocele.

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Conflicts of interest
There are no conflicts of interest.

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