



Practice Pattern of Redo Varicocelectomy for Recurrent Varicocele according to Type of Initial Treatment: Retrospective Analysis of a United States-Based Insurance Claims Database

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Purpose: The objective of this study was to investigate the type of redo varicocelectomy according to the initial surgery type using a large population of USA insurance data.

Materials and Methods: This is a retrospective observational cohort study. Administrative claims data were extracted from the IBM® MarketScan Research Database. We included all newly diagnosed patients with varicocele from January 2007 to December 2014 using International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes. The treatment methods were identified by Current Procedural Terminology (CPT) code.

Results: A total of 261,785 subjects were diagnosed with varicocele. Of these, a total of 19,800 (7.6%) patients underwent varicocele surgery. Inguinal, abdominal, laparoscopic, microsurgery, and embolization surgery were performed in 66%, 19%, 10%, 3%, and 2%, respectively, as initial treatment. A total of 340 patients (1.7%) underwent redo varicocele surgery. Inguinal, microscopic, embolization, abdominal, and laparoscopic surgery were used as the redo method in 43%, 25%, 16%, 8%, and 7%, respectively. The redo inguinal approach was the preferred method in patients who first underwent inguinal, abdominal, and laparoscopic surgery, but not in patients who underwent microscopic or embolization procedures. Most patients who initially underwent microscopic varicocelectomy or embolization underwent redo varicocelectomy using the same method.

Conclusions: Compared to the type of initial varicocelectomy, there were changes in the proportion of each type of surgical approach in redo operation procedures. While inguinal varicocelectomy is the most common method in redo operations, the number of microscopic varicocelectomy or embolization procedures is significantly increased in redo surgery.

Keywords: Embolization, therapeutic; Recurrence; Reoperation; Varicocele; Vascular surgical procedures

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INTRODUCTION

A varicocele is defined as an abnormal dilatation of the veins within the pampiniform plexus as a result of venous reflux. Varicocele represents one of the most common amenable urologic anomalies that is surgically corrected in adolescent males, with an incidence of approximately 15% [1]. The main indications for surgical treatment are persistent testicular size discrepancy greater than 20%, abnormal sperm parameters, and testicular pain attributable to the varicocele [2,3].

Surgical treatment includes laparoscopic, open inguinal, open retroperitoneal, microscopic subinguinal, and embolization approaches. The success rate of these types of varicolectomy is very high; however, a few patients undergo repeated surgical treatments for recurrence.

The redo surgical method depends on the surgeon's preference and the initial type of surgery. For example, when initial surgery was performed *via* the microscopic subinguinal approach, a laparoscopic or embolization approach may be selected for redo varicolectomy to avoid adhesion in the surgical field and interruption of the testicular blood supply. Otherwise, a microscopic approach could be chosen because of the higher success rate of microscopic surgery compared with other methods [4-6].

Elucidation of the practice pattern of redo varicolectomy can facilitate the selection of the optimal redo approach by physicians and patients. However, to our knowledge, no study has yet reported on the preferred practice pattern of redo varicolectomy based on the initial methods because of the extremely limited number of patients who undergo such procedures.

Our purpose was to investigate the type of redo varicolectomy according to the initial surgery type using a large United States population *via* individual-level insurance data.

MATERIALS AND METHODS

1. Data source and ethics statement

This study involved a retrospective observational cohort. Administrative claims data were extracted from the IBM[®] MarketScan Research Database. This database includes retrospective claims information, such as inpatient and outpatient enrollment demographics, in the United States.

All data were de-identified and all outputs, formulas, and tables comply with the Stanford Center for Population Health Sciences or the data proprietor's cell size restrictions, whichever is more restrictive. Through the Stanford Center for Population Health Sciences, the Stanford Institutional Review Board has reviewed and approved (no. PHS-40974) an umbrella protocol which governs the hosting, curation, and use of de-identified data for clinical outcomes research at Stanford.

2. Patients and data inclusion

We included all newly diagnosed patients with varicocele who underwent any form of surgical treatment, such as open inguinal surgery, open abdominal surgery, laparoscopy, microsurgical subinguinal surgery, and embolization from January 1, 2007 to December 31, 2014. The patient cohort with varicocele was selected using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) code for varicocele. Each surgical treatment method was identified using the corresponding Current Procedural Terminology (CPT) code, which indicates the procedure a patient underwent in the United States insurance system. Patients who were at least 10 years of age and whose records contained both the ICD-9-CM code for varicocele (456.4) and a CPT code for varicolectomy (55530 [open inguinal], 55535 [open abdominal], 55550 [laparoscopic]) were identified. The microsurgical approach was identified by the CPT code 69990. The embolization CPT codes were 37204 and 37241.

Demographic factors such as age and sex were extracted from the database. Race, inpatient medications, and laboratory results were not included in the database.

The minimum period between initial and redo surgery was 6 months. If a patient underwent redo surgery within 6 months, we considered the case an absence of recurrence and, therefore, did not include it in the population with redo surgery. The minimum follow-up period was 1 year after initial varicolectomy. Patients who were not followed-up for at least 1 year after initial varicolectomy were excluded from our cohort. Patients who underwent varicolectomy more than three times were also excluded.

3. Redo surgery analysis

We evaluated the number and type of the initial surgery in our cohort. We extracted the population who

underwent redo surgery using CPT codes and evaluated the number and type of redo surgery according to the initial surgical approach. According to our data policy, we did not indicate the precise number of data points if there were less than 11 events in any category, instead describing these instances as 'less than 11.'

RESULTS

1. Study population

A total of 261,785 subjects were diagnosed with varicocele between 2007 and 2014. A total of 19,800 patients underwent initial varicocele surgery in this population. The mean age at first surgery was 29.6±12.3 years and the median follow-up period from the first surgery was 24.3 months.

2. Type of initial surgery

Inguinal varicocele surgery was the most frequently used method for initial surgery. The distribution of varicocele surgery according to surgical approach is shown in Fig. 1A.

Inguinal varicocele surgery was performed in 66% of total initial varicocele surgeries and the abdominal approach was used in 20%. Laparoscopic, microsurgery, and embolization surgery constituted 9%, 3%, and 2% of cases, respectively.

3. Type of redo surgery

A total of 340 patients underwent redo varicocele surgery. The incidence of redo surgery among all pa-

tients who underwent initial varicocele surgery was 1.7%. The mean age at the second surgery was 30.3±14.9 years. The distribution of redo varicocele surgery based on the surgical approach is displayed in Fig. 1B.

Inguinal varicocele surgery was the most frequently used redo method (43%), followed by microsurgery (25%). Embolization, abdominal, and laparoscopic approaches were used in 16%, 8%, and 7% of cases, respectively.

4. Redo surgery type according to type of initial surgery

Among the 340 patients who underwent redo surgery, the most common method was an open inguinal approach. Type of redo surgery according to initial surgery type is displayed in Fig. 2.

There was a significant difference in the proportion of each type of redo surgery according to initial surgery type. Redo open inguinal surgery was performed in 49% of patients who first underwent open inguinal, open abdominal, and laparoscopic approaches, while 12% of patients underwent redo inguinal surgery after first having microscopic surgery or embolization.

Among the 41 patients who initially underwent microscopic varicocele surgery, most (83%) underwent microscopic varicocele surgery for redo surgery. Of the 15 patients who initially underwent embolization, almost all (87%, 13/15) underwent redo embolization.

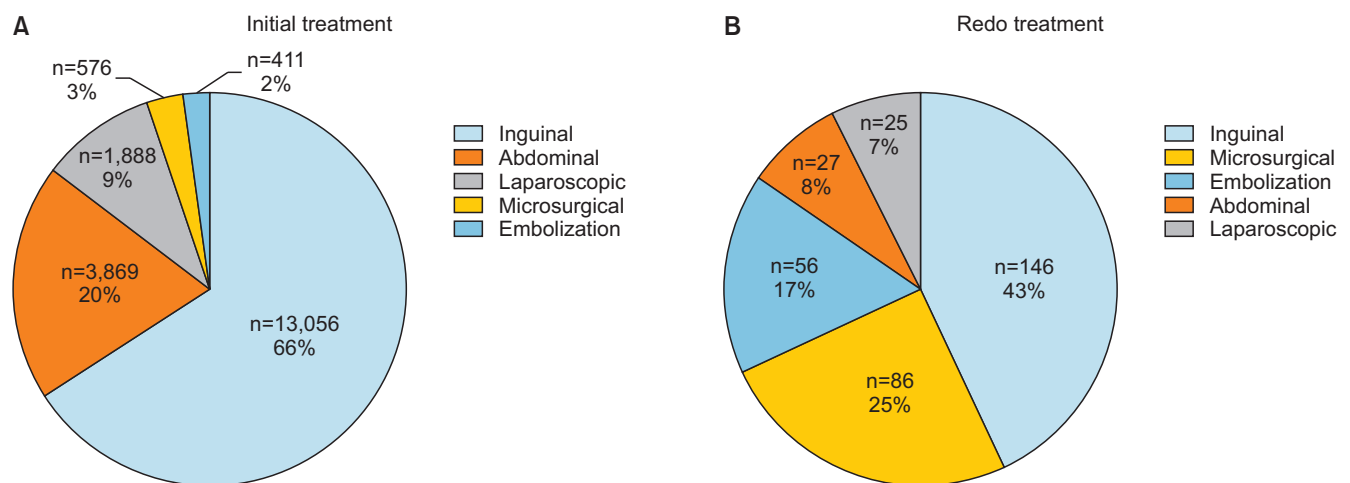


Fig. 1. The number of each type of varicocele treatment. (A) The number of each type of treatment for initial varicocele surgery. (B) The number of each type of treatment for redo varicocele surgery.

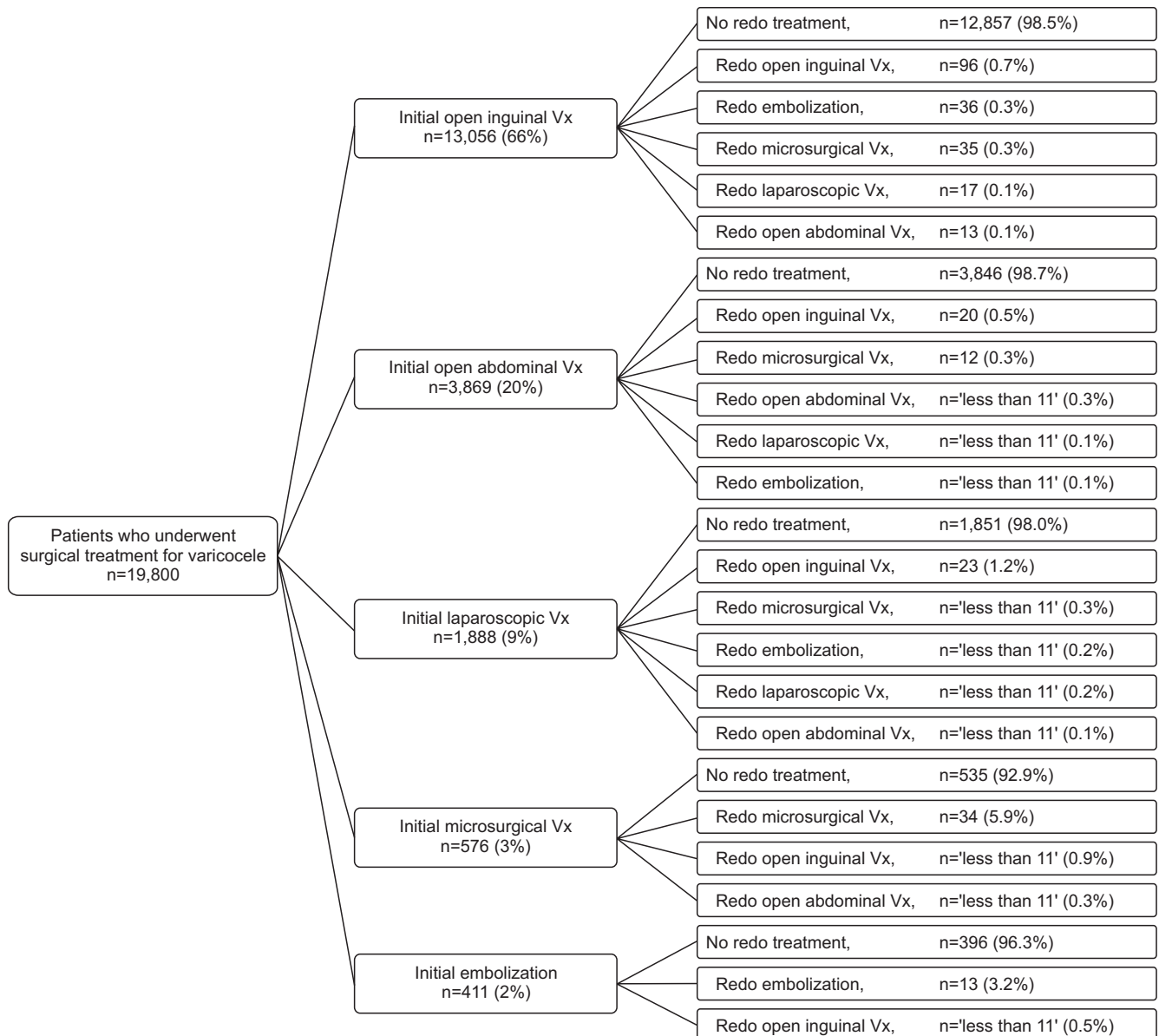


Fig. 2. Flow chart of the proportion of each type of redo treatment for recurrent varicocele according to the type of initial treatment. According to our data policy, we did not indicate the precise number of data points if there were less than 11. Instead, we described these cases as 'less than 11'. Vx: varicolectomy.

DISCUSSION

The methods of surgical treatment for varicocele include open inguinal (Ivanissevitch), open abdominal (Palomo), laparoscopic, and subinguinal approaches with or without microscopy and embolization. Varicocele recurrence is one of the most common complications associated with varicocele surgery. The success rate of varicolectomy is very high but not 100%. Recent studies reported the rates of recurrence for laparoscopic (1.2%), open inguinal (1.3%), open retroperi-

toneal (9.3%), microscopic subinguinal (0.9%–2.5%), and embolization (3.6%–8.9%) [4-8].

An optimal method for initial varicolectomy has yet to be established, and the ideal surgical approach for redo varicolectomy represents another area of controversy. The choice of redo surgical method in clinical practice is dependent on age, surgeon's preference, experience, and previous surgery type.

In this study, open inguinal varicolectomy was the most popular method used by surgeons in the United States. This may be attributable to surgeons' prefer-

ence and experience. Microscopic surgery has a lower recurrence rate but is associated with hurdles, such as experience and availability of equipment. Moreover, there is not much difference between the success rates of open and microsurgery.

Our results show a difference in the proportion of microscopic surgery and embolization treatments between initial and redo surgeries. Although inguinal varicocelelectomy was still the most commonly used method of redo surgery, the microsurgical approach is likelier to be used in redo than initial surgery and is the second most common method (25%) chosen for redo surgery. For example, 49% of recurrences after inguinal varicocelelectomy were treated *via* the same inguinal approach, whereas microsurgery was performed in 18% of such patients. Furthermore, embolization, which is rarely used for initial varicocelelectomy, was the third most common choice for redo treatment. Surgeons who initially perform open varicocelelectomy have a tendency to choose a second open varicocelelectomy in patients who experience recurrence. This may be because many surgeons find the method easy to perform and are confident in their skills. Surgeons who want to be assured of success might choose microscopic surgery, performed either by themselves or by referral to a specialized center. As a result, the proportion of microscopic surgery rises among redo varicocelelectomies.

Patent internal spermatic veins are the most common cause of persistent or recurrent varicocele after surgery [9,10]. Microsurgical inguinal varicocelelectomy provides direct visual access to all forms of testicular venous drainage and results in a significant decrease in the incidence of varicocele recurrence [6,11]. Redo surgery may be a burden to surgeons and patients afraid of recurrence, and represents one of the factors associated with increased use of the microscopic approach in redo surgery. One study demonstrated the effectiveness of microscopic subinguinal redo varicocelelectomy. Most of the patients (84%) initially underwent inguinal or abdominal surgery and no recurrence was seen after redo microscopic surgery [12]. Our study showed that 83% of patients (34/41) who had recurrence of varicocele following initial microscopic surgery underwent redo microscopic surgery. A few physicians were concerned about the risk of arterial injury; however, most surgeons who are experienced with microscopic surgery preferred microsurgery [12].

Open inguinal surgery often leaves a scar or adhe-

sion in the surgical field that prevents easy identification of the remaining or recurrent small vessels. Embolization may be a good option in such cases and our study shows that 18% of patients underwent embolization for recurrence after inguinal varicocelelectomy. Kim et al [13] evaluated the effect of embolization for recurrent varicocele after laparoscopic, retroperitoneal, or inguinal ligation. Embolization was technically feasible in 93% of cases, and 80% showed complete resolution on physical examination.

Unlike inguinal surgery, only 8% of cases of initial laparoscopic or abdominal surgery were treated with embolization for recurrent varicocele. Two-thirds of patients (62%) underwent redo open inguinal surgery, probably because the surgeons believed that laparoscopy or abdominal surgery do not affect the inguinal surgical field.

Almost all of the patients who underwent embolization initially underwent redo embolization. It is possible that these patients had contraindications for open surgery, or that physicians who preferred embolization as the initial method strongly preferred radiological interventions.

This study has several limitations. First, we could not evaluate a patient's symptoms or varicocele grade during the initial or redo surgery. In this study, we analyzed redo surgical cases but not recurrent cases. Recurrence should be evaluated and defined according to symptoms or clinical findings. However, our data did not completely reflect the patients' clinical status. Therefore, we could not compare effectiveness or recurrence rate according to the initial and redo surgical methods.

Second, inconsistent or incorrect reporting of insurance codes during the study period by the hospitals limited the reliability of our evaluations of surgical choice. The microsurgical approach was adopted in only 3% of cases, which was similar to the proportion seen in another United States-based population study [7]. Lack of experience and non-availability of microscopic equipment are significant hurdles to the microscopic approach. Also, use of the microscopic approach might be underestimated by the underutilization of CPT code 69990; a similar explanation was given in another study [7].

Third, the data in this study do not present adolescent and adult varicocele separately. Treatment patterns may differ between adolescent and adult vari-

cocele patients. When we did divide the patients into adolescent *vs.* adult groups, we found no significant differences because of the small number of patients who underwent redo surgery. This represents another limitation of this study.

Fourth, the data in this study was from a United States insurance company. The choice of redo surgery depends on the physician's evaluation and patient's status as well as insurance status. In addition, the availability of specialized facilities in the hospital, including microscopy and radiology, also affects the choice of redo surgery type. Therefore, these results may not represent the situation in other countries.

Notwithstanding these limitations, this study is notable as it is the first large population study to examine the type of redo varicocelectomy according to initial surgical type. Our results may be helpful to physicians and patients considering redo varicocelectomy. For treatment of recurrent varicocele after open varicocelectomy, microscopic surgery or embolization are not always necessary. About half of recurrences following open surgery were treated by redo open surgery. In addition, we assumed that embolization is performed mostly to avoid arterial injury when varicocele recurred after microscopic varicocelectomy. However, almost all cases of recurrent varicocele following microsurgery were treated by redo microscopic surgery. Redo microscopic varicocelectomy after initial microscopic varicocelectomy seems to be a feasible method.

CONCLUSIONS

Compared with the type of initial varicocelectomy, there were changes in the proportions of each type of surgical approach in redo procedures. A redo open inguinal approach was most commonly used after initial open inguinal, open abdominal, and laparoscopic approaches.

Although inguinal varicocelectomy is still the most commonly used method in redo operations, microsurgical interventions and embolization rank second and third, respectively, in redo cases. This suggests that microscopic varicocelectomy or embolization is selectively preferred compared with initial treatment.

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Conflict of Interest

The authors have nothing to disclose.

Author Contribution

Conceptualization: HKP, GEM, KJC, BIC. Data curation: HKP, KJC, BIC. Formal analysis: HKP, SL. Investigation: HKP, KJC, BIC. Methodology: HKP, BIC. Validation: HKP, GEM, SL. Visualization: HKP, WSC. Writing – original draft: HKP, WSC. Writing – review & editing: HKP, WSC.

Data Sharing Statement

The data required to reproduce these findings cannot be shared at this time due to legal and ethical reasons.

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