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INCIDENCE AND POSTOPERATIVE OUTCOMES OF ACCIDENTAL LIGATION OF THE TESTICULAR ARTERY DURING MICROSURGICAL VARICOCELECTOMY

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ABSTRACT

Purpose: In this study the frequency and outcomes of unintentional testicular artery ligation during microsurgical varicocelectomy were evaluated.

Materials and Methods: From 1984 to 2002, 2,102 cases of microsurgical varicocelectomy were evaluated. Accidental artery ligation was confirmed intraoperatively by observation of pulsatile twitching of the ligated vessel stump under 25× magnification.

Results: The complication was identified in 19 cases (0.9%) and all occurrences were unilateral, with 74% on the left side and 42% on the right side. In addition to the vasal artery at least 1 alternative artery was identified in all cases. Average testis volume before surgery was 15.8 ml. Azoospermia was found in 26% of cases. After surgery during the median followup of 19 months testicular atrophy developed in 1 patient (5%). In this cohort significant improvement was found in serum total testosterone in 80% (from 362 to 493 ng/dl) and in sperm count in 80% (from 12 to 22 × 10^6 per ml). Return of motile sperm to the ejaculate was found in 40% of azoospermic cases. The natural pregnancy rate was 14%, which is significantly lower than the 46% previously reported in the historical cohort of varicocelectomy cases.

Conclusions: The incidence of accidental testicular artery ligation in microsurgical varicocelectomy was approximately 1%. Testicular atrophy developed in 1 patient (5%). Preservation of cremasteric and/or secondary internal spermatic arteries likely contributed to a low incidence of adverse outcomes. The natural pregnancy rate was low which may be due to the high proportion of azoospermic men before surgery. It is possible that the smaller testes usually associated with azoospermia indicate smaller testicular arteries, thus posing a greater risk of accidental ligation.

KEY WORDS: varicocele, complications, treatment outcome, ligation, arteries

Varicocelectomy is the most commonly performed surgical treatment for male infertility.[1] The incidence of testicular artery ligation during nonmicroscopic varicocelectomy is unknown. Animal studies revealed that in rats and dogs atrophy occurs in a majority of testes after ligation of internal spermatic arteries in spite of an intact deferential artery.[2–4] In humans in the absence of an adequate collateral arterial supply, arterial obstruction during varicocelectomy can lead to ischemia of the testis resulting in atrophy and azoospermia.[5]

Accidental arterial injury during varicocelectomy may be a common occurrence, particularly if the surgery is performed without adequate optical magnification.[6] However, the actual rate of this complication is unknown and is probably underestimated in most series since most accidental arterial ligations–especially in nonmicrosurgical cases–go unrecognized intraoperatively. In this study we evaluated the frequency and outcomes of accidental testicular artery ligation during microsurgical varicocelectomy.

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MATERIALS AND METHODS

From 1984 to 2002, 2,102 men who underwent microsurgical inguinal or subinguinal varicocelectomy performed by a single surgeon (MG) were evaluated. The technique of microsurgical varicocelectomy was as described previously.[7] With the patient under general or regional anesthesia a subinguinal incision is made to isolate the spermatic cord. The ipsilateral testis is delivered above the wound to expose the gubernacular and external spermatic veins, which are ligated or cauterized. The external and internal spermatic fascia of the spermatic cord are opened to expose the internal spermatic veins. Under 8 to 25× optical magnification all veins within the cord, with the exception of the vasal veins, are doubly ligated with hemoclips or 4-zero silk ligatures and transected. Structures that are spared during the surgery include vas deferens and associated vessels, cremasteric muscle fibers and associated arteries, lymphatics and nerves. Papaverine solution is used to irrigate as needed to prevent

spasm of vessels and to facilitate identification of arteries. The arterial nature of structures is confirmed by elevation with the tips of the microneedle holder until it is completely occluded, and then slowly lowering it until a pulsating blush of blood appears just over the needle holder. Accidental artery ligation was confirmed intraoperatively by observation of pulsatile twitching of the ligated vessel stump under 25× magnification. All cases of accidental arterial ligation were identified and followed prospectively.

Postoperative followup visits with semen analyses and serum hormonal profile evaluations were performed at 3, 6 and 12 months. Preoperative and postoperative clinical parameters were analyzed with a 2-tailed paired sample t test. The extents of change in preoperative and postoperative parameters were compared with those of a historical cohort of 357 cases of varicocelectomy from our center using the 2-tailed t test and, for proportion comparison, Fisher's exact test.[8]

RESULTS

Accidental artery ligation was identified in 19 of 2,102 cases (0.9%). The clinical characteristics of this cohort are shown in tables 1 and 2. On preoperative semen analyses 26% of men (5 of 19) were azoospermic.

Mean operating time was 45 minutes per side. In addition to the deferential arteries, in all cases more than 1 arterial structure was identified on each side. Of the accidental arterial ligations 74% (14 of 19) were on the left side and 42% (5 of 12) were on the right. In none of these cases did accidental arterial ligation occur bilaterally.

Postoperatively 80% of patients (15 of 19) returned for followup with a median followup of 19.1 months (range 1 to 120). One patient (5%) had a decrease in ipsilateral testicular volume by 20% (from 15 to 12 ml) during followup. Postoperative clinical parameters and pregnancy outcomes are shown in tables 3 and 4. Overall 12 of 15 patients (80%) had a significant (greater than 20%) improvement in hormonal or semen parameters. Among the subjects who were azoospermic before surgery, 40% had sperm return to the ejaculate postoperatively. The overall clinical pregnancy rate of this cohort was 29% with a natural pregnancy rate of 14%.

Compared to data from the historical cohort of patients who underwent varicocelectomy (table 5), subjects in the current series with accidental arterial ligation demonstrated a significant postoperative increase in serum testosterone level and sperm count. However, the magnitude of sperm count increase was significantly lower in the arterial ligation group. In addition, the natural pregnancy rate at 1 year was significantly lower.

DISCUSSION

The goal of varicocelectomy is to ligate all venous drainage in the spermatic cord with the exception of the deferential veins, while sparing important structures such as lymphatic vessels, arteries and nerves. The use of the operating microscope in varicocelectomy makes it feasible to achieve this goal in a majority of cases.[7–10] As a result the incidence of persistence/recurrence of varicocele after microsurgical varicocelectomy is 0% to 2%, which is the lowest in comparison to all other varicocele treatment modalities[7–10] including open and laparoscopic surgery, and radiographic occlusion.[6]

TABLE 1. *Characteristics of men who had accidental arterial ligation during microsurgical varicocelectomy*

	Av (range)
Pt age	37.9 (30–49)
Testicular vol (ml)	15.8 (8–20)
Serum total testosterone (ng/dl)	362 (168–505)
Follicle-stimulating hormone (normal 0.9–14.8 IU/l)	19.2 (3.1–72.6)
Luteinizing hormone (normal 1.7–13.0 IU/l)	7.0 (1.8–24)

TABLE 2. *Presentation of varicocele in the study cohort*

% Presentations:		
Primary infertility	89	
Secondary infertility	11	
Hypogonadism	32	
Scrotal pain	16	
Yrs of symptoms (range)	2.3 (0.5–6.6)	
% Grading:		
I	24	
II	55	
III	21	
% Unilat	37	
% Bilat	63	
Median preoperative sperm count (range):	12	(0–87) × 10^6/ml
% Motility (range)	45	(22–70)
% Normal morphology (range)	38	(1–79)
% Pos for antisperm antibodies	10	

TABLE 3. *Postoperative outcomes of the study cohort*

	% (No./total No.)
Increased total testosterone	80 (12/15)
Increased sperm counts	80 (11/14)
Increased sperm motility	29 (4/14)
Increased normal sperm morphology	43 (6/14)

Simultaneously the complication rates for hydrocele, due to ligation of lymphatics, and for arterial ligations are significantly lower compared to other forms of treatment.[6,9] Despite the use of the microscope which allows clearer arterial identification, accidental arterial ligation occurs in approximately 1% of cases as demonstrated in the current series. Several reasons may explain how this complication occurs.

First, the size of the arteries may be so small that the pulsation is difficult to identify. Men who have small arteries often have smaller testicles, as supported by the current data that the mean testicular volume of these patients was significantly smaller (15.8 vs 18.3 ml) compared to uncomplicated varicocelectomy. Thus, it appears that men who have small testicular volume as well as small corresponding arteries are probably at higher risk for accidental arterial ligation.

Second, aggressive manipulation of the vessels during dissection can lead to spasm, making it difficult to identify arterial pulsation. Even with the use of papaverine irrigation and Doppler ultrasonography the arterial pulses may not always be evident. Since these arteries are small (1 mm in diameter on average) any degree of spasm may mask the arterial pulsation.[11,12]

Third the arteries tend to be in close proximity to or buried under complex branches of veins (eg, the venae comitantes). Until each individual branch of the vessels is freely dissected from the others, adhesion of the artery to the venous complex can make the arterial pulsation less prominent, leading to a higher risk of accidental ligation. Thus, the practice of not dissecting individual vessels freely before ligation is unsafe and should be avoided.

Although a lower natural pregnancy rate (14%) at 1 year was noted, the small sample size of patients with accidental testicular artery ligation in the current series limits the validity of comparison to the historical cohort of varicocelectomy cases (which included more than 350). Further studies with a larger cohort that allows matching of age and other preoperative parameters for more detailed analysis, are required to confirm our findings.

When an artery is ligated and transected, the resistance of the vessels increases significantly and the short stump pulsates with an exaggerated twitching motion. This is the reason the arterial nature of the vessel is often evident only after accidental ligation and transection. The actual frequency of accidental arterial ligation may be higher than we have reported. Experience of the surgeon and how carefully each ligated stump is reinspected are some of the

TABLE 4. *Comparison of preoperative and postoperative parameters*

	Preop	Postop
Total testosterone (mean ng/dl ± SD) (p value):	362 ± 112	493 ± 131 (<0.005)
Pts on clomiphene citrate (6)	332 ± 89	601 ± 162 (<0.001)
Pts not on clomiphene citrate (9)	376 ± 130	431 ± 123 (<0.01)
Mean sperm counts (p value):	12×10^6	22×10^6 (<0.001)
% Motility	45	40 (not significant)
% Normal morphology	38	36 (not significant)
Mean age of female partners (range)	34.1 (28–44)	
% Clinical pregnancy rates (No.):	29 (4)	
Natural	14 (2)	
Intrauterine insemination	7 (1)	
In vitro fertilization/intracytoplasmic sperm injection	14 (2)	

TABLE 5. *Comparison of the current series to a historical cohort of varicocelectomy cases from the same center[4]*

	Current Series	Historical Cohort
No. pts	15	357
Av testicular vol (range)/ p value	15.8 (8–20)	18.3 (8–30) <0.05
Mean ng/dl ± SD serum testosterone (p value):		
Preop	362 ± 112	319 ± 128
Postop	493 ± 131	409 ± 144
% Change	36	28 (not significant)
Mean sperm counts (p value):		
Preop	12×10^6	37×10^6 (<0.005)
Postop	22×10^6	47×10^6
% Change	100	27
% Yr 1 natural pregnancy rate (p value)	14	46 (<0.01)

important variables in determining the actual complication rate. Some cases of arterial ligation may indeed not have been recognized. Further studies, perhaps using pathological evaluation of a segment of each ligated vessel, may provide a more accurate estimate of the complication rate.

In the current series patients who had accidental arterial ligation during varicocelectomy did have significant improvement in serum testosterone and sperm count. The improvement of motility and normal morphology were not significant. Although only 1 case of testicular atrophy occurred in the current series, the natural pregnancy rate in our cohort was significantly lower than in uncomplicated varicocelectomy. This outcome may be related to the poor fertility potential of these patients who had small testicular volume and severely impaired semen parameters initially. However, suboptimal spermatogenic recovery due to arterial injury may have directly decreased the treatment efficacy of varicocelectomy. Therefore, accidental arterial ligation during varicocelectomy should be avoided with every effort possible.

One intraoperative management option that should be considered when accidental arterial ligation is encountered is primary arterial repair. In the current series we performed testicular artery reanastomosis in 2 cases. Although technically this repair is not more difficult than microsurgical vasovasostomy, the actual benefit of such a repair is unclear and evaluation of the long-term patency of such a tiny vessel is difficult at best.

It should be noted that in all cases in our series, including the 2 in which vascular repair was performed, there were at least 2 arterial branches present. These collaterals included branches of the internal testicular arteries, cremasteric arteries and deferential arteries. The presence of these collaterals likely contributed to a low incidence of adverse postoperative outcomes. Although the benefits of arterial repair remain to be established, we believe that in cases in which additional significant arterial branches are not clearly identified or the security of the deferential artery is uncertain, such as in patients with previous vasectomy and vasal artery transection, primary repair of the ligated artery should be attempted to minimize the potential of postoperative testicular atrophy.

CONCLUSIONS

Accidental arterial ligation occurs in approximately 1% of cases of microsurgical varicocelectomy. Small testicular volume, which may correlate with severely impaired semen parameters, appears to be a risk factor since the associated arterial structures tend to be small and difficult to identify. There was 1 case of testicular atrophy, although there was significant postoperative improvement in serum testosterone level and sperm count in men with ligated arteries. The natural pregnancy rate was significantly lower than in arterial intact cases. Although this lower natural pregnancy rate may be related to the poor fertility potential of these patients with small testicular volume and severely impaired semen parameters, suboptimal spermatogenic recovery due to arterial injury may have contributed to poor outcomes in these men. Thus, preservation of the main testicular artery is strongly recommended during varicocelectomy.

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