Percutaneous Treatment of Varicocele with Microcoil Embolization: Comparison of Treatment Outcome with Laparoscopic Varicocelectomy

Carlos Bechara*, Sarah M. Weakley*, Panagiotis Kougias*, Husam Athamneh*, Patrick Duffy*, Mohit Khera†, and Peter H. Lin

Successful treatment of a testicular varicocele, which can result in scrotal pain and swelling as well as male subfertility, can be accomplished via operative ligation of the varicocele or interventional treatment with coil embolization of the testicular vein. This study compared the treatment outcome of percutaneous embolization treatment versus laparoscopic varicocelectomy in patients with symptomatic varicoceles. Patients with varicoceles undergoing either laparoscopic varicocelectomy or percutaneous coil embolization of the testicular vein during a recent 5-year period were analyzed. Treatment outcome and hospital costs of these two minimally invasive treatment modalities were compared. Forty-one patients underwent percutaneous coil embolization of the testicular vein, which were compared with a cohort of 43 patients who underwent laparoscopic varicocelectomy. Technical success in interventional and laparoscopic treatment was 95% and 100%, respectively. The mean operative time or procedural time was 63 ± 13 minutes and 52 ± 25 minutes for interventional and laparoscopic cohorts (not significant), respectively. Embolization treatment resulted in two recurrent varicoceles (4.8%) compared to one patient following laparoscopic repair (2.3%, not significant). Embolization treatment was associated with a lower complication rate than laparoscopic repair (9.7% vs 16.3%, p = .03). Regarding cost analysis, no significant difference in hospital cost was noted between the interventional or laparoscopic treatment strategies. Both laparoscopic varicocelectomy and coil embolization are effective treatment modalities for varicoceles. With lower treatment complication rates in the interventional treatment group, coil embolization of the testicular vein offers treatment advantage compared with laparoscopic repair in patients with varicoceles.

Key words: laparoscopic varicocelectomy, microcoil embolotherapy, percutaneous embolization, varicocele embolization

Varicocele is dilatation and tortuosity of the pampiniform plexus and testicular veins within the scrotum. It is present in 6% of children, 15% of male adults, and 40% of men presenting with infertility.1-3 The pathophysiology of varicocele is different compared with that of varicose veins as the congenital absence of valves in the spermatic vein is the predominant etiology for varicocele. In contrast, venous valvular incompetence owing to post-thrombotic syndrome caused by venous thrombosis or reflux is the primary factor for varicose veins. Other factors that play a role are the anatomic difference in the left and right testicular veins and the nutcracker phenomenon (compression of the left renal vein between the aorta and the superior mesenteric artery). It is believed that varicocele impairs testicular growth and causes infertility owing to increased intrascrotal temperature or to hypoxia from venous hypertension.4-6 The exact mechanism is not very well understood, but animal and clinical data suggest impairment of spermatogenesis leading to infertility.1,7

Varicocele is a clinical diagnosis and is more common on the left side. The presence of right-sided varicocele should alert the treating physician to rule out right renal
cell carcinoma. Only palpable varicoceles have been associated with infertility. Treatment of varicocele must be proposed when all of the following conditions are present: palpable varicocele, documented couple infertility, no female infertility issues or potentially curable problems, and abnormal sperm analysis. In addition, treatment should be offered to young men with palpable varicocele and abnormal sperm analysis who desire future fertility. Adults with unilateral or bilateral varicocele and ipsilateral reduced testicular size should also be offered treatment.

A variety of treatment approaches, including surgical or interventional strategies, have been used for varicocelectomy. The ultimate goal is to stop the veins from refluxing to the testis and preserving arterial and lymphatic drainage. Although the traditional surgical treatment for varicocele involves operative ligation of the spermatic vein, several less invasive operative strategies, including laparoscopic varicocelectomy and subinguinal microscopic varicocelectomy, have been described. Radiologic treatment with percutaneous embolization of the internal spermatic vein using catheter-directed coil placement has similarly gained popularity in clinical practice owing to perceived advantages of less patient discomfort and rapid recovery. Percutaneous embolization is an attractive alternative to minimize the associated risks with open procedures. In addition, a pre-embolization venogram identifies all of the diseased veins and collaterals, resulting in lower recurrences. Although percutaneous embolization has been used for varicocele treatment for over three decades, the majority of clinical experiences were based on either pushable coils or sclerosing agents. Detachable microcoils are low-profile systems using a 0.014-inch guidewire platform, which allows for precise embolization. Although these detachable microcoils have been widely used in treating cerebrovascular aneurysms, they have recently gained greater use in other extracranial applications for embolotherapy, such as percutaneous varicocele treatment.

In this article, we analyzed the treatment outcome of two minimally invasive varicocele treatments by comparing laparoscopic varicocelectomy and percutaneous varicocele embolization using detachable microcoils. Procedural complication, recurrence rate, and treatment outcome were analyzed between these two minimally invasive treatment strategies.

### Patients and Methods

A retrospective analysis of clinical records at three institutions was performed from January 2004 to June 2009. Patients who underwent concomitant urologic procedure at the time of varicocele treatment were excluded from this analysis. Particular attention was focused on patients who underwent either laparoscopic varicocelectomy or percutaneous embolization of gonadal veins. Patients were divided into two groups. Group A included those who underwent laparoscopic varicocelectomy and group B included pa-
tients who were treated with detachable microcoil embolization for varicocele. All laparoscopic procedures were performed under general anesthesia, whereas all percutaneous embolization procedures were performed under either local anesthesia or conscious sedation. All patients received intravenous antibiotics before and after the varicocele procedures. Narcotic analgesics with morphine were provided as needed in the form of patient-controlled analgesia or oral tablets in both patient groups. Data relating to follow-up visit and treatment outcome were evaluated.

Data regarding patient demographics, procedural parameters, and clinical outcome were analyzed between the two groups and are summarized in Table 1. Hospital cost data, rather than hospital charges, were assessed by directly obtaining the pertinent information from the hospital accounting department. Statistical analysis was performed by means of the Student t-test and the Fisher exact test using a computer statistical software program (SAS, SAS Institute, Cary, NC). The test results were considered significant at a p value of less than .05.

Laparoscopic Varicocelectomy

All laparoscopic varicocelectomy procedures were performed under general anesthesia either in an ambulatory outpatient surgical center or outpatient hospital setting using techniques previously described. All patients were required to empty their bladder before entering the operating room to avoid catheterization. Following the induction of general inhalational anesthesia, the patient was placed in the Trendelenburg position. Carbon dioxide gas was used to establish a pneumoperitoneum at a rate of 1.5 L/min by means of an umbilical laparoscopic port placed using a modified Hassan technique. Intraperitoneal pressure was maintained at less than 15 mm Hg throughout the procedure. An additional laparoscopic port for instrumentation was created in the right lower quadrant and suprapubic area, respectively. Following dissection of the peritoneal sheet overlaying the spermatic bundle, approximately 5 cm cranial to the vas and internal ring, the spermatic veins, artery, and surrounding tissue were either clipped using laparoscopic staples or ligated using the LigaSure Vessel Sealing System (Valleylab, Boulder, CO). The laparoscopic port sites were closed using 3-0 Vicryl sutures or Dermabond (Ethicon, Somerville, NJ) at the end of the procedure.

Percutaneous Embolization for Varicocele

All percutaneous varicocele intervention procedures were performed under local anesthesia with conscious sedation in which internal spermatic veins were catheterized and embolized. Gonadal shields were routinely used in adolescent male patients. We routinely access the right common femoral vein for access, although jugular veins or brachial veins have also been used for access purposes. Following the placement of a 5F introducer sheath (Boston Scientific, Natick, MA) in the right femoral vein, inferior vena cava-grams and left renal venograms were obtained using a pig-tail catheter with patients in a 30° reverse Trendelenburg position with mild Valsalva maneuver to hold the breathing. Selective catheterization of the left gonadal vein was performed with a 5F JB3 or Cobra catheter (Cook, Bloomington, IN), and a coaxial microcatheter (Rapid Transit, Cordis, Miami, FL) was advanced to the inguinal canal. Contrast medium was injected throughout the course of the spermatic vein to identify potential duplications or collateral vessels. The vessels within the inguinal canal were then occluded with detachable microcoils (Terumo, Ann Arbor, MI). The position of the detachable coils can be adjusted accordingly to ensure precise coil detachment and deployment. Completion venography was performed to document successful embolization. Pressure was held at the puncture site for 5 to 10 minutes to achieve hemostasis following sheath removal.

Results

We identified 84 patients who underwent either endovascular or laparoscopic treatment of 95 varicoceles. Among them, 41 patients (group A) received catheter-based embolization for varicoceles, whereas 43 patients (group B) underwent laparoscopic treatment of varicoceles. Embolization was not technically feasible in two patients in group A owing to venous spasm with difficulty cannulating of the testicular vein, which resulted in a technical success rate of 95%. In contrast, all patients in group B underwent planned laparoscopic repairs, with a success rate of 100%.

The mean operative time or procedural time was 63 ± 13 minutes and 52 ± 25 minutes for group A and B (not significant), respectively. Among them, bilateral varicocele embolizations were performed in five patients in group A, whereas bilateral laparoscopic repairs were performed in six patients in group B. The mean procedural times for unilateral and bilateral embolization in group A were 34 ± 14 minutes and 57 ± 35 (p < .04), respectively. The mean operative times for unilateral and bilateral laparoscopic repair in group B were 49 ± 21 minutes and 67 ± 26 (p < .5), respectively. The mean lengths for follow-up in groups A and
B were 21 months and 26 months, respectively. The mean age of patients in groups A and B were 23.8 ± 5.5 years and 29.8 ± 6.7 years, respectively.

The treatment outcomes and complications in patients in group A and B are summarized in Table 1. Embolization treatment resulted in two recurrent varicoceles (4.8%) compared to one patient following laparoscopic repair (2.3%, not significant). The recurrent varicoceles in group A occurred at 7 months and 16 months following the embolization procedure, whereas the only recurrent varicocele in group B occurred 2 years following laparoscopic repair. This difference was not significant. Embolization treatment was associated with a lower complication rate than laparoscopic repair (9.7% vs 16.3%, p = .03). These complications, as shown in Table 1, included wound infection, incisional hernia, epididymo-orchitis, and injury to the genitofemoral nerve. One patient with recurrence in group A experienced spontaneous resolution, whereas the other patient underwent repeat embolization intervention, which remained successful after 15 months of follow-up. The only patient who developed recurrence following laparoscopic repair declined any further intervention and was lost to follow-up.

Regarding hospital cost analysis, patient data were available for analysis in only 37 of 41 patients in group A and 35 of 43 patients in group B. Specific analysis regarding the procedure cost showed that the mean embolization procedure cost per patient in group A was $5,642 ± $729, whereas the mean operating room cost per patient who underwent laparoscopic repair in group B was $4,742 ±$683 and the (NS). The majority of patients in group A underwent an outpatient procedure as 11 patients (29%) were admitted to the hospital for overnight monitoring. In contrast, 26 patients (60%) received inpatient admission following laparoscopic repair. The disparity of the frequency of inpatient admission has led to difference in inpatient cost as average inpatient costs per patient in groups A and B were $75 ± $24 and $821 ± $195, respectively (p = .01). Taken altogether regarding the procedure cost and hospital cost, the mean cost for patients who were treated with endovascular embolization was $7,362 ± $821 and the mean direct hospital cost to patients who underwent surgical repair was $8,612 ± $948 (p = .4).

Discussion

Varicocele is one of the most common treatable causes of male infertility. It has a detrimental effect on spermatogenesis, resulting in low sperm count, decreased sperm motility, and low number of normal sperm morphology compared to patients without varicocele.9 Careful patient selection is crucial and requires a thorough medical and reproductive history, physical examination, and at least two semen specimen analyses prior to embolization. These patients should be offered either surgical or percutaneous embolization because it does improve semen parameters.10 Although laparoscopic treatment with ligation of spermatic veins is considered a less invasive treatment compared with the traditional surgical approach, its associated complications include postoperative hydrocele and testicular atrophy.17 The overall complication rates of laparoscopic varicocelectomy range from 3 to 5%.16–18 Catheter-based interventional treatment with percutaneous embolization is a minimally invasive treatment alternative that enables the procedure to be done without general anesthesia with rapid recovery time. However, this interventional procedure can have a high recurrence rate as high as 10% owing in part to the failure to recognize gonadal venous pathways.15 Our study was notable because it represents the first study that analyzed two minimally invasive treatment modalities of varicocele by comparing laparoscopic varicocelectomy and percutaneous gonadal vein embolization. The findings of this study showed superior early outcome in the embolization cohorts owing to an expeditious recovery course, whereas the long-term treatment outcomes were equivalent among both treatment modalities.

A wide range of treatment strategies have been described for varicoceles, which have been linked to impaired infertility and testicular growth failure owing in part to increased intrascrotal temperature.4,5,19 Surgical ablation was first described in the 1880s as an effective treatment modality for scrotal pain and subfertility associated with varicoceles.20 Current surgical approaches include (a) microsurgical varicocelectomy, (b) laparoscopic varicocelectomy, and (c) conventional open varicocelectomy, which can be accomplished by retroperitoneal, inguinal, or subinguinal varicocele ligation.1,10 Endovascular treatment with spermatic vein embolization was first described as a treatment option for varicocele in the late 1970s.21 Since then, studies with sample sizes greater than 5,000 patients have been reported.22 Although treatment success and complication rates continue to improve with modifications of both surgical and endovascular techniques, each of these treatment modalities is associated with a definite risk of clinical failure or varicocele recurrence. Taken altogether, clinical failure or recurrence rates for surgery and endovascular treatment have been reported to be 1 to 10%.1,5,9,11,17,19

Studies that compared treatment outcome between sur-
Surgical and interventional treatment strategies for varicocele have yielded both mixed and controversial findings as there has been no randomized publication comparing operative and endovascular treatment strategies. Despite well-published techniques on surgical and endovascular approaches, questions remain whether varicocele embolization is as safe and effective compared with operative treatment. Analyzing several studies that directly compare open surgery versus embolization, treatment outcome of embolization was similar to operative repair in eventual pregnancy rate.1,2,5,8,9,23 Significant improvement in semen analysis was similar in four studies, with one demonstrating the superiority of surgery and another showing a better outcome with embolization. The recurrence rate of varicocele ranged from less than 2 to 11% for embolization and 0 to 45% for surgery.1,2,8,9,12,25 One clinical study that analyzed the cost of surgical repair of varicoceles versus percutaneous gonadal vein embolization found no difference between the two treatment modalities.21 Several studies underscore several advantages in favor of embolization when compared with surgical treatment.1,12,21,24 Among them, there was a clear trend of lower morbidity and faster recovery with embolization. Feneley and colleagues reported that patients who underwent surgical repair required an average of 2 to 3 weeks of recovery time, whereas patients treated with embolization required only 2 days for complete recovery.25 Similarly, a study by Dewire and colleagues noted that 24% of surgical patients required overnight hospital stay following varicocelectomy operation, whereas all patients treated with percutaneous embolization were discharged home on the same day.21

Several studies have similarly reported various clinical advantages of catheter-based embolization when compared with surgical treatment.1,12,14,21,24 For instance, patients with cardiopulmonary comorbidities can undergo varicocele embolization under local anesthesia, whereas general anesthesia is routinely necessary with surgical repair. Additionally, patients with bilateral varicoceles can undergo catheter-based embolization via single femoral vein access, in contrast to two separate surgical incisions with operative interventions. Without the need to create a surgical incision, catheter-based varicocele embolization is associated with a significant lower risk for wound complications such as infection or dehiscence. Lastly, embolization is associated with a high technical success rate in treating recurrent or persistent varicoceles, with studies reporting a success rate of 96% compared with 61% in those who were treated by surgical approach.25,26 In a clinical study that involved questionnaire analysis, Feneley and colleagues surveyed patients who had undergone both surgical ligation and embolization regarding their preferred treatment modality; all respondents preferred embolization over surgical repair.25 This finding underscores an important patient-driven variable that will undoubtedly make embolization a critical treatment strategy in the management of varicoceles. A recent article by Beutner and colleagues compared the outcome of three different minimally invasive procedures in treating varicocele, with treatment strategies including laparoscopic varicocelectomy, antegrade sclerotherapy, and retrograde gonadal embolization.24 The authors noted that laparoscopic varicocelectomy was more effective in treating varicocele than antegrade sclerotherapy and retrograde embolization. In their experience, retrograde embolization with 3% polidocanol sclerosant solution had a higher failure rate with a greater recurrence incidence compared with laparoscopic treatment. In their overall experience of 101 cases of gonadal embolization and 122 cases of laparoscopic varicocelectomy, the recurrence rates were 18.8% and 4.9%, respectively. The overall complication rates were higher in the laparoscopic group compared with the embolization cohorts, which were 13.1% and 7.9%, respectively. The higher recurrent rate following sclerosant embolization has been reported previously, which in part can be attributable to the sclerosant migration resulting in thrombophlebitis of the pampiniform plexus.24 The recurrence rate of percutaneous embolization for patients referred for infertility has been less than 4%.2,12 Other articles with longer follow-up showed a recurrence rate of 7% with a mean follow-up of 4 years and 11% with a mean follow-up of 22 months.14,25,26

The technical success of percutaneous embolization in our series was 95%, which was consistent with other published reports in the literature.1,2,14,27–29 The early series on percutaneous embolization treatment have noted a high treatment failure rate of as high as 20%, which can be attributable to failure to recognize anatomic venous variables, vasospasm, or technical difficulties related to devices or embolization particles.12,14,24,25 With greater publications in the literature regarding percutaneous varicocele treatment, this has led to improvement in technique as well as refinement with embolization equipment, which has resulted in overall improvement in technical success of percutaneous embolization. Current varicocele embolization treatment can be accomplished safely through a 5F introducer sheath using microcatheters under local anesthesia.30 The testicular vein needs to be embolized to isolate all collaterals to minimize recurrence, and, if necessary, the collaterals can be embolized. It is our preference to use detachable
Bechara et al

microcoils to embolize the testicular vein (Figure 1). The detachable microcoils offer a greater degree of precision, reducing the risk of misplacing the coils, migration, and vessel thrombosis.31 These microcoils can be retrieved prior to deployment if the interventionalist is not satisfied with either the coil location or configuration. The detachment mechanism is rather simple for the microcoil deployment process through a microcatheter. Current microcoil technology with hydrogel coating allows microcoil expansion up to six times from its original coil volume, which provides the theoretical advantage of reducing the number of microcoils needed for embolization.32

Complications after percutaneous microcoil embolization, although undoubtedly possible, are rather rare. Coil migration could happen if coils are released very close to the testicular and renal vein junction.33–35 The use of detachable microcoils almost eliminates any error in placement, configuration, or undersizing of microcoils in comparison to the vein being embolized. Other complications, such as thrombophlebitis, have been associated with sclerotherapy and are typically treated with antiinflammatory medications and antibiotics.7,12,14,25 If sclerotherapy is considered, some researchers recommend placing coils first in the testicular vein followed by sclerotherapy to prevent reflux of sclerosant into the pampiniform plexus. Other potential complications include vessel vasospasm, dissection, and perforation, which are less likely to occur with the use of low-profile wires and microcatheters.36–40

In conclusion, percutaneous embolization of varicocele with microcoils can be performed safely, with high clinical success rates. Compared with laparoscopic surgical repair, this catheter-based treatment has significant advantages of faster patient recovery and quicker return to normal physical activity. Our cost analysis suggests a cost benefit with embolization therapy when compared with surgical treatment modality. This study underscores the role of percutaneous embolization as the first line of therapy in patients with symptomatic varicoceles.

References

2. Nabi G, Asterlings S, Greene DR, Marsh RL. Percuta-


33. Chomyn JJ, Craven WM, Groves BM, Durham JD.


Author Queries

Journal: Vascular
Paper: VAS_2009_00062
Title: Percutaneous Treatment of Varicocele with Microcoil Embolization: Comparison of Treatment Outcome with Laparoscopic Varicocelectomy

Dear Author,
During the preparation of your manuscript for publication, the questions listed below have arisen. Please attend to these matters and return this form with your proof. Many thanks for your assistance.

RETURN VIA FAX TO SUSAN GALEONE, PRODUCTION ASSISTANT, 215-240-6974 OR SCAN AND RETURN VIA EMAIL TO sgaleone@bcdecker.com

<table>
<thead>
<tr>
<th>Query</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>What do you mean by &quot;and the (NS)&quot;?</td>
</tr>
<tr>
<td>2.</td>
<td>Please complete ref 6 or provide the DOI.</td>
</tr>
<tr>
<td>3.</td>
<td>Please provide the suppl number for ref 7 and the author if there is one.</td>
</tr>
<tr>
<td>4.</td>
<td>The issue number is missing for ref 27.</td>
</tr>
<tr>
<td>5.</td>
<td>The issue number is missing for ref 37.</td>
</tr>
</tbody>
</table>