

Comparative Study of Voiding and
Sexual Function between Open and
Laparoscopic Total Mesorectal Excision
in Patients with Rectal Cancer

Hyuk Hur

Department of Medicine

The Graduate School, Yonsei University

Comparative Study of Voiding and Sexual Function between Open and Laparoscopic Total Mesorectal Excision in Patients with Rectal Cancer

Directed by Professor Nam Kyu Kim

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This certifies that the Master's Thesis
of Hyuk Hur is approved.

Thesis Supervisor : Nam Kyu Kim

Thesis Committee Member : Young Deuk Choi

Thesis Committee Member : Young Tae Kim

The Graduate School
Yonsei University

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TABLE OF CONTENTS

ABSTRACT	1
I. INTRODUCTION.....	4
II. MATERIALS AND METHODS	6
1. Patients	6
2. Surgical procedure	7
3. Assessment of voiding function.....	8
4. Assessment of sexual function.....	9
5. Statistical analysis	11
III. RESULTS	11
1. Patients	11
2. International Prostatic Symptom Score (IPSS).....	13
3. Uroflowmetry data.....	14
4. International Index of Erectile Function (IIEF).....	16
IV. DISCUSSION	19
V. CONCLUSION	26
REFERENCES	28
ABSTRACT(IN KOREAN)	34

LIST OF FIGURES

Figure 1. Changes of IPSS in overall voiding function before and after surgery	13
Figure 2a. Changes of uroflowmetric findings before and after surgery (peak flow rate).....	14
Figure 2b. Changes of uroflowmetric findings before and after surgery (voiding volume).....	15
Figure 2c. Changes of uroflowmetric findings before and after surgery (residual volume)	15
Figure 3. Changes of IIEF in overall sexual function before and after surgery	17
Figure 4. Changes in IIEF domain score before and after surgery (erectile function).....	17
Figure 5. Changes in ejaculation ability before and after surgery.....	18

LIST OF TABLES

Table 1. Patient characteristics	12
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ABSTRACT

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Voiding and sexual dysfunction are common complication after rectal cancer surgery. The aim of this study was to evaluate and compare these functional outcomes between open and laparoscopic surgery. 97 patients (62 male and 35 female) who underwent open (N=41) or laparoscopic (lapa) (N=56) surgery for rectal cancer were prospectively enrolled between April 2008 and August 2009. We performed urine flowmetry and standard questionnaires using the International Prostate Symptom Score (IPSS), the International Index of

Erectile Function (IIEF). All study and questionnaires were performed preoperatively and one month, 3 months, 6 months, and 12 months after surgery. Overall voiding function score increased one month after surgery (open: 9.3 ± 4.6 to 14.0 ± 8.2 , lapa: 8.3 ± 5.3 to 12.3 ± 5.2 ; $P=0.002$, $P<0.001$, respectively), and after 6 months, the score still increased in both groups, but had no statistical significance (open: 9.9 ± 4.5 , lapa: 9.2 ± 5.6 ; $P=0.546$, $P=0.280$, respectively). After 12 months, the score was similar with preoperative status (open: 9.6 ± 5.3 , lapa: 8.4 ± 4.6 ; $P=0.760$, $P=0.815$, respectively). Significant decrease in peak flow rate and voiding volume were seen until 6 months after surgery, but recovery was observed after 12 months in both groups. Residual volume increased until 6 months after surgery, but returned to preoperative status after 12 months. In 33 male patients, overall sexual function and domain scores were significantly decreased after surgery in both groups. Overall sexual function score showed recovery as time passes, but significantly decreased until 12 months after open surgery (N=17) (before: 55.2 ± 9.8 , one month: 20.9 ± 13.7 , 6 months: 42.7 ± 16.8 , 12 months: 48.7 ± 15.9). In laparoscopic surgery group (N=16), overall sexual function also decreased until 6 months after surgery, but showed similar status at 12 months (before: 55.4 ± 9.0 , one month: 21.7 ± 11.2 , 6 months: 48.7 ± 12.9 , 12 months: 52.2 ± 11.7).

Domain scores including erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall satisfaction showed the similar pattern. Significant differences in sexual function, in both overall score and individual symptom scores, were detected at 6 months after surgery between laparoscopic and open groups, but there are no significant differences at other time points. Of 33 patients who had normal ejaculation ability before surgery, 26 patients (79%) {open: 13 (76.5%), lapa: 13 (81.3%)} showed normal function after 12 months. Voiding and male sexual function significantly decreased after both open and laparoscopic surgery. Voiding function recovered after 6 months in both groups, but sexual function recovered more quickly in the laparoscopic group and returned to preoperative status after 12 months. Laparoscopic rectal cancer surgery showed similar outcomes in voiding function compared with open surgery and a trend of early recovery in sexual function.

Key words : rectal cancer, total mesorectal excision, laparoscopic surgery, voiding function, sexual function

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I. INTRODUCTION

The primary goal of rectal cancer surgery is to insure complete excision of tumor, to minimize local recurrence, and to prolong survival. In addition, the preservation of quality of life including voiding and sexual function is a major concern of surgery. Voiding and sexual dysfunction are common problems resulting from injury to the pelvic autonomic nerve during rectal resection.

Currently total mesorectal excision (TME) represents the standard operative

procedure for treatment of rectal cancer. In the TME technique, the rectum is mobilized circumferentially under direct vision, with sharp dissection between the parietal and visceral planes of the pelvic fascia. This procedure has permitted a reduction in the local recurrence rate and minimized voiding and sexual dysfunction with an awareness of the pelvic autonomic nerve pathways¹⁻⁴. These dysfunction usually arises from injury to the autonomic nerves in the pelvis and along the distal aorta. Autonomic nerves, containing sympathetic and parasympathetic fibers, could be damaged differently depending on the type of operation performed, the plane of dissection, the ligation level of the inferior mesenteric artery, the degree of preservation of the autonomic nerves, and the extent of pelvic dissection⁵⁻¹⁰.

Before the introduction of TME, the incidence of postoperative voiding and sexual dysfunction was high with rates reported from 10–30% and 40–60% respectively¹¹⁻¹⁴. Recent studies which perform the autonomic nerve preservation with TME have demonstrated that the incidence of voiding and sexual dysfunction has decreased to the range of 0-12%, and 10-35%, respectively^{6-10,15,16}.

Laparoscopic TME for rectal cancer is technically feasible, offering acceptable complication rates and short-term oncologic outcomes comparable to those of

open surgery¹⁷⁻²¹. Laparoscopic surgery, although technically demanding and associated with a long learning curve, has the advantage of clear and magnified visualization for the smallest structures, and may allow for easier identification and preservation of the autonomic nerves in narrow pelvis. However, there has been little literature about the incidence of voiding and sexual dysfunction after laparoscopic TME. Previous studies that compared laparoscopic TME with open TME have shown that laparoscopic TME may be associated with increased rates of sexual dysfunction, and, but no differences in voiding dysfunction²²⁻²⁵. This prospective clinical study aimed to evaluate voiding and sexual function of patients who underwent laparoscopic TME for rectal cancer in comparison with conventional open TME.

II. MATERIALS AND METHODS

1. Patients

From April 2008 to August 2009, 97 patients with the diagnosis of rectal cancer were included in this study. This study was non-randomized, open, controlled trial and patients were assigned for elective conventional or laparoscopic surgery for rectal cancer. Preoperative evaluations consisted

of history taking, physical examination, carcinoembryonic antigen (CEA) level, peripheral blood test, colonoscopy, abdomino-pelvic computed tomography and rectal magnetic resonance imaging. Patients received preoperative chemoradiation therapy were also included in this study. Informed consent was obtained from each patient. The study was approved by the Institutional Review Board.

2. Surgical procedure

The surgical technique of total mesorectal excision and autonomic nerve preservation was same in either conventional open and laparoscopic procedure. For port placements in laparoscopic procedure, an initial 12-mm port placement was carried out using the open technique, and pneumoperitoneum was accomplished using carbon dioxide. A standard 10-mm laparoscope was inserted through the 12-mm trocar, and then two 5-mm ports were inserted in the upper right and left abdominal quadrants and two more 12-mm ports were placed in the lower right and left abdominal quadrants under laparoscopic guidance.

Autonomic nerve preservation consists of the identification and preservation of the superior hypogastric plexus, the bilateral hypogastric nerves and sacral

splanchnic nerves (nervi erigentes), together with the pelvic autonomic nerve plexus (inferior hypogastric plexus). The plane of pelvic dissection was chosen along the parietal pelvic fascia, leaving the hypogastric nerve over the aorta. The left and right hypogastric nerves were identified at the level of the aortic bifurcation. In doing lateral dissection, the intact mesorectum was separated from the pelvic autonomic nerve plexus, leaving the sacral splanchnic nerve and the pelvic autonomic nerve plexus undamaged on the lateral pelvic wall. At the level of the fourth sacral vertebra, the rectosacral fascia was divided sharply, creating an easy opening of the retrorectal space up to the anal sphincter. (In all selected cases a clear oncologic distal and lateral margin was obtained after completion of pelvic dissection.)

3. Assessment of voiding function

All patients who filled out questionnaires underwent follow-up examinations at certain times after surgical resection. The questionnaire used was based on the International Prostatic Symptom Score (IPSS)²⁶. Further subdivisions were added to seven items, which included incomplete bladder emptying, frequency, intermittency, urgency, weak stream, straining, and nocturia. The scoring system for voiding function described above was based on a 0 to 5 scale, as

follows: 0, not at all; 1, less than 1 time in 5; 2, less than half the time; 3, about half the time; 4, more than half the time; and 5, almost always. IPSS was calculated by adding the item scores. The sum of scores for no symptoms is 0 and 35 for maximum symptoms. Patients with a relevant past history, such as benign prostate hyperplasia or previous history of urinary bladder or prostate gland operation, were excluded. Peak urine flow rate, voiding volume and residual urine volume were confirmed both preoperatively and postoperatively. The peak urine flow rate was carried with a Urodyn® (Dantec, Copenhagen, Denmark) flow meter and residual urine volume by ultrasonography at 3.5 mHz (Brüeland and Kjær, Nærum, Denmark). All evaluations including questionnaire and uroflowmetry were performed preoperatively, 1 month, 3 months, 6 months, and 12 months after operation.

4. Assessment of sexual function

The questionnaire was based on the International Index of Erectile Function (IIEF)²⁷. Fifteen items were checked, including erectile frequency, erection firmness, penetration ability, maintenance frequency, maintenance ability, intercourse frequency, intercourse satisfaction, intercourse enjoyment, ejaculation frequency, orgasm frequency, desire frequency, desire level,

overall satisfaction, relationship satisfaction, and erection evidence. The scoring systems were from 0 to 5 (0, none; 1, almost; 2, a few; 3, sometimes; 4, most times; 5, almost always) on each of 10 items and from 1 to 5 (1, very low; 2, low/a few; 3, moderate; 4, most/high; 5, very high/almost always) on each of 5 items. Based on a 15-item analysis, five response domains were identified: 1) erectile function, 2) orgasmic function, 3) intercourse satisfaction, 4) sexual desire, and 5) overall satisfaction. Erectile function included the following items: erection frequency, penetration ability, maintenance frequency, maintenance ability, and erection firmness. Intercourse satisfaction items included intercourse frequency, intercourse satisfaction, and intercourse enjoyment. Orgasmic function included two items: ejaculation frequency and orgasm frequency. Sexual desire included desire frequency and desire level. Overall satisfaction was assessed using overall satisfaction and relation satisfaction. IIEF domain scores were computed by adding the scores of individual items in each domain. Overall male function scores were calculated by combining domain scores. All the questionnaires were performed before and 1 month, 3 months, 6 months, and 12 months after surgery and the total score of each domain was compared before and after operation.

5. Statistical analysis

Statistical analysis was carried out using SPSS 12.0 for Windows (SPSS Inc., Chicago, IL, USA). Student t-test for continuous variables and chi-square test for categorical variables were used for statistical comparison of clinical characteristics. Differences of scores for bladder function and sexual function between before and after operation within each groups was tested with the paired t-test. Differences of scores in bladder and sexual function at any time point between the laparoscopic and open surgery groups were compared using student t-test. A value of $P < 0.05$ was considered significant.

III. RESULTS

1. Patients

A total of 97 patients were recruited in this study. 41 patients received open surgery and 56 patients received laparoscopic surgery. The Questionnaires and uroflowmetric analysis were completed in all patients until 12 months after surgery. The two groups were comparable in terms of age, sex, tumor location, type of operation, pathologic stages. Preoperative or postoperative chemoradiation therapy also showed no significant difference between two

groups. A summary of patient characteristics comparing open and laparoscopic surgeries is shown in Table 1.

Table 1. Patient characteristics

Variables	Open TME (N=41)	Laparoscopic TME (N=56)	P
Mean age (yr) (range)	55 (28-74)	58 (30-74)	NS
Sex			
Male	26(63.4)	36 (64.3)	NS
Female	15 (36.6)	20 (35.7)	
Tumor location			
Upper (>10cm)	7 (17.1)	10 (17.9)	NS
Middle (5-10cm)	23 (56.1)	35 (62.5)	
Low (<5cm)	11 (26.8)	11 (19.6)	
Type of operation			
LAR	35 (85.4)	52 (92.9)	NS
uLAR with CAA	6 (14.6)	4 (7.1)	
Pathologic stage			
0	3 (7.5)	2 (3.6)	NS
I	7 (17.5)	16 (29.1)	
II	12 (30.0)	14 (25.5)	
III	13 (32.5)	20 (36.4)	
IV	5 (12.5)	3 (5.5)	
Adjuvant Treatment			
Preop. CRT	13 (31.7)	13 (23.2)	NS
Postop.CRT	7 (17.1)	9 (16.1)	
No CRT	21 (51.2)	34 (60.7)	

TME, total mesorectal excision; LAR, low anterior resection, uLAR, ultra low anterior resection; CAA, coloanal anastomosis; CRT, chemoradiotherapy; Numbers in parenthesis are percentages

2. International Prostatic Symptom Score (IPSS)

The overall symptom scores in both groups were increased one month after surgery (open: 9.3 ± 4.6 to 14.0 ± 8.2 , lapa: 8.3 ± 5.3 to 12.3 ± 5.2 ; $P=0.002$, $P<0.001$, respectively) and 6 months after surgery, IPSS still increased in both groups, but had no statistical significance (open: 9.9 ± 4.5 , lapa: 9.2 ± 5.6 ; $P=0.546$, $P=0.280$). At 12 months after surgery, IPSS was similar with preoperative status (open: 9.6 ± 5.3 , lapa: 8.4 ± 4.6 ; $P=0.760$, $P=0.815$) (Fig 1). Individual symptom scores showed similar trends to the overall symptom scores. No differences in voiding function, either in overall score or in individual symptom scores, were detected at any time point between the laparoscopic and open surgery groups.

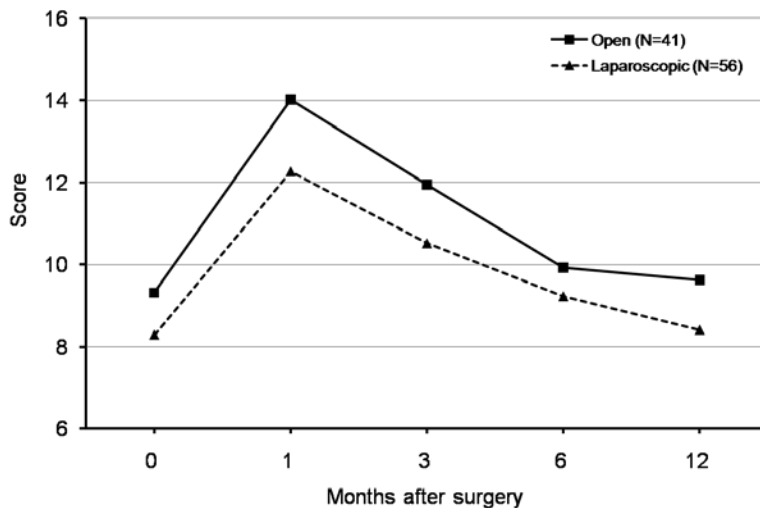


Fig 1. Changes of IPSS in overall voiding function before and after surgery.

3. Uroflowmetry data

Three factors must be considered when assessing urine flowmetric data: mean maximal flow rate or Qmax (ml/s), mean voiding volume or Vcomp (ml), and mean residual volume or RV (ml). Significant decrease in peak flow rate was seen until 6 months after surgery, but recovery was observed at 12 months in both open (before: 20.3 ± 4.2 , one month: 12.5 ± 10.6 , 6 months: 17.5 ± 9.8 , 12 months: 20.3 ± 5.5) and lapa group (before: 21.5 ± 4.2 , one month: 13.9 ± 10.6 , 6 months: 19.5 ± 9.8 , 12 months: 21.5 ± 5.5) (Fig 2a). Voiding volume also decreased until 6 months after surgery, but returned to preoperative status at 12 months in both groups (Fig 2b). Residual volume also increased until 6 months

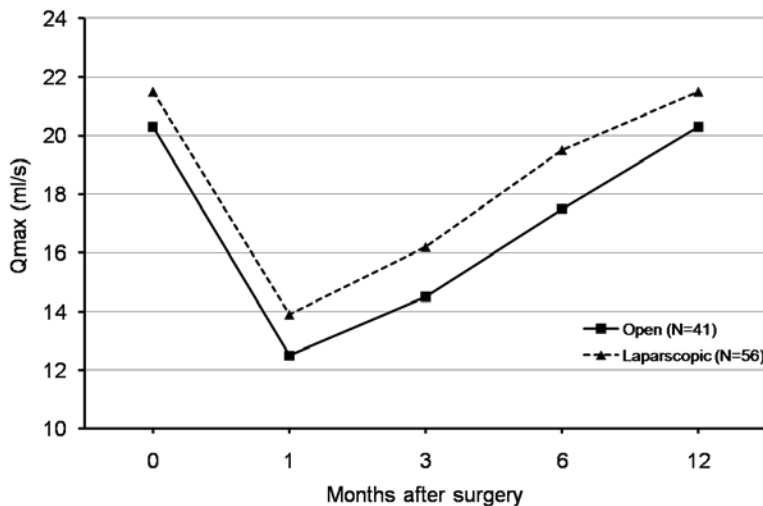


Fig 2a. Changes of uroflowmetric findings before and after surgery (peak flow rate).

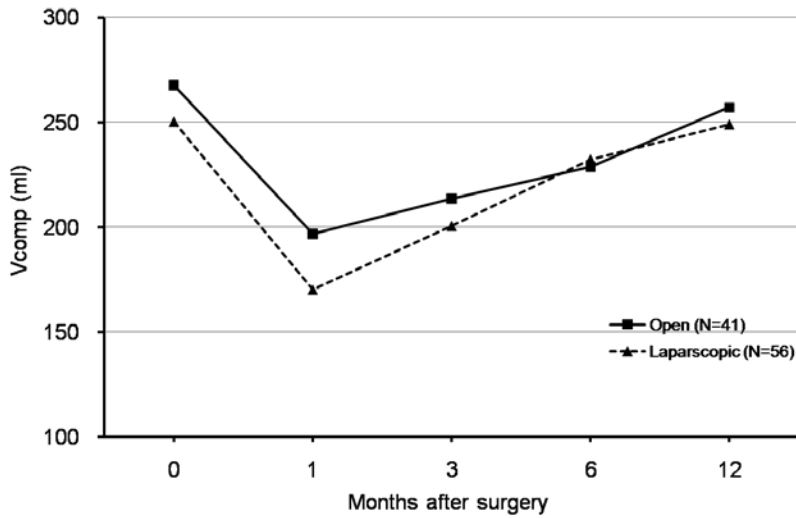


Fig 2b. Changes of uroflowmetric findings before and after surgery (voiding volume).

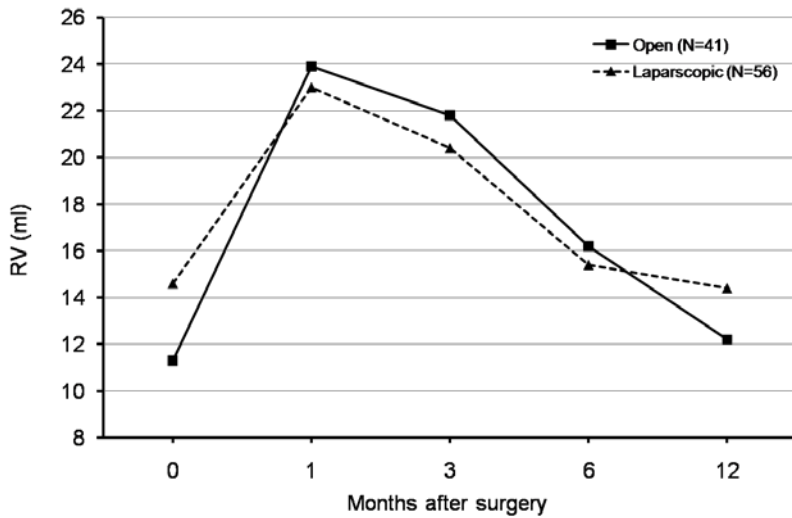


Fig 2c. Changes of uroflowmetric findings before and after surgery (residual volume).

after surgery but returned to preoperative status at 12 months in both open

(before: 11.3 ± 4.2 , one month: 23.9 ± 10.6 , 6 months: 16.2 ± 9.8 , 12 months: 12.2 ± 5.5) and lapa group (before: 14.6 ± 4.2 , one month: 23 ± 10.6 , 6 months: 15.4 ± 9.8 , 12 months: 14.4 ± 5.5) (Fig 2c).

4. International Index of Erectile Function (IIEF)

Overall sexual function and domain scores were significantly decreased after surgery. Overall sexual function score showed recovery as time passes, but significantly decreased until 12 months after open surgery (N=17) (before: 55.2 ± 9.8 , 1 month: 20.9 ± 13.7 , 6 months: 42.7 ± 16.8 , 12 months: 48.7 ± 15.9). In laparoscopic surgery group (N=16), overall sexual function also decreased until 6 months after surgery, but showed similar status at 12 months (before: 55.4 ± 9.0 , one month: 21.7 ± 11.2 , 6 months: 48.7 ± 12.9 , 12 months: 52.2 ± 11.7) (Fig 3). Erectile function score showed a trend to be worse after open rectal resection, similar to overall function score. Erectile function significantly decreased until 12 months after open surgery (before: 24.5 ± 4.2 , one month: 10.1 ± 10.6 , 6 months: 13.0 ± 9.8 , 12 months: 21.5 ± 5.5). In laparoscopic surgery group (N=16), erectile function also decreased until 6 months after surgery, but showed similar status at 12 months (before: 24.4 ± 6.0 , one month: 9.9 ± 7.8 , 6 months: 20.3 ± 6.8 , 12 months: 22.8 ± 7.7) (Fig 4).

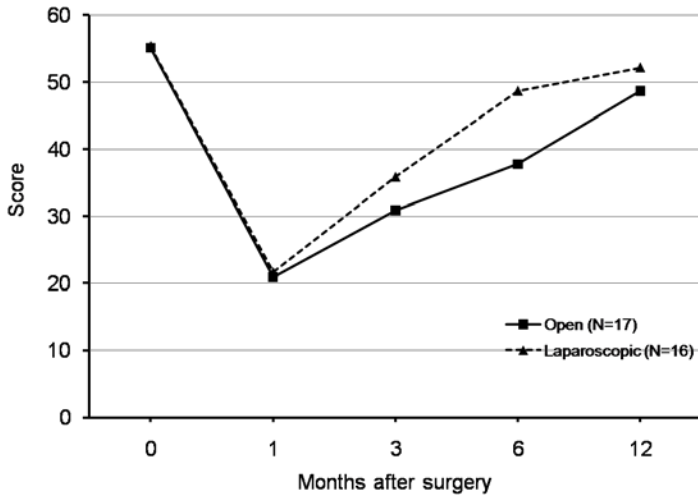


Fig 3. Changes of IIEF in overall sexual function before and after surgery.

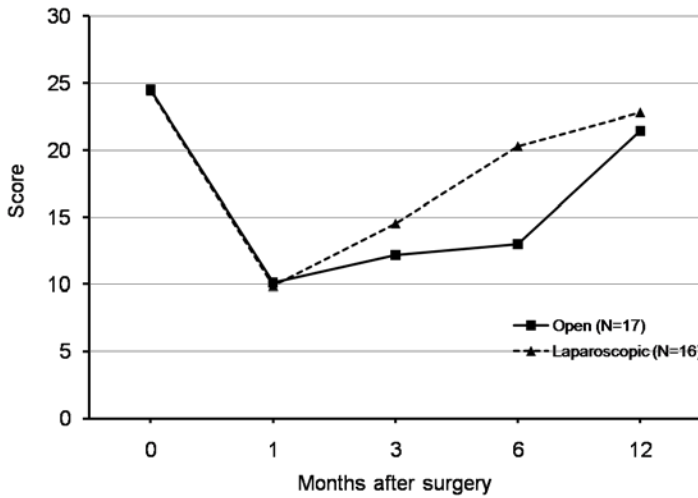


Fig 4. Changes in IIEF domain score before and after surgery (erectile function).

Other domains of sexual function including orgasmic function, sexual desire,

intercourse satisfaction, and overall satisfaction showed the similar pattern with erectile function. All domain scores significantly decreased until 12 months after open surgery but, in laparoscopic surgery group, scores decreased until 6 months after surgery, but showed similar status at 12 months. Significant differences in sexual function, either in overall score or in individual symptom scores, were detected at 6 months after surgery between the laparoscopic and open surgery groups. But, there is no significant differences at other time points.

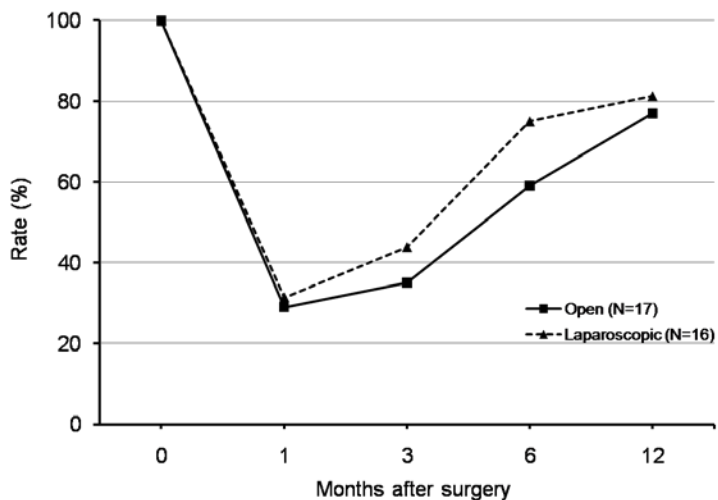


Fig 5. Changes in ejaculation ability before and after surgery.

Of 33 patients (open: 17, lapa: 16) who had normal ejaculation ability before surgery, 10 patients {open: 5 (29.4%), lapa: 5 (31.3%)} showed normal

function at one month after surgery, and 26 patients (78.8%) {open: 13 (76.5%), lapa: 13 (81.3%)} at 12 months after surgery (Fig 5).

IV. DISCUSSION

During the procedure of rectal cancer surgery, there are important steps require attention to avoid autonomic nerve injury. The preaortic plexus may be damaged during ligation of the inferior mesenteric artery (IMA) at its origin on the anterior surface of the aorta. The superior hypogastric plexus and the origin of the hypogastric nerves may be damaged during posterior dissection in front of the aorta and sacrum. Damage at this site can be avoided by the use of sharp dissection under direct vision with either diathermy or scissors. At the level of aortic bifurcation, the superior hypogastric plexus is divided into right and left hypogastric nerve. These nerves go down to the pelvis laterally and join with the pelvic splanchnic nerves (nervi erigentes) to form the inferior hypogastric plexus(pelvic plexus). During pelvic dissection, these nerves can be easily damaged by excessive traction and dissection along the wrong surgical plane. Voiding and sexual function is controlled by sympathetic input from the superior hypogastric plexus and parasymphathetic input from the pelvic

splanchnic nerves. These nerves are susceptible to injury during mesorectal excision of rectal cancer. In simple terms, injury to the sympathetic supply results in bladder instability and ejaculatory difficulties, whereas injury to the parasympathetic supply results in poor detrusor contraction and erectile dysfunction^{23,28}.

Although total autonomic denervation of the bladder after rectal resection is unusual, urodynamic studies show a significant decrease in effective bladder capacity and increases in first sensation to void and residual urinary volume and reported incidences of bladder dysfunction ranged from 10 to 30%¹¹⁻¹⁴. Many of these earlier studies did not use current TME techniques. Since the introduction of TME and the recognized need for autonomic nerve preservation, the incidence of bladder complications appears to have diminished to a level of 0% to 12%^{6-10,15,16}.

Previous comparative studies showed that the incidence of bladder dysfunction was low after both laparoscopic and open approaches, with no difference between the two groups in terms of a change in median IPSS scores for the men and the women. In this study, the voiding function decreased after surgery in both open and laparoscopic surgery groups at the early postoperative status. But, IPSS scores and uroflowmetry data indicated that voiding function

returned to preoperative status gradually, nearly at 6 months and definitely at 12 months after surgery. Only 2 patient (4.9%) in the open TME group and four patients (7.1%) in the laparoscopic TME group had minor urinary dysfunction that did not require long-term intermittent self-catheterization. There was no significant difference between open TME and laparoscopic TME, either in the preoperative occurrence of symptoms or as an consequence of the surgery. These results compares with the findings in previous studies^{22,23}.

In comparison, sexual dysfunction remains a significant problem after TME. This was particularly the case for the 33 sexually active men in the current study. In other studies, the male sexual dysfunction was more common in laparoscopic surgery group compared with open surgery, despite the voiding function is not adversely affected^{22,23}. But, our data demonstrated that laparoscopic surgery group showed better outcomes of sexual function, either overall or domain-specific scores, and earlier recovery to preoperative status until 12 months after surgery. In laparoscopic surgery group after 12 months, 3 (18.7%) male patients experienced overall sexual dysfunction, with the erection problem of 2 patients (12.5%) and ejaculatory problem of 3 patients (18.7%). In open surgery group, the same 4 patients (23.5%) complained of overall sexual dysfunction, erection and ejaculation problem with no

significant difference with laparoscopic TME. These figures compare favorably with those of previous studies using TME that reported male erection problem rate of 10% to 35% and ejaculatory problem rates of 11% to 40%^{6-10,15,16}.

Our experience showed that laparoscopic TME can be performed safely and efficiently by surgeons who have adequate experience with the laparoscopic technique. Laparoscopic TME has some advantages over the open approach. The illuminated and magnified view by laparoscopy helps the operator to identify the interspace of loose connective tissue between the visceral and the parietal pelvic fascia. The 30° laparoscope may serve as the third eye of the surgeon, which can reach the narrow lesser pelvis, breaking through the blind zone and contributing a magnifying effect that makes it easier for the surgeon to identify and protect the pelvic autonomic nerve fiber and plexus.

In this study, voiding function between open and laparoscopic surgery group initially decreased and demonstrated similar recovery pattern postoperatively. Sexual function also initially decreased in both groups, but laparoscopic group showed the earlier recovery and returned to the preoperative status at 12 months postoperatively. The rates of erectile and ejaculatory problems were similar, suggesting that both parasympathetic and sympathetic nerves are

equally at risk of injury and indicating that the most likely site of damage is at the lateral pelvic plexus where both autonomic systems converge. Another explanation attributes this to the proximity of the autonomic nerves in neurovascular bundle anterolaterally to Denonvilliers' fascia ^{29,30}. Accurate dissection in this plane can be easier, particularly during laparoscopic surgery, because of magnification features, and this may account for erectile function being the component of male sexual function most commonly affected by open surgery. In the procedure of autonomic nerve preservation, superior hypogastric plexus and hypogastric nerves can be easily identified and preserved, but deep narrow pelvis is always the major concern and pelvic nerve plexus and neurovascular bundle of anterolateral dissection plane are frequently damaged.

Risk factors for voiding and sexual dysfunction may be grouped into three categories: those related to the patient (age, sex, previous illness history related with voiding and sexual function), those related to the tumor (location, stage), and those related to treatments (type of operation, adjuvant treatment, quality of dissection). In this study, patient factor and tumor factor was not different between two groups. There is no difference in operative procedure including low anterior resection and coloanal anastomosis without abdominoperineal

excision, autonomic nerve preservation with TME was performed in all patients of both groups. Adjuvant treatment was, either preoperatively or postoperatively, performed in both groups with similar rate. Therefore, the difference in sexual dysfunction must relate to technical differences between the two surgical approaches.

Some studies have reported the data on sexual dysfunction after laparoscopic TME. Quah et al. described a higher rate of male sexual dysfunction, but not voiding dysfunction after laparoscopic resection than after open resection²². But, all patients with voiding or sexual dysfunction in the laparoscopic group had resection of either bulky or low rectal cancers. So, they suggested that sexually active males with bulky or low rectal cancers need to be considered by this results, when deciding the best operative approach.

Jayne et al. provided the only RCT report of genitourinary function from the CLASICC trial's patients, with a >50% overall questionnaire response rate^{23,31}. This report found no difference in the bladder function between the laparoscopic and open groups. In men, overall sexual function and erectile function tended to be worse after laparoscopic than open rectal surgery. The only factors significantly associated with the occurrence of post-operative sexual disorders were the performance of TME (more frequent in the

laparoscopic group) and the need to convert to open surgery. One possible explanation for this correlation could be the technical difficulties in laparoscopic TME, particularly for low-lying, anterior or bulky tumors.

Attention to autonomic nerve preservation is of paramount importance, particularly in low rectal resection, if voiding and sexual dysfunction is to be avoided. Especially anterior and posterior dissection plane are important to prevent the injury of pelvic plexus and neurovascular bundle. On the lateral wall of the pelvis, direct injury to pelvic plexus give rise to both voiding and sexual dysfunction due to combined sympathetic and parasympathetic denervation. Efferent branches of the inferior hypogastric plexus are responsible for nearly the entire innervation of the genito-urinary organs: these secondary visceral plexuses give rise to the rectal, uretero-vesical, vesiculo-deferential, prostatic, utero-vaginal and cavernous nerves. The efferent branches of the pelvic plexus are mixed, containing both sympathetic and parasympathetic fibers. Located 10 and 2 o' clock lateral and posterior to the prostatic capsule, very close to the anterolateral aspect of the lower rectum at the level of the seminal vesicles, they run within the neurovascular bundles of Walsh separate from Denonvilliers' fascia. During anterior dissection of the rectum, injury to the cavernous fibers and other efferent branches of the pelvic

plexus are responsible for the majority of sexual dysfunction sequelae. Heald has rightly underlined the importance of dissecting anterior to Denonvilliers' fascia as distally as necessary to keep an anterior security margin but in front of the base of the prostate to avoid injury to the cavernous fibers³². But, in another report, after performing this dissection plane, higher incidence of sexual dysfunction resulted in 50% of male and 60% of female³³. In contrast, some authors demonstrated that Denonvilliers's fascia lies anterior to the rectal proper fascia and is more closely applied to the prostate than the rectum, and to preserve autonomic nerves, dissection behind Denonvilliers' fascia is required. The nerve damage usually occurred in deep narrow pelvis and a fine dissection is needed for detailed anatomical plane to preserve autonomic nerves. Laparoscopic surgery may introduce the more illuminated and magnified view to make precise dissection to be performed.

V. CONCLUSION

Voiding function and male sexual function significantly decreased after surgery for rectal cancer in open and laparoscopic group. Voiding function recovered to preoperative status at 6months after surgery in both groups with similar trends. For sexual function, the introduction of the laparoscopic

technique enables to achieve the earlier recovery of sexual dysfunction than open surgery. The advantages of laparoscopic technique, namely, improved visibility afforded by a magnified and well illuminated field of view, appear to aid the surgeon when confronted with technical surgical difficulties. The multi-institutional prospective randomized studies are needed to determine the superiority of laparoscopic surgery in rectal cancer for preservation of autonomic nerve and better outcomes in voiding and sexual function.

References

1. Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. *Lancet* 1986;1:1479-82.
2. Enker WE. Potency, cure, and local control in the operative treatment of rectal cancer. *Arch Surg* 1992;127:1396-401; discussion 402.
3. MacFarlane JK, Ryall RD, Heald RJ. Mesorectal excision for rectal cancer. *Lancet* 1993;341:457-60.
4. Enker WE, Thaler HT, Cranor ML, Polyak T. Total mesorectal excision in the operative treatment of carcinoma of the rectum. *J Am Coll Surg* 1995;181:335-46.
5. Heald RJ. The 'Holy Plane' of rectal surgery. *J R Soc Med* 1988;81:503-8.
6. Pocard M, Zinzindohoue F, Haab F, Caplin S, Parc R, Tiret E. A prospective study of sexual and urinary function before and after total mesorectal excision with autonomic nerve preservation for rectal cancer. *Surgery* 2002;131:368-72.
7. Masui H, Ike H, Yamaguchi S, Oki S, Shimada H. Male sexual function after autonomic nerve-preserving operation for rectal cancer. *Dis Colon Rectum* 1996;39:1140-5.

8. Maas CP, Moriya Y, Steup WH, Kiebert GM, Kranenbarg WM, van de Velde CJ. Radical and nerve-preserving surgery for rectal cancer in The Netherlands: a prospective study on morbidity and functional outcome. *Br J Surg* 1998;85:92-7.
9. Nesbakken A, Nygaard K, Bull-Njaa T, Carlsen E, Eri LM. Bladder and sexual dysfunction after mesorectal excision for rectal cancer. *Br J Surg* 2000;87:206-10.
10. Havenga K, Enker WE, McDermott K, Cohen AM, Minsky BD, Guillem J. Male and female sexual and urinary function after total mesorectal excision with autonomic nerve preservation for carcinoma of the rectum. *J Am Coll Surg* 1996;182:495-502.
11. Chang PL, Fan HA. Urodynamic studies before and/or after abdominoperineal resection of the rectum for carcinoma. *J Urol* 1983;130:948-51.
12. Fazio VW, Fletcher J, Montague D. Prospective study of the effect of resection of the rectum on male sexual function. *World J Surg* 1980;4:149-52.
13. Kinn AC, Ohman U. Bladder and sexual function after surgery for rectal cancer. *Dis Colon Rectum* 1986;29:43-8.

14. Santangelo ML, Romano G, Sassaroli C. Sexual function after resection for rectal cancer. *Am J Surg* 1987;154:502-4.
15. Enker WE, Havenga K, Polyak T, Thaler H, Cranor M. Abdominoperineal resection via total mesorectal excision and autonomic nerve preservation for low rectal cancer. *World J Surg* 1997;21:715-20.
16. Kim NK, Aahn TW, Park JK, Lee KY, Lee WH, Sohn SK, et al. Assessment of sexual and voiding function after total mesorectal excision with pelvic autonomic nerve preservation in males with rectal cancer. *Dis Colon Rectum* 2002;45:1178-85.
17. Lelong B, Bege T, Esterni B, Guiramand J, Turrini O, Moutardier V, et al. Short-term outcome after laparoscopic or open restorative mesorectal excision for rectal cancer: a comparative cohort study. *Dis Colon Rectum* 2007;50:176-83.
18. Lezoche E, Guerrieri M, De Sanctis A, Campagnacci R, Baldarelli M, Lezoche G, et al. Long-term results of laparoscopic versus open colorectal resections for cancer in 235 patients with a minimum follow-up of 5 years. *Surg Endosc* 2006;20:546-53.
19. Morino M, Allaix ME, Giraud G, Corno F, Garrone C. Laparoscopic

- versus open surgery for extraperitoneal rectal cancer: a prospective comparative study. *Surg Endosc* 2005;19:1460-7.
20. Pikarsky AJ, Rosenthal R, Weiss EG, Wexner SD. Laparoscopic total mesorectal excision. *Surg Endosc* 2002;16:558-62.
 21. Zhou ZG, Hu M, Li Y, Lei WZ, Yu YY, Cheng Z, et al. Laparoscopic versus open total mesorectal excision with anal sphincter preservation for low rectal cancer. *Surg Endosc* 2004;18:1211-5.
 22. Quah HM, Jayne DG, Eu KW, Seow-Choen F. Bladder and sexual dysfunction following laparoscopically assisted and conventional open mesorectal resection for cancer. *Br J Surg* 2002;89:1551-6.
 23. Jayne DG, Brown JM, Thorpe H, Walker J, Quirke P, Guillou PJ. Bladder and sexual function following resection for rectal cancer in a randomized clinical trial of laparoscopic versus open technique. *Br J Surg* 2005;92:1124-32.
 24. Morino M, Parini U, Allaix ME, Monasterolo G, Brachet Contul R, Garrone C. Male sexual and urinary function after laparoscopic total mesorectal excision. *Surg Endosc* 2009;23:1233-40.
 25. Asoglu O, Matlim T, Karanlik H, Atar M, Muslumanoglu M, Kapran Y, et al. Impact of laparoscopic surgery on bladder and sexual function

- after total mesorectal excision for rectal cancer. *Surg Endosc* 2009;23:296-303.
26. Barry MJ, Fowler FJ, Jr., O'Leary MP, Bruskewitz RC, Holtgrewe HL, Mebust WK, et al. The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. *J Urol* 1992;148:1549-57; discussion 64.
 27. Rosen RC, Riley A, Wagner G, Osterloh IH, Kirkpatrick J, Mishra A. The international index of erectile function (IIEF): a multidimensional scale for assessment of erectile dysfunction. *Urology* 1997;49:822-30.
 28. Keating JP. Sexual function after rectal excision. *ANZ J Surg* 2004;74:248-59.
 29. Lindsey I, Warren BF, Mortensen NJ. Denonvilliers' fascia lies anterior to the fascia propria and rectal dissection plane in total mesorectal excision. *Dis Colon Rectum* 2005;48:37-42.
 30. Kinugasa Y, Murakami G, Uchimoto K, Takenaka A, Yajima T, Sugihara K. Operating behind Denonvilliers' fascia for reliable preservation of urogenital autonomic nerves in total mesorectal excision: a histologic study using cadaveric specimens, including a

- surgical experiment using fresh cadaveric models. *Dis Colon Rectum* 2006;49:1024-32.
31. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005;365:1718-26.
 32. Heald RJ, Moran BJ, Brown G, Daniels IR. Optimal total mesorectal excision for rectal cancer is by dissection in front of Denonvilliers' fascia. *Br J Surg* 2004;91:121-3.
 33. Liang JT, Lai HS, Cheng KW. Laparoscopic dissection of Denonvilliers' fascia and implications for total mesorectal excision for treatment of rectal cancer. *Surg Endosc* 2010.

ABSTRACT(IN KOREAN)

직장암환자의 전직장간막절제술 후 배뇨기능 및 성기능 변화에 대한
개복 수술과 복강경 수술의 비교분석

<지도교수 김남규>

연세대학교 대학원 의학과

허 혁

직장암 수술은 근치적 절제와 삶의 질과 관련된 수술 후 성기능 및 배뇨기능의 보존이 중요하다. 직장암의 복강경수술이 널리 시행되고 있으나 기능적 측면에서 개복수술에 대한 비교평가는 아직 명확하지 않다. 본 연구는 직장암의 복강경수술과 개복수술 후 성기능 및 배뇨기능의 변화에 차이가 있는지를 보고자 하였다. 2008년 4월부터 2009년 8월까지 직장암으로 진단받고 전직장간막 절제술을 시행한 97명의 환자를 전향적 연구분석 하였다. 41명은 개복수술, 56명은

복강경 수술을 시행 하였다. 모든 환자에서 국제 전립선 증상 점수 (International Prostate Symptom Score, IPSS)를 이용한 배뇨기능 설문평가를 하였고 33명의 남자환자에서는 국제 발기 기능 지수 (International Index of Erectile Function, IIEF)를 이용하여 성 기능 설문평가를 하였다. 설문조사는 수술 전, 수술 후 1개월, 3개월, 6개월, 12개월에 시행하였다. IPSS 는 수술 후 1달 뒤 조사 하였을 때 개복수술의 경우 9.3 ± 4.6 에서 12.2 ± 5.0 으로, 복강경수술의 경우 8.3 ± 5.3 에서 13.6 ± 7.6 으로 수술 전과 비교하여 유의한 증가를 보였다(각각, $p=0.008$, $p<0.001$). 6달 후 시행된 IPSS에서는 개복수술 시에 11.0 ± 5.5 이고 복강경수술 시에 9.2 ± 5.6 으로 아직 증가는 있었으나 통계적 차이는 없었다 ($P=0.235$, $P=0.280$). 12개월 후 IPSS는 개복수술이 9.6 ± 5.3 , 복강경수술이 8.4 ± 4.6 으로 수술 전과 거의 같은 점수와 배뇨기능의 회복을 보였다 ($P=0.760$, $P=0.815$). 남자의 발기능력에서는 개복 수술 ($N=17$)의 경우 수술 전 24.5 ± 4.2 에서 수술 1달 후 10.1 ± 10.6 , 6달 후 13.0 ± 9.8 , 12개월 후 21.5 ± 5.5 로 회복되는 양상을 보였으나 통계적으로는 유의한 감소를 지속적으로 보였다 ($P<0.001$, $P<0.001$, $P=0.044$). 복강경 수술

(N=16)의 경우 수술 전 24.4 ± 6.0 에서 수술 1달 후 9.9 ± 7.8 , 6달 후 20.3 ± 6.8 , 12개월 후 21.5 ± 5.5 로 점차 회복되었다 ($P < 0.001$, $P = 0.033$, $P = 0.368$). 수술 12개월 후 정상적인 사정이 가능한 환자는 개복수술에서 77.0%(13/17), 복강경수술에서 81.3%(13/16) 였다. 직장암 수술에서 성기능 및 배뇨기능은 수술 전과 비교하여 수술 3개월 후까지 개복 수술이나 복강경 수술에서 모두 유의한 수준의 저하를 보였다. 배뇨기능은 수술 6개월 후 성기능은 수술 12개월 후 개복수술과 복강경수술 양군 모두에서 수술 전에 비등한 회복을 보였다. 직장암의 전직장간막 절제술시 성기능과 배뇨기능의 보존 측면에서 복강경수술은 개복수술과 대등한 결과를 보였다.

핵심되는 말 : 직장암, 전직장간막절제술, 복강경 수술, 배뇨기능, 성기능.