COST COMPARISON OF
TRANSANAL ENDOSCOPIRIC MICROSPUGERY, 
LOW ANTERIOR RESECTION AND
ABDOMINAL PERINEAL RESECTION
FOR SELECTED RECTAL TUMORS

John H. Winston, III, M.D., Resident Physician, Primary Investigator
Thomas J. Stahl, M.D., Attending Physician, Co-investigator
Lee E. Smith, M.D., Director, Co-investigator

Section of Colon and Rectal Surgery
Department of Surgery
Washington Hospital Center
106 Irving Street, N.W.
POB 2100 North
Washington, D.C. 20010

Office: (202)877-8484
Fax: (202)877-8483
ABSTRACT

Background: The purpose of this study is to report the relative costs of transanal endoscopic microsurgery (TEM), low anterior resection (LAR) and abdominal perineal resection (APR.). Methods: Two surgeons collected data about the procedures between June 1996 and December 1999. To study costs, the hospital charges for the procedures were obtained. Results: There were 32 TEM patients, 27 LAR patients and 13 APR patients. The sex and ages were similar. The average inpatient length of stay and costs were 1.4 days and $7,903, 8.8 days and $34,018, 9.1 days and $37,893 for TEM, LAR and APR respectively. Conclusions: It is concluded that TEM is a safe and viable alternative to traditional open surgery for selected rectal neoplasms with a shorter length of stay and less cost.

KEYWORDS: Transanal endoscopic microsurgery, rectal cancer, local excision, cost
INTRODUCTION

In recent years, minimally invasive procedures have been accepted into the surgical armamentarium driven mainly by patient requests for the new "laser surgery" and the promise of reduced overall cost to health care providers and society as a whole. Indeed, laparoscopic cholecystectomy has gone from being a procedure only performed at major institutions to being the standard of care for gallbladder disease in only a decade.

Unfortunately, TEM has not enjoyed similar success. Dr. Gerhard Buess pioneered minimally invasive rectal surgery in the early 1980’s at the University of Colonge in Germany. He designed, developed and used transanal endoscopic microsurgery (TEM) for selected mid and high rectal tumors. He published his first English-language paper in 1984. In 1992, papers were published in the United States. Other countries were soon to follow. In 1996, the results of a United States registry were reported. [3] In that same year, the rate of papers published reached an all-time peak. However to date, only about 80 articles or book chapters have appeared in the English-language literature emphasizing the lack of interest.

Although selection criteria are very specific, TEM quickly became accepted throughout Germany. The use of TEM in the United States is sparse in comparison, most likely due to the lack of publicity for this procedure, difficulty of the technique, coding and re-imbursement, and the initial investment cost for the equipment that is used for such a limited site in the rectum.

No studies have looked specifically at the costs of this procedure versus traditional open procedures in the United States. This study seeks to briefly review the selection criteria, indications, equipment, techniques, preoperative work-up and results of TEM. Significant hospital cost data of the procedure is reported.

STUDY DESIGN AND METHODS

Data was collected prospectively from all TEM's performed by the authors between July 1996 and December 1999 at the Washington Hospital Center in Washington, D.C. The level of the lesions, length of stay and operative times were studied by reviewing the prospectively collected data sheets on TEM, and retrospectively from the office charts and hospital charts on LAR and APR. Costs were obtained from computer generated billing records.
For this study, cost is defined as the total the hospital charged. It does not include surgeon or anesthesiologist fees, preoperative or postoperative work-up or post-operative office visits.

The study population included patients who had resections for benign and malignant rectal neoplasms and malignant polyp sites. Both sexes and all ages, races and religions were included. There were no exclusion criteria. The study was conducted in compliance with all applicable institutional, federal, state and local requirements after review by the hospital institutional review board. No attempt was made to match the patients by age, sex, race, level or type of lesion.

INDICATIONS

The indications for TEM have been reported in several large series. [10, 5, 13, 17, 2, 14, 20, 6] See TABLE 1. The indications for possible cure of early cancers are based on studies of transanal resection of rectal tumors, and the rates of recurrence and metastatic nodal disease. In general the indications are early cancers and benign tumors between 4 and 25 cm levels in the rectum and sigmoid colon. In this study the indications included early carcinomas, adenomas, small carcinoid tumors and palliation of carcinoma.

The indications for LAR are any malignant or benign lesions, which cannot be resected by endoscopic means or local resection. These lesions must be proximal enough to allow resection with adequate radial and distal margins and yet spare the sphincter, thus preserving continence. Typically they are in the proximal or middle rectum, which is usually 7 to 15 cm from the anal verge. In this study, the indications included carcinomas, adenomas, small carcinoid tumors and incompletely excised malignant polyps.

The indications for APR are distal rectal, malignant or benign lesions, which cannot be resected by endoscopic means or local resection. These lesions are near or overlapping the sphincter mechanism, preventing excision with at least a 2 cm distal margin and sparing the sphincter.

Which procedure to employ is based on the preoperative work-up. This work-up must include a history and physical including a careful digital rectal examination. The mass must be biopsied. Rigid sigmoidoscopy finds the level, position and the size. The colon is studied for synchronous lesions by
colonoscopy or flexible sigmoidoscopy combined with barium enema. Computed tomography of the abdomen and pelvis and rectal ultrasound complete the work-up.

DESCRIPTION OF PROCEDURES

TEM employs an operating rectoscope 4cm in diameter and up to 20cm in length, which is inserted through the anus. Exposure is obtained by insufflating the rectum with carbon dioxide, similar to laparoscopy, via a combined endosurgical unit. This unit measures and maintains the intrarectal gas pressure. Water irrigation and controlled suction are included. A stereoscopic microscope magnifies the field six times normal and provides 3-dimensional vision. Cutting, dissection and sewing are carried out via long instruments through gas tight port sites. The instruments include a high-frequency electrocautery knife, grasping forceps and a suction device. The resection site is closed using a long needle driver and short suture. Silver clips are used instead of knots. The technique is described in detail elsewhere. [18,8]

Certain anatomical features pose a threat or preclude TEM. This includes angulation and narrowing at the sigmoid colon, stenosis of the rectum, and anterior or high positions. Anterior lesions in women pose the threat of peritoneal or vaginal perforation. A high, anterior lesion in men poses a risk of peritoneal perforation.

Because full thickness dissection is necessary for cancers only tumors at certain levels can be operated without risk of perforation into the peritoneal cavity. In general these tumors are at 10 cm anteriorly, 15 cm laterally and 20 cm posteriorly. These levels differ by sex and age. This should be taken into account when selecting patients and may influence the choice of procedure.

Adenomas of any size may be treated by TEM including circumferential lesions. The only limiting factor is the ability to control the proximal margin for both dissection and closure of the wound. Because dissection is in a submucosal plane, lesions of any level can be excised.

A LAR is performed via an abdominal incision. The blood supply and lymphatic drainage of the rectum are ligated high and the rectum, including node bearing fat in the mesorectum, are excised to include at least a 2-5 cm margin of normal rectum. For distal and middle rectal cancers a total mesorectal excision is performed. The anastomosis may be performed either by traditional hand-sewn techniques or an
intra-luminal circular stapler. The lower the resection, the more often a temporary, diverting ostomy is used.

An APR is performed via an abdominal and perineal approach. The rectum is mobilized including the mesorectum down to the pelvic floor. Through an elliptical incision around the anus, the anal canal and lower rectum are mobilized to meet the abdominal dissection and the specimen is removed. The transected end of the colon is the brought through the abdominal wall as a permanent stoma. The perineum is usually closed primarily. In this study, a synchronous abdominal and perineal approach was not used.

RESULTS

Demographics: The average ages of the patients were 61 years (range: 41-81), 62 years (range: 38-82) and 59 years (range: 49-92) for TEM, LAR and APR respectively. The distribution of sexes was approximately the same. See TABLE 2.

Tumor location: The average level of the lesions treated by TEM in this study was 8.5 cm (range: 5–13 cm) from the anal verge. The average level of the lesions treated by LAR in this study was 11.1 cm (range: 6-20 cm) from the anal verge. See TABLE 2.

Operative time: In this study the average operative time for TEM was 125 minutes (range: 30-420 minutes). Large adenomas took longer to excise. The average operative time for LAR and APR were 247 (range: 90-600) and 302 (range: 90-420) minutes respectively.

Length of stay: Our length of stay for completed TEM is 1.4 days (range: 1-3) for inpatients. Of the 32 patients, 23 were treated as outpatients with 18 of these patients being discharged from the recovery room. SEE FIGURE 1. For the one converted TEM, the length of stay was 8 days. The length of stay was 8.8 (range: 3-22) days for LAR and 9.1 (range: 5-12) days for APR. SEE FIGURE 3.

Cost: The cost of TEM was markedly lower than the traditional procedures. TEM patients discharged from the recovery room result in an average cost of $6,190. Patients discharged from the short stay floor
cost an average of $8,135. The average cost for inpatients was $10,745. LAR’s and APR’s cost an average
of $34,018 and $37,893 respectively. The only converted case cost $25,682. SEE FIGURE 2.

DISCUSSION:

TEM, like most minimally invasive procedures, has the advantages of decreased length of hospital
stay and decreased pain. It additionally provides better exposure for local excision and decreased
morbidity and mortality [15, 1]. However, other minimally invasive procedures do not have an
unequivocal cost advantage compared to their radical counterparts. SEE TABLE 3.

The disadvantages of TEM include the lack of lymph nodes for prognostic information. Thus
patients are referred for adjuvant therapy or radical resection based on depth of penetration and statistical
probability of nodal involvement; positive margins; lymphatic, vascular, or neural invasion; poor
differentiation; rectal wall penetration; mucinous cells or positive lymph nodes

The advantages of the open procedures are the ability to study the lymph nodes. Disadvantages
include higher mortality and morbidity rates, possible sphincter loss with permanent colostomy, fecal
incontinence and frequency, increased convalescence and pain, risk of genitourinary dysfunction and
longer hospital stay.

Winde, et. al. reported a prospective, randomized trial between TEM and LAR for pT1 lesions of
the rectum. They found local recurrence rates of 4.6% and five-year survivals of 96% for both procedures.
complication rate with similar 5-year survival was found in low-risk pT1 lesions. Thus for early selected
lesions, TEM is clearly the optimal procedure.

Many studies have reported the distance of resected lesions from the anal verge. The minimum is
1 cm and the maximum 25 cm from the anal verge. [3, 10, 14, 1, 4] This study revealed similar distances.
Higher cancers may best be resected by traditional means as a full-thickness resection is necessary for cure.

The average operative time as reported from previous studies is 80 to 116 minutes. [3, 4, 7, 11,
19, 16] In Winde’s study, average operative times were 149 minutes and 103 minutes for LAR and TEM
respectively. [15] This study revealed an average time of 125 minutes. Shorter operative times equates to
cost savings.
Previous studies have reported the average length of stay to be 0.7 to 8.8 days. [3, 1, 9, 12] The shorter times were reported in American papers. Winde, et. al. found an average length of stay of 15.4 days and 5.7 days for anterior resection and TEM respectively. [15] Length of stay is the most important factor in determining cost. TEM clearly has a short length of stay. In fact, it can be performed as ambulatory surgery. Most of the TEM patients were treated as outpatients cutting cost by two-thirds. The single conversion did not affect cost significantly.

For TEM, usually general anesthesia by endotracheal tube is used. However, local with sedation, spinal or epidural regional anesthesia can be used successfully. This is an attractive option in patients who are a high anesthetic risk, which is also an indication for this procedure in and of itself. LAR and APR categorically necessitate general anesthesia by endotracheal tube.

In this study 94% (31/33) of the attempted TEM’s, 100% of the LAR’s and 100% of the APR’s were under general anesthesia. Local anesthesia was used in 3% (1/33) and epidural anesthesia was used in 3% (1/33) of the TEM patients. None of the APR or LAR patients were given regional anesthesia. There were no known complications directly related to anesthesia alone in TEM.

Close postoperative surveillance is necessary to detect recurrence. Using a combination of history, physical examination, laboratory studies, endoscopy, and ultrasound may allow early detection. Recurrence is usually local. Even with carcinoma, studies reveal early detection affords the opportunity for a radical salvage operation.

Certain cost factors were not included in this study. However, the patients undergoing TEM would have greater costs savings if quality of life, recovery time, return to work, pain medication usage and work restrictions were included. Many patients who have LAR or APR elect to take early retirement or disability. This doesn’t happen after TEM.

Clearly the initial investment needed for the equipment is an issue. It is noted that the equipment is reusable and durable. Even though it is complex, the learning curve is quickly achieved especially with those surgeons already facile in other minimally invasive techniques.
CONCLUSIONS:

It is concluded that TEM is a low cost means for treatment of selected tumors of the rectum. This includes benign and malignant tumors. The procedure allows the outpatient resection of tumors otherwise relegated to a costly operative procedure with the additional morbidity and mortality of open surgery. When approaching these select lesions, TEM should be considered a cheaper, safer procedure.
LEGEND

TABLE 1     Criteria and Indications for T.E.M.
TABLE 2     Patient Demographics
TABLE 3     Advantages of T.E.M.
FIGURE 1    Discharge Status of T.E.M. Patients
FIGURE 2    Average Cost of Procedures
FIGURE 3    Average Number of Inpatient Days
## TABLE 1
CRITERIA AND INDICATIONS FOR T.E.M.

<table>
<thead>
<tr>
<th>Indications for possible cure in cancer:</th>
<th>Other indications in cancer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancers 4 – 20 cm from the anal verge</td>
<td>Patients unwilling to undergo conventional surgery</td>
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<tr>
<td>Well to moderate differentiation</td>
<td>Patients unable to undergo radical surgery</td>
</tr>
<tr>
<td>No vascular, lymphatic, neural invasion</td>
<td>Palliation of bleeding or obstruction</td>
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<td>Mobile by digital exam</td>
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<tr>
<td>Less than 3 cm</td>
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<td>uT1 or uT2, N0 by transanal ultrasound</td>
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<table>
<thead>
<tr>
<th>Indications in adenomas:</th>
<th>Other indications and uses:</th>
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<tbody>
<tr>
<td>Lesions 4 – 25 cm from the anal verge</td>
<td>Rectal prolapse</td>
</tr>
<tr>
<td>Any size (even circumferetial)</td>
<td>Resection of benign tumors (e.g. lipomas, carcinoids)</td>
</tr>
<tr>
<td></td>
<td>Rebiopsy of suspicious sites</td>
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<td></td>
<td>Strictures</td>
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<td></td>
<td>Flap closure of high fistulas</td>
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<td></td>
<td>Treatment of synchronous colorectal lesions</td>
</tr>
<tr>
<td></td>
<td>Full thickness biopsies of rectum (e.g. Hirschsprung’s)</td>
</tr>
</tbody>
</table>
### TABLE 2

**PATIENT DEMOGRAPHICS**

<table>
<thead>
<tr>
<th></th>
<th>NUMBER</th>
<th>MALE</th>
<th>MEAN AGE (years)</th>
<th>MEAN O.R. TIME (minutes)</th>
<th>MEAN LEVEL (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEM</td>
<td>32</td>
<td>20</td>
<td>61</td>
<td>125</td>
<td>8.5</td>
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<tr>
<td>LAR</td>
<td>27</td>
<td>11</td>
<td>62</td>
<td>247</td>
<td>11.1</td>
</tr>
<tr>
<td>APR</td>
<td>13</td>
<td>5</td>
<td>59</td>
<td>302</td>
<td>------</td>
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### TABLE 3

**ADVANTAGES OF T.E.M.**

<table>
<thead>
<tr>
<th>Advantage</th>
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<tbody>
<tr>
<td>Decreased convalescence</td>
</tr>
<tr>
<td>Decreased pain</td>
</tr>
<tr>
<td>Decreased length of stay</td>
</tr>
<tr>
<td>Decreased cost</td>
</tr>
<tr>
<td>Decreased morbidity</td>
</tr>
<tr>
<td>Decreased mortality</td>
</tr>
<tr>
<td>More precise excision via optics and exposure</td>
</tr>
<tr>
<td>No erectile or ejaculatory dysfunction</td>
</tr>
</tbody>
</table>
FIGURE 1

DISCHARGE STATUS OF TEM PATIENTS
FIGURE 2

AVERAGE COST OF PROCEDURES
FIGURE 3

AVERAGE NUMBER OF INPATIENT DAYS
REFERENCES


