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An analysis of fluid loss during transcervical resection of submucous myomas

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Objective: To determine the contribution of several variables to fluid loss during transcervical resection of submucous myomas.

Design: An observational study using multiple linear regression analyses.

Setting: A university-affiliated training hospital and a university department of clinical epidemiology and biostatistics.

Patient(s): Patients with submucous myomas.

Intervention(s): Transcervical resection of submucous myomas and monitoring of fluid loss.

Main Outcome Measure(s): Patient age, uterine enlargement, treatment with GnRH analogues or 8-ornithine-vasopressin, type of anesthesia, number of myomas, intramural extension of the myoma (type of myoma), and operating time were tested as variables.

Result(s): Only intramural extension of the myoma and operating time were obviously related to fluid loss. For the other variables, such a relation was weak at best. The relation between fluid loss and operating time was not modified by any of the other variables.

Conclusion(s): Because fluid loss is an important limiting factor in the transcervical resection of submucous myomas, special attention should be paid to reduction of the operating time and preoperative assessment of the intramural extension of the myoma to guide appropriate patient selection. (Fertil Steril® 1997;68:881-6. © 1997 by American Society for Reproductive Medicine.)

Key Words: Abnormal uterine bleeding, myomas, hysteroscopy, transcervical resection, intravasation

Hysteroscopic transcervical resection of submucous myomas has been performed for several years (1-5). The accuracy of intrauterine diagnosis, when compared with dilatation and curettage, has improved with the use of diagnostic hysteroscopy and transvaginal ultrasonography (US). The number of patients undergoing transcervical resection is increasing as the advantages of avoiding laparotomy,

hysterotomy, and hysterectomy become apparent. Resection seems to be very efficient and effective for the treatment of pedunculated and sessile submucous myomas, but long-term follow-up results are necessary to confirm the presumed advantages. The treatment of submucous myomas with deep intramural extension is more difficult and multiple procedures may be necessary for complete resection (6).

Although the procedure is relatively safe, the most dangerous potential problem during surgery is excessive intravasation of the fluid used to distend and irrigate the uterine cavity. This problem is well described for endometrial resection (7-10). Severe fluid overload can cause complications similar to those of the urologic transurethral resection syndrome, including hyponatremia, pulmonary edema, heart failure, cerebral edema, and even death.

Management of this risk relies on close monitoring

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of the fluid balance and interruption of the procedure before excessive fluid absorption occurs. Even with monitoring, however, fluid loss can occur before it is noticed during assessment of the fluid balance. New electronic balances and pumps should overcome this problem in the future by providing continuous on-site registration of the fluid balance.

Identifying patients at risk for excessive fluid loss is of great importance because the procedure should be interrupted in the event of >1.5–2 L of fluid loss (7–9). During preoperative counseling, it should be decided whether transcervical resection or an alternative treatment is appropriate for the patient, after assessing the chances of success and failure.

To facilitate this counseling, we analyzed the relation of several variables to fluid loss during myoma resection, to identify them as risk factors. In addition, we tested some surgical variables to identify possible options for improved treatment. A discussion of the management of the transurethral resection syndrome and other electrolyte disturbances is beyond the scope of this study.

MATERIALS AND METHODS

From August 1987 until January 1995, 283 patients with abnormal uterine bleeding and submucous myomas were treated. A total of 339 procedures were performed. A continuous-flow 8- or 9-mm Olympus resectoscope (Olympus Optical Co. Europe GmbH, Hamburg, Germany) was used, with high-frequency wire loops for cutting and coagulation. For distention and irrigation of the uterine cavity, sorbitol 4% was used. To achieve sufficient flow, the 3-L fluid bags were compressed by a cuff with a maximum cuff pressure of 150 mm Hg.

During resection, both inflow and outflow stopcocks were open to maximize flow and reduce intrauterine pressure, unless heavy bleeding necessitated higher pressures, which were achieved by gradual closing of the outflow stopcock. The outflow was passive and no suction was applied. The lowest pressure compatible with clear vision always was preferred. The actual intrauterine pressure was difficult to assess because the pressure applied to the infusion system decreases along the infusion line and in the cavity when the outflow stopcock is open. The actual pressure probably varied between 40 and 60 mm Hg with the outflow stopcock open and between 120 and 140 mm Hg with the outflow stopcock closed.

The patients were lying on special plastic sheets to prevent fluid leaking from the vagina from soaking into the underlying drapes. The fluid from the plastic sheet dripped into a specially designed sink that was mounted at the lower end of the operating table. The sink was connected to a calibrated

4-L (outflow) bottle by a large tube. As a result, all the vaginal fluid leakage was collected and measured.

The outflow fluid from the resectoscope was collected in the same calibrated 4-L bottle. The 3-L sorbitol bags were hung on a balance so that the amount of inflow fluid could be measured at any time during the procedure. The difference between the amount of inflow and outflow fluid (fluid loss) was assessed continuously during surgery by a special operating theater staff member. In this way, all the fluid was measured without any spillage.

As a guideline, the resection was finished rapidly when a fluid loss of approximately 1,500 mL was noticed, and it was interrupted when the fluid loss exceeded approximately 2,000 mL and complete resection was not expected to be achieved within a few minutes. Further details of the technique used have been described previously (6).

Only the primary 283 procedures were included in the analyses. The remaining 56 procedures were repeated procedures performed for incomplete resection with residual myoma tissue. Because the vascularization of the uterus and the residual myoma tissue may have been altered, these procedures were not considered to be representative with respect to the objective of the study and therefore were not analyzed.

The relation between fluid loss and the variables given in Table 1 was tested. The size of the uterus at bimanual pelvic examination was assessed preoperatively. Patients who were pretreated with GnRH analogues received them at least 4 weeks before surgery. Spinal anesthesia was allowed only in patients who had submucous myomas without intramural extension that had been diagnosed after preoperative assessment with US, diagnostic hysteroscopy, and laparoscopy.

The use of adjuvant 8-ornithine-vasopressin (10 mL of a 5% or 10% solution in saline, POR 8; Sandoz Pharma, Basel, Switzerland) depended on the surgeon's preference. 8-Ornithine-vasopressin was administered at the beginning of the procedure by deep intramural injection through the cervix. The number of submucous myomas was noted during hysteroscopy. The number of pedunculated and/or sessile subserous myomas was noted during preoperative laparoscopy or during concomitant laparoscopy at the time of surgery. Possible intramural myomas without submucous or subserous extension were not taken into account.

To categorize the degree of intramural extension, we designed a classification system for submucous myomas that since has been adopted by the European Society of Hysteroscopy and the European Society of Gynecologic Endoscopy (6). Pedunculated submucous myomas without intramural extension

Table 1 Variables Used in the Analysis

Variable	Type of variable	Mean	Median	SD	Range	Category*
Patient age (y)	Interval	37.8	37	6.6	20–62	<35 (91)/35–39 (86)/40–44 (58)/≥45 (48)
Uterine size	Binomial					Normal (190)/Enlarged (93)
GnRH analogue treatment	Binomial					No (226)/Yes (57)
8-ornithine-vasopressin treatment	Binomial					No (126)/Yes (157)
Type of anesthesia	Binomial					General (243)/Spinal (40)
No. of myomas at hysteroscopy	Interval	1.63	1	1.71	1–15	1 (208)/2 (46)/3–4 (17)/≥5 (12)
No. of myomas at laparoscopy	Interval	0.75	0	1.30	0–8	0 (182)/1 (45)/2–3 (42)/≥4 (14)
Operating time (min)	Interval	47.4	45	17.8	15–120	≤30 (63)/31–45 (93)/46–60 (87)/>60 (40)
Maximum intramural extension	Nominal					Type 0 (73)/Type I (99)/Type II (111)

* Number of patients in parentheses.

are classified as type 0 myomas. When the myoma is sessile and the intramural part constitutes <50%, it is classified as type I. When the myoma has an intramural extension of >50%, it is classified as type II.

The degree of intramural extension can be assessed by observation of the angle of the myoma with the endometrium at the attachment to the uterine wall. Careful inspection with varying degrees of uterine distention is necessary because the endometrium may smooth away the actual angle. The extent of intramural extension was classified during hysteroscopy in our study. In patients with multiple myomas, the classification was based on the myoma with the most extensive intramural extension.

To investigate the relation of these variables (Table 1) to fluid loss, we used multiple linear regression analyses, particularly analyses of covariance. From a preliminary analysis, it was obvious that these could be used validly only after a transformation of the observed fluid loss. Because of the occurrence of the value zero, the square-root transformation was chosen.

From a residual analysis based on a linear regression analysis with all variables from Table 1 as independent variables, it was concluded that this transformation led to reasonable normality of the residuals. The variance of the residuals in different subgroups defined by the independent variables was reasonably constant: the maximum ratio of highest versus lowest variance was 2.04, with *P* values from the *F* test (or Bartlett's test) varying from 0.023 to 0.99.

A backward elimination procedure was used to identify variables from Table 1 with an independent relation to fluid loss. Analysis of covariance was used to test whether the relation between fluid loss and operating time was modified by other variables (test for parallelism). The same method was used to test whether a relation between fluid loss and treatment with GnRH analogues or 8-ornithine-vasopressin

differed between the three types of intramural extension of the myomas, by including an interaction between GnRH analogues or 8-ornithine-vasopressin and myoma type in the model.

Linearity of the relation between the square root of fluid loss and age, the number of myomas at hysteroscopy, the number of myomas at laparoscopy, and operating time was tested by comparing a model with only the linear term with a model that also included a nominal variable consisting of categories. The categories used also are given in Table 1.

RESULTS

The operative procedures were uneventful in all patients. No serious complications occurred. No patients complained of dyspnea, headache, or cerebral confusion. Most patients with a fluid loss of >1,500 mL had nausea.

The absolute amounts of fluid loss are given in Table 2. Table 3 shows the *P* values from the analysis (backward elimination). There is strong evidence that fluid loss is related to operating time and type of intramural extension of the myoma and that these relations are independent of each other and cannot be explained by any of the other variables used in the analysis. There is no evidence of a relation between fluid loss and type of anesthesia or number of myomas at hysteroscopy.

Table 2 Absolute Amounts of Fluid Lost During Transcervical Resection for the Different Types of Myomas

Type of myoma	Fluid absorption* (mL)	Operating time (min)†	Rate of fluid loss (mL/min)†
0 (n = 73)	450, 0–1,700, 365	36	12.5
I (n = 99)	957, 0–3,000, 707	47	20.4
II (n = 111)	1,682, 50–4,500, 944	56	30.0
All (n = 283)	1,111, 0–4,500, 899	47	23.6

* Values are means, ranges, and SD.

† Values are means.

Table 3 *P* Values From Backward Elimination

Variable	Step 0	Step 1	Step 2
Patient age	0.052	0.053	0.056
Uterine size	0.034	0.032	0.030
GnRH analogue treatment	0.029	0.026	0.028
8-ornithine-vasopressin treatment	0.090	0.090	0.079
Type of anesthesia	0.400	0.400	<u>0.400</u>
No. of myomas at hysteroscopy	0.850	<u>0.850</u>	<u>0.850</u>
No. of myomas at laparoscopy	0.063	0.061	0.054
Operating time	<0.0001	<0.0001	<0.0001
Type of myoma	<0.0001	<0.0001	<0.0001

Note: Underlined *P* values indicate variables not in the model.

For the other variables, the evidence is weak at best, especially in view of the number of variables tested. Analysis of covariance did not give any indication that the relation between fluid loss and operating time is modified by any of the variables still in the model at step 2 of the backward elimination (smallest *P* value for lack of parallelism: 0.41).

For age (*P* = 0.78), number of myomas at hysteroscopy (*P* = 0.97), and number of myomas at laparoscopy (*P* = 0.89), we found no evidence for non-linearity of the relation to fluid loss. For operating time, linearity seems doubtful (*P* = 0.0091). A graphic impression of the form of this relation is given in Figure 1 (a cubic polynomial). There appears to be a rise until approximately 50 minutes, after which a leveling-off occurs. The second rise is

caused by only three points and therefore should not be taken seriously.

When controlled for operating time, there was no clear indication that the relation between treatment with GnRH analogues and fluid loss differed between the three types of intramural extension of the myomas (*P* = 0.12). The same holds true for the relation between 8-ornithine-vasopressin and the type of myoma (*P* = 0.057). Because the use of GnRH pretreatment and the use of adjuvant 8-ornithine-vasopressin during surgery were not randomized, these variables may be subject to bias. This is discussed in the next section.

DISCUSSION

Although modern electronic balances and pumps have improved the accuracy with which we can measure the deficit of the distending and irrigating fluid during transcervical resection, a gold standard for measuring intravasation is still lacking. Ethanol labeling of the fluid is an elegant technique, but it is indirect as a method and has not been fully evaluated (11, 12). Nevertheless, measuring the fluid deficit is safe because the amount of fluid intravasated never exceeds the amount of fluid lost.

Intravasation originates from uptake of the pressurized fluid into the uterine vessels. The risk factors for intravasation are not very well known because no studies have tested their independent contribution or relation to fluid loss. The variables

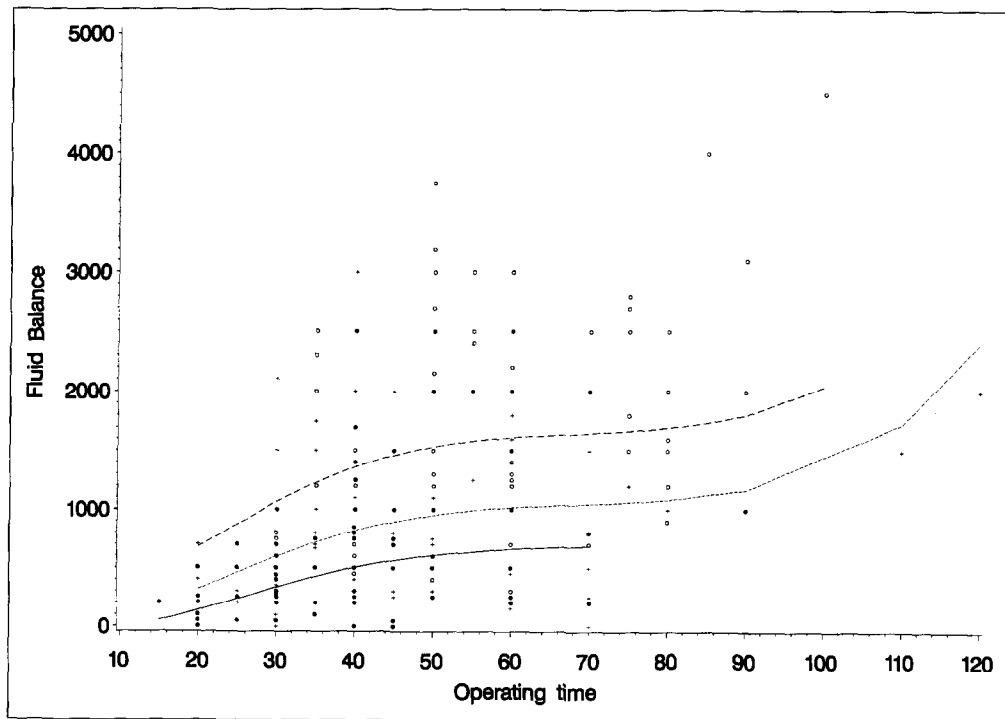


Figure 1 The relation between fluid loss and operating time for the different types of myomas. The closed circles and solid line indicate type 0; the crosses and small-dashed line indicate type I; and the open circles and large-dashed line indicate type II. The operating time is given in minutes and the fluid balance in milliliters.

tested in this study showed a very divergent relation to fluid loss.

Age alters the condition of the vascular system and therefore may influence the size and resistance of the uterine vessels. However, the relation between age and fluid loss was weak in our study.

The size of the uterus could influence fluid loss because vascularization increases with enlargement of the uterus. However, our *P* values of approximately 0.03 are not convincing evidence for uterine size as a risk factor for intravasation.

Gonadotropin hormone-releasing hormone analogues can reduce the size and vascularization of both the uterus and the myoma and should be used before myomectomy, although opinions conflict in this matter. Theoretically, fluid loss would have been expected to be lower after reduction of the number and particularly the size of the uterine vessels. The preoperative administration of GnRH analogues showed some evidence of a relation to fluid loss, but with *P* values between 0.026 and 0.029, this evidence was weak.

It certainly leaves unanswered the question of whether to recommend the preoperative use of GnRH analogues in all cases of transcervical myoma resection to reduce fluid loss. However, especially during the learning phase of the technique, all precautions to reduce fluid loss are justified. Further, in the case of deep intramural extension of the myoma, reduction of the size of both the myoma and the vessels could be important in terms of efficacy and the chance of complete resection, but this subject is beyond the scope of this study.

Because 8-ornithine-vasopressin is a synthetic polypeptide with a potent and specific vasoconstrictive effect on the microcirculation, the intramural injection of 10 mL (of a 5% or 10% solution) was expected to reduce fluid loss substantially. However, the analysis showed no significant reduction of fluid loss. Apparently, it is difficult to infiltrate the vascularization of the myoma to create local ischemia.

Further, the outcome of the analysis for GnRH and 8-ornithine-vasopressin is expected to be considerably biased in this retrospective analysis, because the selective use of both substances probably was reserved for the more difficult cases. A randomized study could measure the effect of the use of GnRH and/or 8-ornithine-vasopressin on fluid loss more appropriately. Spinal anesthesia was expected to increase fluid loss by increasing the venous capacity in the lower half of the body. However, we found no relation between the type of anesthesia used and the amount of fluid lost.

With *P* values of >0.05 , the number of myomas, either at hysteroscopy or at laparoscopy, was not found to be related to fluid loss as an independent

variable. This means that the observation of multiple rather than single myomas is less important during preoperative counseling, if the chances of success are related to extensive fluid loss.

The two main factors contributing to fluid loss are operating time and intramural extension of the myoma. Moreover, this analysis showed that operating time was not modified by any of the other variables, such as the number of myomas. One variable that could influence the analysis but was not tested in the study is the size of the myoma. The size of a myoma is very difficult to estimate at hysteroscopy, and US measurements are reproduced poorly. Therefore, size was unsuitable for inclusion in the analysis.

The strong relation between intramural extension of the myoma and fluid loss can be explained by studies of the vascular morphometry of the myometrium with or without the presence of myomas. Deeper into the myometrium, the number of vessels decreases but their size increases. Duffy (13) found a mean vessel frequency varying from 3.98/mm² at 2 mm into the myometrium to 1.67/mm² at 8 mm and, in contrast, a mean vessel area varying from 0.75 mm² at 2 mm to 4.06 mm² at 8 mm. Therefore, in a patient with a myoma with deep intramural extension, intravasation will increase because of damage to larger-sized vessels and probably also because of the higher intrauterine pressure necessary to obtain clear visualization as a result of bleeding.

The strong relation between operating time and fluid loss does not require much explanation and seems logical. This relation probably was underestimated because the operations sometimes were interrupted because of excessive fluid loss. Therefore, special attention should be paid to reducing the operating time. Although we recognized the importance of the experience of the surgeon in this matter, we could not analyze this variable because the surgeons in this study did not differ much in experience. Because the intramural part of a submucous myoma is the most difficult to resect, uses the most operating time, and influences fluid loss strongly, type II myomas should be treated by transcervical resection only in specific cases by very experienced surgeons.

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