

NOTES cholecystectomy: matched-pair analysis comparing the transvaginal hybrid and conventional laparoscopic techniques in a series of 216 patients

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Abstract

Background Natural orifice transluminal endoscopic surgery (NOTES) is currently a very important topic for both gastroenterologists and surgeons. We have developed a technique of transvaginal hybrid NOTES cholecystectomy (TVC) that leaves no visible scar and is applicable to daily use. This technique is compared to the conventional laparoscopic cholecystectomy (CLC) in a matched-pair analysis. **Methods** From June 2007 until February 2009, 108 NOTES cholecystectomies were performed. For a matched-pair analysis we first selected a group of 192 female patients who had undergone CLC and who were operated on by the same group of surgeons in the same time period. Then 108 pairs who had TVC were matched according to the degree of inflammation of the gallbladder and age. We were able to contact 208 patients at least 3 months after surgery. Hence, the study analysis was performed with 100 complete pairs. **Results** All 200 cholecystectomies were performed successfully without conversion. The TVC procedure was significantly longer than CLC (52 vs. 35 min, $p < 0.001$). There were no intraoperative complications in either group. There were no significant differences with respect to reoperations, wound infections, consumption of analgesic drugs, length of hospital stay, and sick leave. Seventy-five TVC and 73 CLC patients had sexual intercourse after the operation without any complaints.

Conclusion We present here the largest series of NOTES for cholecystectomy published to date and the first comparative study with the gold standard. The TVC technique is as successful as the CLC, it causes no more complications than CLC, especially with respect to the vaginal approach, it is more time-consuming to perform, but has an ideal cosmetic result, i.e., no visible scar.

Keywords NOTES · Transvaginal cholecystectomy · Comparative study

Natural orifice transluminal endoscopic surgery (NOTES) is currently a very important topic for both gastroenterologists and surgeons. In the beginning this idea was based on the use of flexible endoscopes in the abdominal cavity. Experimental operations in the animals have been performed using different approaches (transgastric, transcolonic, transvaginal, and transvesical) aiming at almost all intra-abdominal organs [1–13]. There is currently much activity in this developing field. Operations in humans have rarely been performed using this technique because it is very demanding and has associated potential risks. Transgastric and transvaginal appendectomies, cholecystectomies, sleeve gastrectomies, a radical sigmoidectomy, a nephrectomy, and a liver resection have been performed in small numbers in humans using flexible endoscopes with the assistance of additional abdominal trocars [14–22].

In June 2007 we performed the first NOTES procedure using rigid instruments [23]. Further experience with this technique was very positive [24, 25]. Within 26 months, a total of 140 transvaginal cholecystectomies (TVC) were performed using a 5-mm trocar in the umbilicus. In Germany, a growing number of patients are treated this way. Unlike NOTES procedures with flexible endoscopes, this

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technique can be applied to routine use. Two main questions need to be answered: (1) What is the benefit of this procedure compared to conventional laparoscopic cholecystectomy (CLC)? (2) Do we cause specific problems by using the transvaginal approach? To address these questions, we compared the transvaginal technique with the conventional by means of a matched-pair analysis.

Methods

The transvaginal technique was offered to female patients with symptomatic cholelithiasis. Initially, we started with easy cases, i.e., slim patients who had had no previous operations and no signs of acute cholecystitis. With growing experience, this technique was offered to all patients. Finally, it was the patient who made the decision about which operative technique to have, except when contraindications were present, such as a BMI > 35, a previous operation in the small pelvis, previous radiation therapy where severe adhesions could be expected, and endometriosis.

All NOTES procedures have been prospectively documented in our database. Age, medical history, previous operations, indication, degree of inflammation, operation time, intra- and postoperative complications, amount of analgesic drugs used, and length of hospital stay were registered. Discharge was planned for the second postoperative day. One week after the operation the patients were examined by the gynecologists in our team. After at least 3 months patients were interviewed concerning late complications in the abdomen or vagina. The patients were asked whether they had sexual intercourse since the operation and about any possible negative experiences. A structured questionnaire was used, and the interview was performed by telephone by one of the authors (Table 1).

From June 2007 until February 2009, a total of 722 cholecystectomies were performed in our department. Four hundred sixty-nine patients were female (65%); 108 of

them (23%) were operated on transvaginally. These operations were performed by the head of the surgical department (CZ) or by one of the three consultants (HM, AM, MA).

For a matched-pair analysis we first selected a group of patients who had undergone CLC in the same time period, who were female, and who had been operated on by the same group of surgeons (192 patients). Then 108 pairs were created by matching patients from each group according to the degree of inflammation of the gallbladder (acute and chronic cholecystitis or no cholecystitis) and age (± 10 years). Two hundred eight patients (96%) were able to be contacted for a follow-up interview. Hence, the study analysis was performed with 100 complete pairs.

Statistical analyses

All descriptive comparisons between patients operated on with the TVC method and their matched controls were done through paired *t* tests for continuous variables and McNemar tests for categorical variables. The level of significance was 0.05, two tailed. Statistical analyses were performed using SAS 9.1.3 and SPSS 15.

Operative technique

The TVC technique starts with a 5-mm incision deep in the umbilicus, insufflation of the abdomen, and diagnostic laparoscopy. A 5-mm dissector (Storz, Tuttlingen, Germany) and a 10-mm optic (Olympus, Hamburg, Germany), both extra long, are inserted with the patient in a steep anti-Trendelenburg position in the posterior fornix of the vagina under laparoscopic control. The optic in the umbilicus is replaced by another dissector. The gallbladder is retracted with the instrument positioned through the vagina, and is then dissected via the umbilicus. When the cystic duct and the cystic artery are identified, they are clipped through the umbilicus with a 5-mm clip device (Ethicon, Hamburg, Germany) and divided from there. The gallbladder is then mobilized with an electric hook. For removal, the 5-mm optic from the umbilicus is used again. A removal bag can be used through the 10-mm vaginal trocar. The gallbladder is then pulled through the 10-mm colpotomy, which can be enlarged bluntly with a clamp if needed. The defects in the vagina are sutured with resorbable thread.

A single-shot antibiotics is given. Postmenopausal patients receive estrogen suppositories for 5 days. It is recommended not to have sexual intercourse for 2 weeks.

Our operative technique has been approved by the local ethical committee of the Hamburg chamber of physicians (Ärztchamber Hamburg), including the quality control described in the present study. All patients gave written informed consent.

Table 1 Questionnaire for the telephone interview 3–10 months after surgery

1. How long was the period of your sick leave? How many days did you remain off work?
2. Did you have a wound infection?
3. Do you have a hernia at the trocar site?
4. Do you have upper abdominal pain?
5. Do you have lower abdominal pain?
6. Are you completely well in general?
7. Did you have sexual intercourse after the operation?
8. If yes to 7, did anything change compared to before the operation?
9. Would you recommend the operation you had?

Conventional laparoscopic cholecystectomies are performed with a 10-mm optic at the upper border of the umbilicus and one or two 5-mm and one 10-mm working trocar in the upper abdomen. The gallbladder is removed at the umbilicus, where an enlargement of the wound is sometimes necessary.

Results

The average age of the 100 patients who underwent TVC was 49 years (range = 16–76) and the age of those who underwent CLC was 50 years (range = 18–76) years. The average age difference between the pairs was 1.1 years (not significant). In each group 12 patients had acute or chronic inflammation of the gallbladder. The average BMI was 26 kg/m² (range = 16–35) in the TVC group and 26 kg/m² (range = 18–40) in the CLC group. Thirty-five patients had previous abdominal operations before TVC and 54 before CLC.

All 200 cholecystectomies were performed successfully with the chosen technique without conversion. Four cases in the TVC group required an additional abdominal 2- or 5-mm trocar. The average operation time was 52 (range = 23–100) min in the TVC group and 35 (range = 17–75) min in the CLC group. This difference is statistically significant ($p < 0.001$).

There were no intraoperative complications in either group. There was one major postoperative complication after TVC which required reoperation. A patient was readmitted 3 weeks after surgery with a Douglas pouch abscess, which had to be drained laparoscopically. In the CLC group two patients had to be reoperated on, both on the second postoperative day, one for bleeding and one for bile leakage from an accessory duct (not significant).

Wound infection occurred in one patient after TVC (the above-mentioned Douglas pouch abscess) and in three patients after CLC. This difference is not statistically significant ($p = 0.625$).

Patients received 3.3 single doses of analgesic drugs in each of the two groups. Postoperative hospital stay averaged 2.1 days after TVC and 2.3 days after CLC (not significant) (Table 2). One week after TVC, 85 patients presented for the gynecological control examination. There were no pathological findings.

The interviews were conducted 3–10 months after surgery (mean = 5 months) (Table 3). Twenty-nine percent of patients were immediately able to work after TVC and 20% after CLC, analyzed in 51 pairs without pensioner (not significant). Patients in the TVC group required 7.1 days of sick leave and those in the CLC group required 6.7 days (not significant). There were no trocar hernias in either group. Pain in the upper abdomen was mentioned by 14

Table 2 Patient's characteristics and data on operation and postoperative course of 100 TVC and 100 CLC

	TVC (<i>n</i> = 100)	CLC (<i>n</i> = 100)
Age (range) (years)	49 (16–76)	50 (16–76)
BMI (range) (kg/m ²)	26 (16–35)	26 (18–40)
Previous operations	35	54
Gallbladder inflammation	12	12
Operation time (range) (min)*	52 (23–100)	35 (17–75)
Intraoperative complications	0	0
Reoperations	1	2
Wound infections	1	3
Analgesic drugs (doses)	3.3	3.3
Postoperative hospital stay (days)	2.1	2.3

* $p < 0.001$

Table 3 Results of interview given 3–10 months postoperatively (mean = 5 months)

	TVC (<i>n</i> = 100)	CLC (<i>n</i> = 100)
Sick leave (days) ^a	7.1	6.7
Trocar hernia	0	0
Free of abdominal symptoms*	81%	60%
Recommendation of the operation technique	96%	99%
Sexual intercourse postoperative	75	73
Dyspareunia	0	0

* $p = 0.007$

^a In 51 pairs without pensioners

TVC patients and by CLC 16 patients (not significant). Three patients in each group complained about lower abdominal pain. Eighty-one percent in the TVC were entirely free of abdominal symptoms, as were 60% in the CLC group ($p = 0.007$). Ten patients spontaneously volunteered that they were not satisfied with their scars after CLC. In the TVC group there were no similar complaints. After TVC and CLC, 75 and 73 patients, respectively, had sexual intercourse, 22 and 24 had none, and 3 in each group did not answer this question. Nobody noticed any change compared to before the operation and there were no complaints about dyspareunia. Ninety-six patients in the TVC group and 99 in the CLC group (not significant) would recommend the technique of cholecystectomy that the patient had experienced.

Discussion

We present a study of the largest series of a surgical procedure using a natural orifice in humans. We have shown

that a transvaginal NOTES cholecystectomy can be successfully performed in 100 patients (as in all 140 patients that we operated on within 26 months). The technique is safe and did not lead to any serious complications and to only one infection.

We present the first comparative study of a NOTES procedure with the gold standard. TVC obviously has a better cosmetic result as it leaves no visible scar. In the literature, there are several other theoretical advantages to the NOTES procedure (less pain, fewer wound infections and trocar hernias, shorter hospital stay and sick leave) compared to the conventional laparoscopic technique. We conducted this study to obtain reliable data on this topic. We chose the method of a matched-pair analysis because a randomized trial did not seem realistic, as up to now only 23% of our female patients are interested in this technique and most of them are not willing to be randomized.

The pairs were well matched in age, BMI, and infectious status of the gallbladder, allowing a reliable comparison of the two techniques. The fact that there were more previous operations in the CLC group did not seriously influence our study because in this group all operations could be performed successfully and without intraoperative complications.

Our study clearly shows that TVC needs significantly more operative time. The reason for this is that the handling of the instruments is more difficult. However, this does not lead to more intraoperative complications as there were none in either group and there was no need to convert to another technique. Furthermore, TVC led to one reoperation compared to two in the CLC group. We did not observe any difference in postoperative pain between the groups, with analgesic intake being the same. In our experience with routine laparoscopic operations, postoperative pain is usually due to the pneumoperitoneum as opposed to the trocar sites. We can imagine that larger and more sophisticated (pain score) studies will show advantages for NOTES procedures concerning pain, but the difference will be marginal. The length of hospital stay was the same in both groups. However, it must be taken into account that for several reasons patients with cholecystectomy in Germany generally have a 2-day inpatient stay.

We had a follow-up rate of 100% of the 200 patients in this study. Wound infections occurred more often after CLC, but the difference is not statistically significant. It is known from the gynecologic literature that the risk of infection is negligible after the transvaginal approach (for hysterectomy) to the abdomen, significantly less than after abdominal hysterectomies [26]. After laparoscopic cholecystectomy the infection rate increases to 6% [27]. The number of patients who immediately returned to work and the length of sick leave of the others did not differ significantly between the groups. In the follow-up period none of the patients noticed a hernia. We know from the

literature that a rate of trocar hernias of up to 1% must be expected after laparoscopic cholecystectomy [27]. On the other hand, hernias at a trocar site of a 5-mm instrument (as used in TVC) are not known. Hence, longer follow-up studies will certainly show an advantage for TVC in this respect.

In the interview, patients were separately asked about symptoms in the upper and lower abdomen to find any possible effect of the transvaginal approach. There was no difference between the groups. However, when asked about general well-being at the time of the interview, significantly more patients who underwent a transvaginal operation were completely well. This result was surprising to us and should not be overestimated. Reasons for not feeling completely well varied and were often not related to the cholecystectomy. As mentioned above, though, several patients who had CLC stressed the fact that they were not satisfied with their scars. This is at least one difference between the groups that is related to the operative technique.

The postoperative frequency of sexual intercourse was the same in both groups. Nobody, especially among the 73 patients with the transvaginal operation, had noticed any difference compared to before the operation. This is very important for future planning of NOTES procedures.

In 2005 the NOSCARGROUP discussed the problems of NOTES operations, which must be resolved for safe application of this technique to humans [28]. Twelve “potential barriers to clinical practice,” such as access and closure of the access, prevention of infection, and spatial orientation, were listed. Our operative technique (and the use of laparoscopic instruments) presents a solution for all these barriers.

Returning to the questions raised at the beginning of this article, we can answer them as follows: (1) This transvaginal approach for cholecystectomy is as successful as the conventional laparoscopic technique. It is more demanding for the surgeon and needs more time. Intra- and postoperative complications as well as consumption of analgesics, length of hospital stay, and length of sick leave are not different than those after CLC. There tends to be fewer wound infections, probably fewer trocar hernias, and the general well being of the patient is better, mostly because of patients complained about their scars after CLC. The cosmetic result is better after TVC. Hence, as long as a longer operation time is accepted, transvaginal hybrid cholecystectomy tends to have advantages compared to conventional laparoscopic cholecystectomy. (2) No specific problems are caused by the transvaginal approach.

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