脈が滑り落ちるとその後の操作が危険である．血管処理に際しては背側にできる限りフリースペースを作って間膜背側の臓器への損傷を避けながら，血管の走行に平行および垂直に交互に鉗子で剝離を進める．超音波凝固切開装置で止血・切離を行う場合でも血管が太い場合は二重三重に血管を凝固してから切離する．また超音波凝固切開装置のアクティブブレードの先端は視野内において，ブラインドで操作して血管や臓器を傷つけないよう心がける．

鉗子はなるべく先端の丸いラチェットのないものを用い，鉗子を通じて組織の感触を得ながら操作する．また腸管などを把持・牽引する場合，腸管の漿膜損傷をきたさないよう，無傷性腸把持鉗子を用いその弾力性に合わせて愛護的に把持する．腹腔内での腸管吻合に際し，自動縫合器や吻合器の誤作動は重篤な術後合併症につながる危険性があり，適切な処置が要求される．もしドーナッツの形成が不完全であったなら，躊躇せず開腹し追加縫合をすべきである．

■■■

おわりに

腹腔鏡下大腸手術を安全に遂行するための要点を紹介した．腹腔鏡下手術にはさまざまな落とし穴があり，種々の工夫が必要である．合併症を避けてこそ，腹腔鏡下大腸手術は初めて低侵襲手術となる．

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（KOKUBA Yukihito, et al 北里大学医学部外科：〒228-8555 神奈川県相模原市北里 1-15-1）

学会告知板

第 15 回腹腔鏡的治療研究会

期　日：2004 年 12 月 4 日（土）
会　場：東京エーザイ株式会社本社 5 階
会　長：三宿病院第 1 外科　鈴木正敏
主　題：腹腔鏡下治療に関する演題を広く募集致します．
応募要綱：演題名，発表者，所属，抄録を 400 字以内にして，下記に E メールまたは FAX または郵送で御連絡下さい．
演題募集期限：9 月 10 日（金）
事務局：国家公務員共済組合連合会三宿病院
（担当）安富久記，土屋敏子
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Operation

直腸癌に対する腹腔鏡下低位前方切除術

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中村隆俊　旗手和彦　渡邊昌彦

金原出版株式会社

特集　最新　直腸癌手術

直腸癌に対する腹腔鏡下低位前方切除術

國場幸均*　佐藤武郎*　小澤平太*
中村隆俊*　旗手和彦*　渡邊昌彦**

はじめに

直腸癌に対する腹腔鏡下手術を安全に施行するには，良好な視野の確保に始まり限られた閉鎖腔の中で癌部への愛護的操作と，神経損傷を回避しつつ腸管の剝離や切離操作を行わなくてはならない。骨盤内の外科解剖の熟知を要求され，腸管切離部が低位になればその手技はさらなる工夫を要する[1)~3)]。一方，開腹手術と比較し腹腔鏡による拡大視効果は直腸癌手術においてきわめて有効であり，骨盤内解剖の把握を助け視野展開に慣れれば，良好な視野のもと出血なく安全に剝離・授動することが可能となる。本稿では，直腸癌の腹腔鏡下低位前方切除術における視野展開から困難とされる腸管切離までの工夫を紹介する。

I. 適　応

適応は，腫瘍進行度および占居部位で異なる。結腸癌においては，手技の習熟とともに段階的に適応を広げ，現在は漿膜浸潤癌（SE）までを適応としている。直腸 Rs ではS状結腸癌への手術手技とほぼ同等に行えるため SE とした。しかし，直腸 Ra，Rb においては，腫瘍近傍への鉗子操作を余儀なくされ，骨盤腔内での腫瘍への愛護的操作の困難性と Rb 領域は難度の高い側方郭清も必要とすることから，MP，N（－）までを適応としている。また，視野確保，鉗子操作の困難な巨大腫瘍は除外している。

II. 手術方法

1. 体　位

骨盤腔内の良好な視野を確保することは，重要な要素のひとつである。落ち込んでくる小腸に視野を遮られ，狭い骨盤腔内での鉗子操作に閉口することが少なくない。体位変換による頭側への小腸の排除が必須であり，そのためには体幹の確実な固定と十分なローテーションを可能とする手術ベッドを使用することが大変有用である。手術開始前にローテーションを行い，固定具合と循環動態の変動具合を麻酔医との共同で確認する（図1）。

2. 術者，モニター・配線の位置

術者，病変部，モニターを一直線に並べ，モニターは術者の視点の高さと一致するのがよい。術者，助手の移動が制限されないよう，各器具への接続コードは体幹の1カ所より配線されるように接続する。本法は長時間に及ぶことがあるので，できるかぎり鉗子操作が楽なストレスのかからない姿勢となるようにする[4)]。

3. 腹　腔　鏡

硬性鏡は，斜視鏡（30，45°）を使用している。剝離層や血管根部に対して多方向からの視野を確保でき有用である。とくに本法では超音

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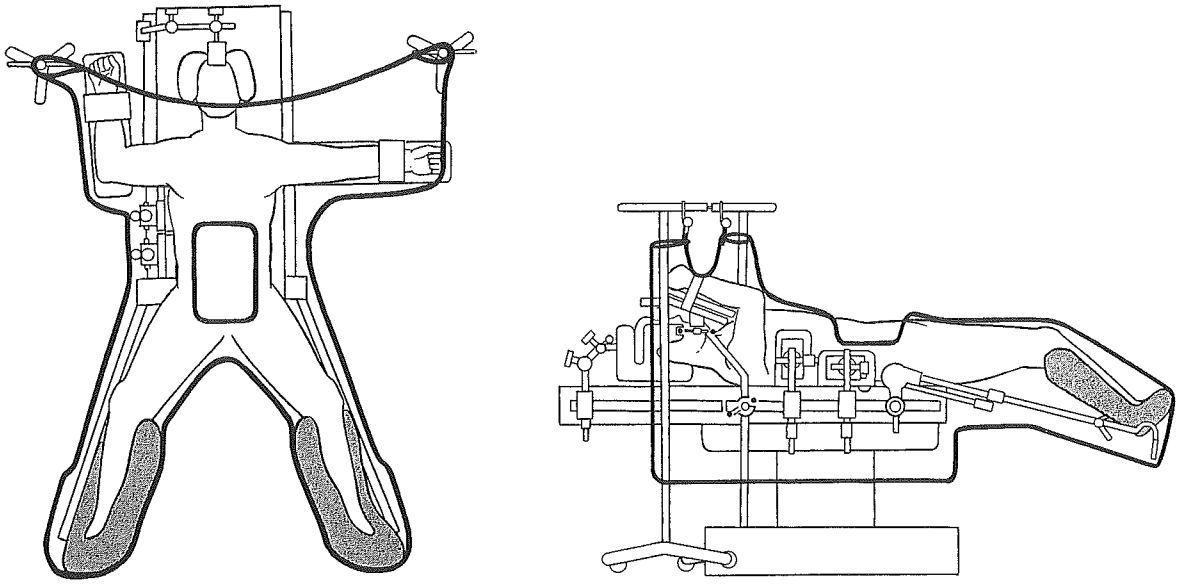

図 1　術者側の上肢は挙上し，下肢はレビテイターにより開脚とする。
頭部と体幹は，側部支持器で固定する。

波凝固切開装置を骨盤腔内で使用する頻度が多く，そのミストで頻回にレンズが曇るため2本ずつ用意するとよい。

最近では，画質も良好な5 mm径のフレキシブルスコープが開発され，これを使用している。

4．小切開の先行・トロカールの挿入

最初に下腹部正中で恥骨結合と臍部のほぼ中央に約3 cmの小切開をおく。そこにラップディスクミニ（八光社）を装着し，10 mmトロカールを用い気腹する。そこよりのスコープ観察下でほかのトロカールを順番に挿入していく。以前は，小切開の位置を臍部としていたが，臍周囲への術後の腸管癒着の防止，疼痛の軽減，整容的配慮の目的で小切開の位置を下腹部正中へと変更した（図2）。

5．リンパ節郭清と神経温存

S状結腸～直腸を腹側やや左側へ牽引し岬角近傍の直腸間膜右側を傍直腸溝に沿って切開する。直腸間膜を仙骨前面より挙上させ直腸固有筋膜の背側で出血の少ない剝離層を探り，上下腹神経叢を背側に落としながら大動脈前面へと急がずていねいに剝離を進め下腸間膜動脈（以下，IMA）根部に向かう（図3）。D3郭清においては，神経を背側に温存しながら頭側方向へと剝離し，超音波凝固切開装置を用いIMA根部のリンパ節郭清を行う。超音波凝固切開装置のアクティブブレードによる血管壁の損傷に注意してIMA根部右壁をまず露出し，ついで左壁を必要最小限度の剝離とし，血管根部のみのクリッピングを行い切離する。血管根部の切離を先に行うと血管根部左側の上下腹神経の走行がより明瞭に観察され，これを温存することが容易となる（図4）。IMA根部と同じ高さでIMV，LCAを切離する。

6．内側からの腸間膜剝離

IMA根部の切離を行うと大動脈前面から外側方向への腸間膜の剝離は容易となる。後腹膜側へ剝離層が深くならないように注意し，尿管が腸骨動脈を乗り越える部まで確実に背側へ剝離する。さらに腹膜翻転部近くまで直腸後腔の剝離を行う。間膜右側から左側方向へ進めるが，剝離面が正しければ出血なく下腹神経や骨盤神経叢は温存される。内側からの剝離はここまでとし，尿管の前面へ小ガーゼを挿入しておく。そこより外側の精巣（卵巣）動・静脈の剝離は腸管外側からの剝離のほうが剝離層の同定

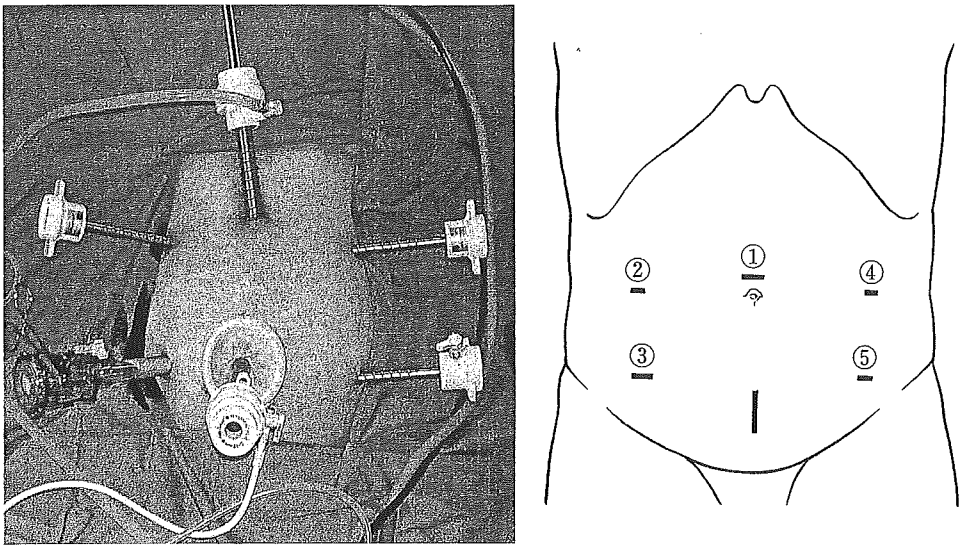

図 2　トロカールの位置
約 3 cm の小切開を先に下腹部正中におく。ラップディスクミニを装着し，そこよりのスコープ観察下で順次トロカールを刺していく。
① 12 mm カメラポート　② 5 mm ポート：術者左手　③ 12 mm ポート：術者右手　④ 5 mm ポート：術者左手あるいは助手右手　⑤ 助手左手

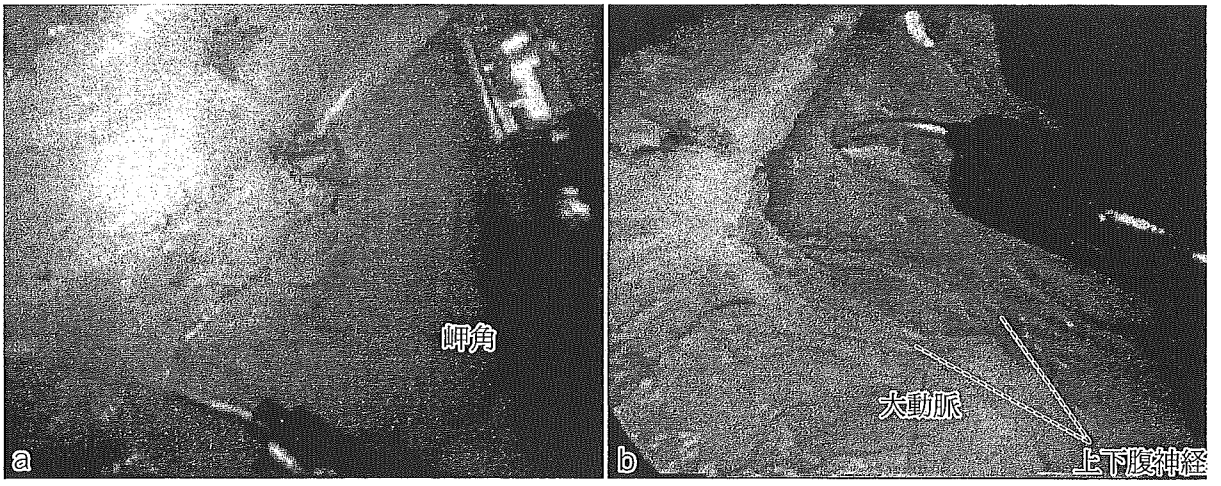

図 3　大動脈前面の剝離と IMA 根部郭清
a）岬角付近より内側の間膜切開を開始する。
b）上下腹神経を温存しつつ IMA 根部に進む。

と手技的に容易である（図 5）[5]。

7．S 状結腸から上部直腸の授動

S-D junction 部から下行結腸側の臓側腹膜と壁側腹膜をていねいに剝離すると自ずと精巣（卵巣）動・静脈は後腹膜側へと温存され，尿管前面に挿入しておいたガーゼの前面へと剝離層は到達する（図 6）。外側と内側からの剝離層を連続させ口側と肛門側へと剝離を広げる。あとの吻合口への緊張を軽減できるよう余分に下行結腸の剝離を行っておく。次に直腸を右頭

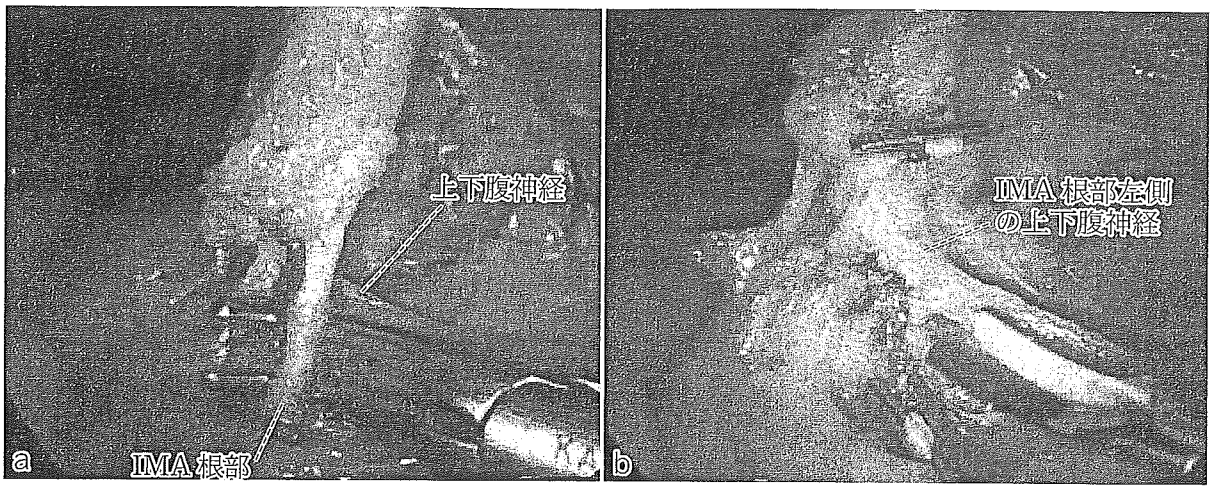

図4 血管処理
a）IMA根部を神経損傷に注意しながら郭清し，血管壁を露出する。
b）十分な距離の血管壁を露出し，クリッピングとLCSを用いて切離する。

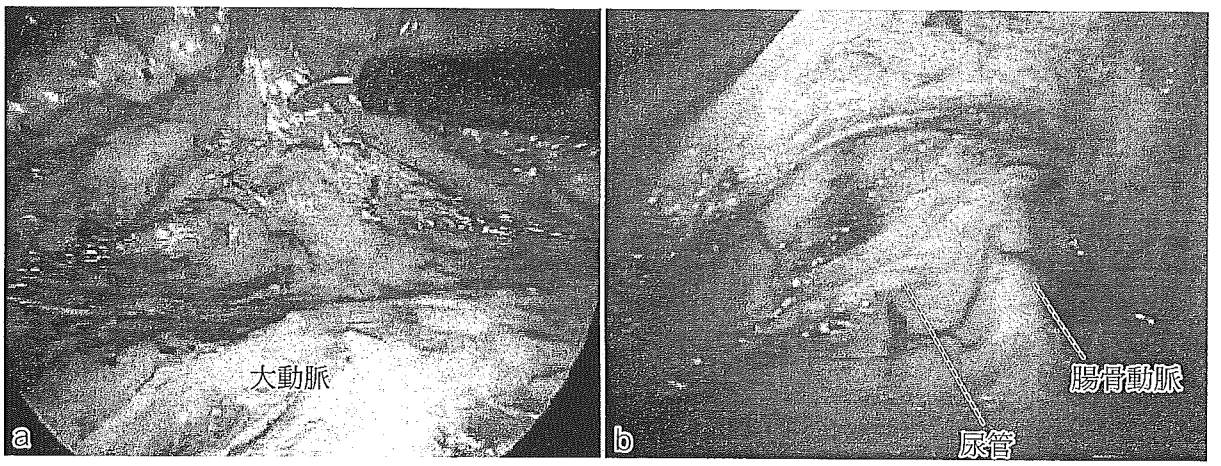

図5 内側からの剝離範囲
a）IMA・IMVを切離すると，内側からの腸間膜剝離は容易となる。
b）内側からの剝離は，尿管が左総腸骨動脈を乗り越える部までとする。
そこより外側の剝離は，腸管外側からの剝離が容易である。

側に牽引し直腸左側を展開し下腹神経を背側に落とすと，間膜と腹膜の接合部が明らかになる。次に間膜を肛門側に向けて，右側と同じレベルまで切開する（図7a）。

8. 下部直腸の剝離

腹膜翻転部以下の剝離では，仙骨直腸間膜を切開し直腸後壁側を肛門側に十分に剝離しておく（図7b）。直腸前壁の剝離は腹膜切開ののちに男性では精嚢後面，女性では腟後壁を挙上させDenonvilliers筋膜を直腸側に落とす。視野の確保が大切だが，スネークリトラクターやツッペル鉗子を利用するとよい。直腸両側に存在する出血の少ない膀胱直腸間隙と直腸後壁の剝離を先に肛門側へ進めると，側方靱帯や中直腸動・静脈が索状物として認識され，それを超音波凝固切開装置で外肛門括約筋群に向けて切

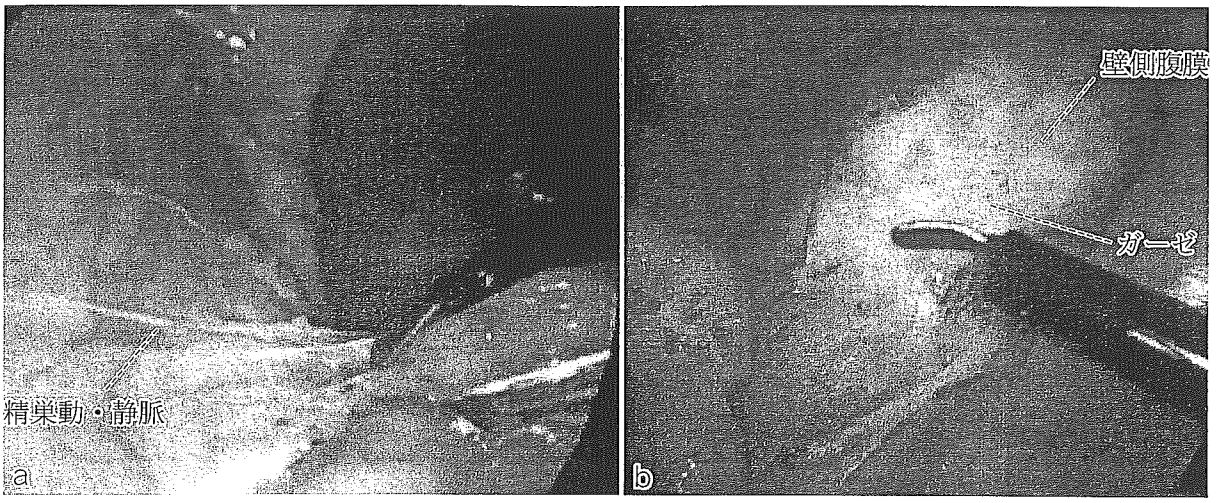

図 6　外側からの腸管剝離

a）S-D junction 部の壁側腹膜を損傷しないよう授動する。腹腔鏡の視野を尾側あるいは頭側より剝離層に対し水平方向に構える。

b）挿入ガーゼ前面の内側からの剝離層と外側からの剝離層を膜1枚切開し連続させる。

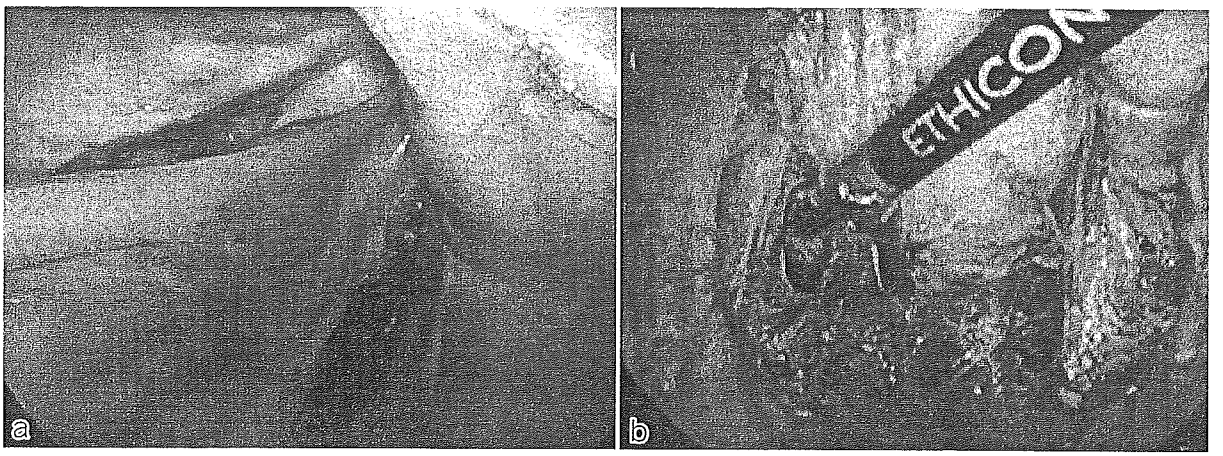

図 7　直腸剝離

a）傍直腸溝に沿って直腸間膜を切離する。

b）安全な DST には直腸後腔の十分な剝離が必要である。

離すると出血をみない（図8）。直腸切離予定部より肛門側を余分に剝離しておくことは，のちの腸間膜・腸管切離を安全に行うために必須である[6]。

9．直腸切離

直腸の切離にあたっては，まず右側の直腸間膜から切開を加え，注意深く鈍的に脂肪組織を剝離し直腸壁を確認する。その脂肪組織を血管とともに超音波凝固切開装置で丹念に止血しながら切開しできるかぎり直腸壁を露出する。その際，超音波凝固切開装置のアクティブブレードは手前側にして直腸壁や脂肪組織内の血管に当たらないように注意する。この操作では，キャビテーションが直腸壁側に向かい組織が脆弱化してしまう危険性があり，のちの縫合不全を招くおそれがあるので注意する。直腸後壁の脂

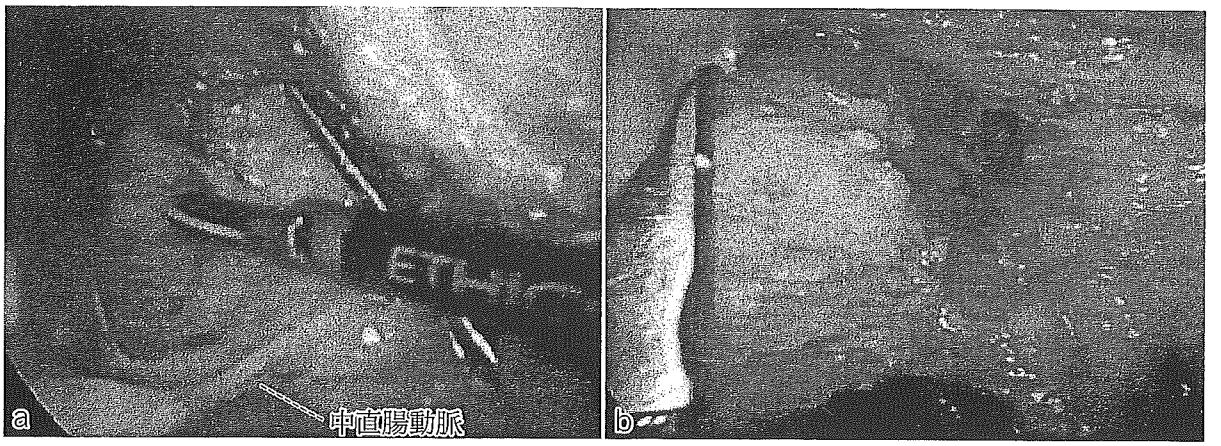

図 8　腹膜翻転部以下の剝離
a）左側の膀胱直腸間隙と中直腸動脈　b）右側の膀胱直腸間隙と側方靱帯

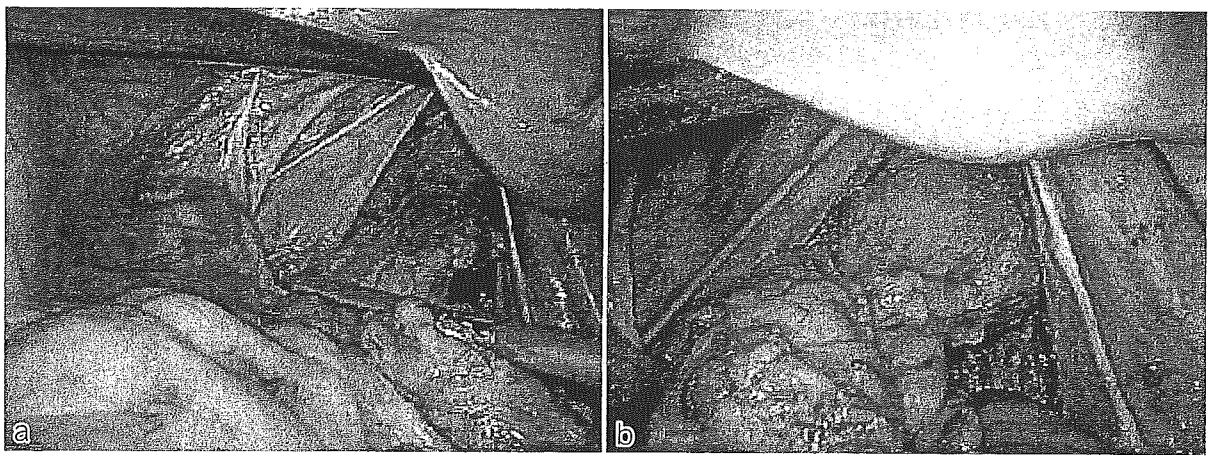

図 9　直腸洗浄
a）腫瘍の肛門側を 5 mm 径腸鉗子によりクランプ　b）洗浄

肪組織をできるだけ右側から処理したのちに直腸左側を右側と同様に脂肪組織を切離して左右同じレベルで直腸壁を露出する。超低位吻合の場合では，これらの腸間膜処理は不要である。腫瘍の肛門側に腸クランプ鉗子を掛け直腸洗浄と切離を行う（図 9）。その際，山本らが開発した屈曲可能な直腸クランプ鉗子を使用すると大変便利である。洗浄を容易とするばかりではなく，腸管が扁平となり自動縫合器がスムーズに挿入でき安全な切離が可能となる（図 10）[7]。腸管切離の自動縫合器はなるべく直腸に直角にかけ 1 度で切離ができるようにする。

1 度で切離が完了しない場合は，2 度目の自動縫合器の切離線が 1 度目の切離線よりやや肛門側になるように掛ける。前述したように切離予定部より肛門側が余分に剝離されていないと，自動縫合器は直腸長軸に直角には掛からず，腸管の切離線が肛門側に斜めになって 2 度目の切離線はさらに斜めになり，切離に要する縫合器の数が増し吻合が的確に行えない。

10．体外操作

下腹部正中のラップディスクミニ（八光社）周囲を大ガーゼで覆う。肛門側切離断端より病変腸管を体外へ引き出し，血流と吻合口への緊

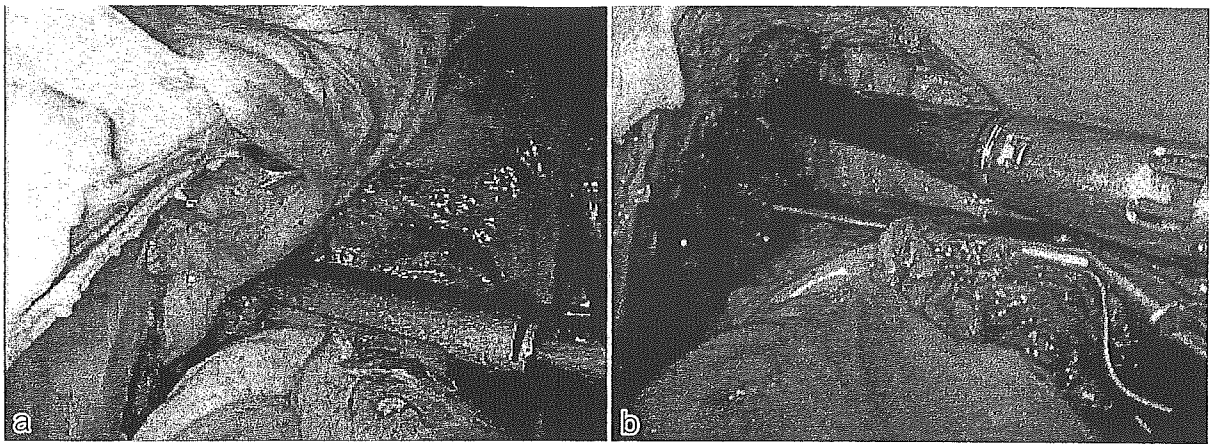

図 10　下部直腸の切離

a）下部直腸は長軸に対し直角に把持し切離することがむずかしい。

b）腸把持部分の屈曲可能なクランプ鉗子を使用すると容易に自動縫合器の挿入から切離までを可能とする。

張具合を確認し病変切除を行う。口側切離断端が恥骨結合部まで届くよう腸間膜処理することは周知のとおりである。アンビルヘッドを断端に挿入して腸管壁が全周性に縛り込まれるよう巾着縫合で縛りこむ。

11．直腸吻合

アンビルヘッドを装着した切離断端を腹腔内に還納，ラップディスクミニを閉鎖する。再気腹後，体位変換を行い直腸断端周囲の視野を良好に保つ。自動吻合器を肛門から愛護的に挿入し吻合器の先端が直腸断端に到達したら，センターロッドが縫合線の近くぎりぎりに出るように操作する。このとき吻合器を前後左右に動かすだけではなく，時計回りや反時計回りに捻るとなお合わせやすい。縫合線が先端の水平部分の中央にくるように，先端が漿膜を押し上げた段階で，電気メスで漿膜を切開すると容易にセンターロッドが露出する。さらにアンビルホルダーで断端を押し下げてセンターロッド全体を露出させる（図11 a）。アンビルヘッドをセンターロッドと連結させ口側腸管に捻れがないことを確認する，その後ゆっくりと周囲の脂肪組織や間膜を巻き込まないように注意深く吻合する（図11 b）。製造メーカーにより自動吻合器の使用法に若干の違いがあるのであらかじめ確認しておく。自動吻合器を引き抜いたら，必ずドーナッツの形成を確認する。吻合に緊張がかからず口側腸管がやや弛む程度がよく，もし緊張がかかっているようなら脾彎曲部を授動する。ドレーンは仙骨前面に留置するが，なるべく先端が吻合部に直接当たらないようにする。

III．適応と本法の問題点

直腸癌の腹腔鏡下手術においてその拡大視効果はきわめて有用である。適正な剝離層や神経走行の詳細な観察が可能で，骨盤内の解剖を理解していれば無血野に神経温存しつつ直腸周囲を剝離することが可能である。しかし，腸間膜脂肪が厚く狭骨盤の症例では，開腹手術と同様に腹腔鏡下手術でも視野展開は困難である。低位直腸での剝離操作や腸管切離は習熟を要し，腫瘍への愛護操作が困難なため腫瘍散布の危険性は高い。Rs癌ならS状結腸癌と同様な手技であり進行癌でも適応可能と考えるが，Ra～Rb癌においては手技に習熟するまでは適応を早期癌にとどめ習熟した術者でもMP癌までが適応として妥当と考える。また，側方郭清が必要な進行癌は，現時点では適応外としている。

本法を遂行するにあたりもっとも問題となるのは，洗浄から切離をいかにストレスなく安全

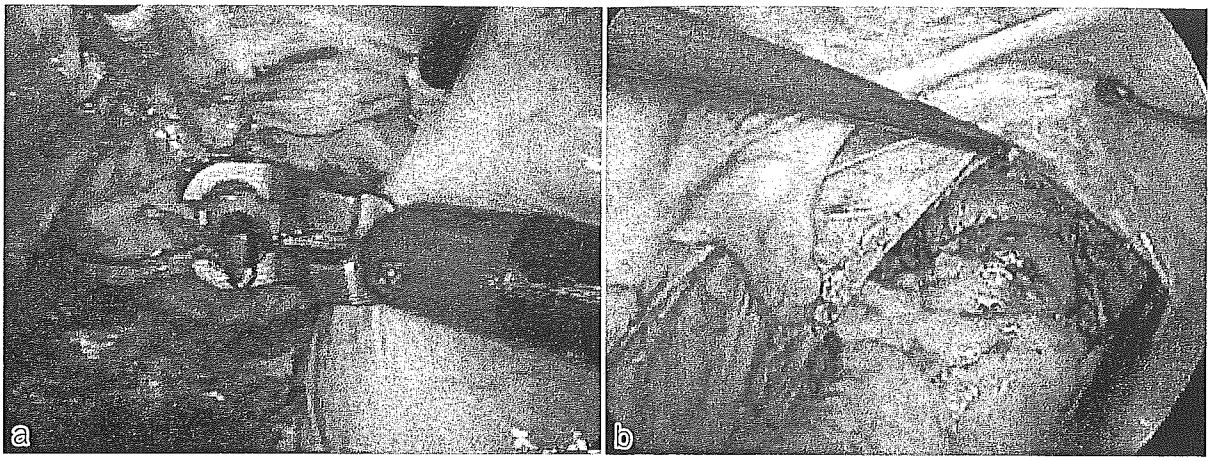

図 11　結腸直腸吻合
a）センターロッドを縫合線の近くぎりぎりに出す。アンビルホルダーにより断端を押し下げてセンターロッド全体を露出させる。
b）口側腸管の捻れがないことを確認し，周囲組織を巻き込まないよう注意深く吻合する。

に行うかである。拡大視効果により良好な視野下で直腸低位までの剝離操作は開腹手術以上の繊細な手技が可能となった。しかし，現存の腹腔鏡手術用腸鉗子では直腸低位においての腫瘍肛門側の適切なクランプは困難である。着脱式腸鉗子なども開発され解決されつつあるが，満足の得られるものとはいいがたい。腸把持部分の屈曲が調節でき把持力の強い腹腔鏡用クランプ鉗子が開発され，これを使用すると比較的安全に洗浄から切離が行える[7]。超低位の切離にも対応できるようさらなる改良が望まれる。DST 吻合においては，現在使用可能な自動縫合器では，長軸に対し垂直に 1 回での確実な直腸切離は困難である。厚い直腸壁では確実な stapling が得られず，ミスファイアーとなる場合がある。これら器具の改良が進み安全な直腸切離が可能となれば，腹腔鏡特有の拡大視効果と相まって，腹腔鏡手術は直腸癌手術における必須の手術法となるであろう。

おわりに

直腸癌に対する腹腔鏡下手術の視野の展開から直腸切離までの工夫につき紹介した。本法を遂行するにあたって，その腫瘍学的要因と技術的要因の両方を考慮し慎重に適応を広げることが肝要である。

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A new technique of laparoscopic surgery for rectal disease

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RESUMEN

La cirugía laparoscópica rectal es una técnica que tiene que realizarse en un espacio reducido de la pelvis. Si se realiza una operación excesiva con una visión difícil, por ejemplo, en una mujer en la que el campo está perturbado por el útero, es posible producir un trauma en el órgano o un sangrado inesperado. Teniendo presentes estos problemas, realizamos cirugía laparoscópica en 44 casos de enfermedad rectal con varias técnicas que hemos inventado. En estos casos, se realizó en el pequeño espacio una retracción ya sea del útero o el recto y en caso de tener que realizar resección anterior, se amarró la cinta de manera ajustada alrededor del recto por debajo del tumor para evitar tocar el tumor y para permitir una adecuada irrigación vascular en el resto del recto. Con el uso de nuestras técnicas, no tuvimos daños intestinales ni sangrados inesperados en mujeres. Además, la resección anterior laparoscópica del recto no causó ningún daño intestinal, ni sangrado inesperado ni fuga anastomótica. Tampoco tuvimos ninguna recurrencia de tumor local. Creemos que estas técnicas pueden reducir las complicaciones que traumatizan al intestino con fórceps e impiden la implantación en la anastomosis. Este informe técnico valida que nuestras modificaciones en la técnica de cirugía laparoscópica rectal son útiles cuando un cirujano tiene que trabajar en un espacio reducido.

PALABRAS CLAVES: Cirugía Laparoscópica, Enfermedad rectal.

SUMMARY

Laparoscopic rectal surgery is a technique that has to be done in a narrow space: the pelvis. If an immoderate operation is performed with a difficult view, for example in female where the field is disturbed by uterus, it is possible to produce organ trauma or an unexpected bleeding. Taking these problems in mind, we performed laparoscopic surgery in 44 cases of rectal disease with several techniques which we have invented. In these cases either the uterus or the rectum was retracted in the narrow space, and if an anterior resection was to be done, the tape was tied tightly around the rectum below the tumor to avoid touching the tumor and leaving adequate vascular irrigation to the remnant rectum. With the use of our techniques, we did not have female intestinal injury or unexpected bleeding. In addition laparoscopic anterior resection of rectum did not cause any intestinal injury, or unexpected bleeding or anastomotic leakage; also we did not have any local tumor recurrence. It is our belief that these techniques can decrease complications that traumatize the grasping intestine with intestinal forceps and prevent implantation in the anastomosis. This technical report validate that our technique modifications for rectal laparoscopic surgery are useful when a surgeon has to work in a narrow space.

KEY WORDS: Surgical laparoscopy, rectal disease.

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INTRODUCTION

In the past decade laparoscopic surgery has become the world standard for cholecystectomy, it is easy to be done by an expert surgeon, has a lower morbidity and mortality compared to conventional cholecistectomy and in addition reduces medical costs. Now laparoscopic colorectomy will become a worldwide surgical technique because it has similar advantages. However, laparoscopic colorectomy has numerous factors that may be difficult to have an adequate surgical view. This is true specially, when a patient with rectal disease is operated with a restricted view in the narrow space of the pelvis; this event often yields to damage bowel with forceps or to induce an unexpected bleeding. We invented several techniques to get a better view of the pelvis when laparoscopic surgery is performed for rectal disease in a narrow pelvic space.

PATIENTS AND METHODS

Between 1996 and 2003, a total of 208 cases underwent laparoscopic colorectal surgery at the Department of Surgery - Fujita Health University Hospital. Of these, 10 cases were converted to open surgery. So far laparoscopic pelvic surgery was performed in 44 patients.

As operative methods of laparoscopic pelvic surgery, high anterior resection was performed in 18 cases, low anterior resection in 17cases, Rectopexy in 7 cases, and partial resection, adhesiotomy, enucleation and total colectomy were also performed in every case.

Appliance

For this type of surgery 3 mechanical devices were used:

1. Uterine manipulator (Etikon.com products). Figure 1.
2. Tape maked with Tetron jointed the dull tip needle

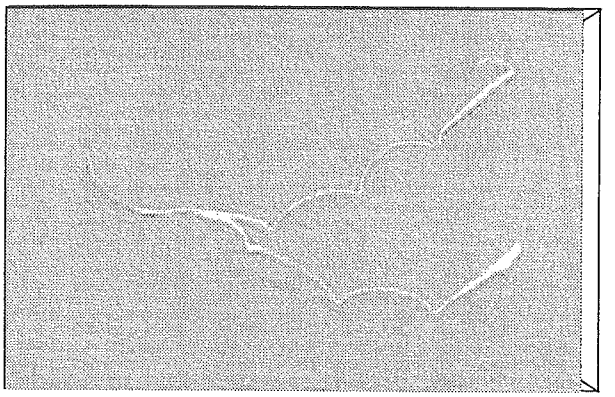

Figure.2. Tetron Tape joint the dull tip needle with obtuse angle, 1-0 (45mm) 3mm.

with obtuse angle, 1-0 (45mm) 3mm. Figure 2.

3. Diamond Flex Retractor 45°(Genzyme Surgical Products)

Surgical technique

1. Previous preparation:
   Patients were placed on clear liquid diets two days before surgery, and received GOLYTELY mechanical bowel preparation one day before the operation.

2. In order to get a better pelvic view in a female patient where the field is disturbed by uterus:
   2.1 Use of uterine manipulator. (Etikon.com products)
   2.1.1 The uterine manipulator is inserted from the vagina to the uterus by the assistant. The uterus is controlled by the bar of it and

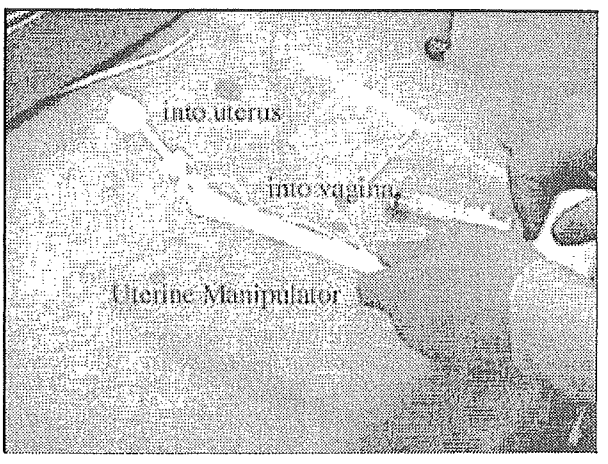

Figure.1. UTERINE MANIPULATOR. This device is introduced from the vagina to the uterus. The assistant controls the bar of it and removes uterus from the field. The uterus is hatched up by this manipulator.

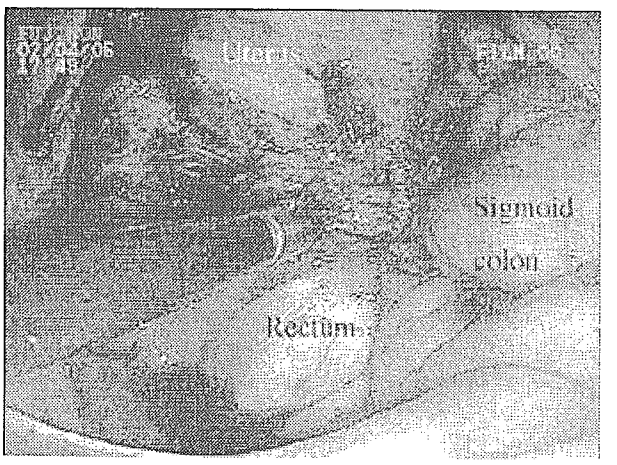

Figure 3. Endometriosis between uterus and intestine with a severe adhesion. Using UTERINE MANUPULATER during surgery allows a better view and adequate mobilization between uterus and bowel. By controlling the UTERINE MANUPULATER it is easy to remove things with the scissors and abrasive forceps.

is removed from the operating field by the assistant Figure 3.

2.1.2 Lifting of the uterus with a thread: A needle with a thread is inserted into the abdominal cavity through the trocar. A needle is passed directly into the myoma with the uterus. Using the blunt tipped needle, the thread is caught and taken out through the abdominal wall. The thread is tied and fixed to the abdominal wall.

2.2 Another technique is used a straight needle with a thread:

2.2.1 A straight needle is inserted from the abdominal wall into the peritoneal cavity. The needle is passed through the broad ligament and the needle is taken out at around the same site of insertion. The thread is tied from the extra-corpus and the uterus is fixed to the abdominal wall. Figure 4.

3. Technique of laparoscopic pelvic surgery for non-resectable rectal disease

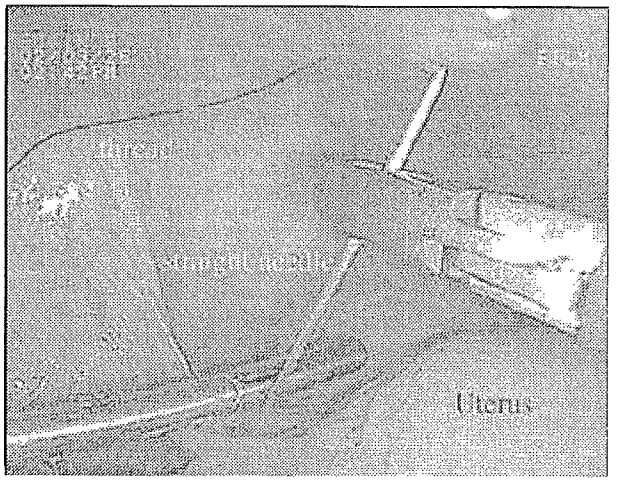

Figure. 4. A straight needle is inserted from the abdominal wall into the peritoneal cavity. The needle is passed through the broad ligament and the needle is taken out at around the same site of insertion.

3.1 When the mesorectum is mobilized, the rectum is lifted up using Diamond Flex Retractor 45° that was pulled through behind the rectum (Figure 5).

3.2 Technique of laparoscopic surgery for Rectal Cancer

3.3 Exclusion criteria for laparoscopic anterior resection of the rectum are tumor size > 5cm, T4, or rectum below the peritoneal reflection (Rb).

3.4 The position is changed from supine to Trendelenburg and lifted up about 15 cm. on an electrical operating room table. The technique and sites of trocar in laparoscopic low anterior resection has been presented in detail elsewhere.

3.5 To start with, the promontrium is a symbol of the starting point that retroperitoneum is opened with diathermy scissors from right side at the bottom of the rectum.

3.6 The dissection proceeds to the root of IMA, this is performed after the upper border of presacral fascia is confirmed. Following confirmation of the left ureter and a part of presacral nerve plexus and then the ureter and lumbar splanchnic nerve are left behind.

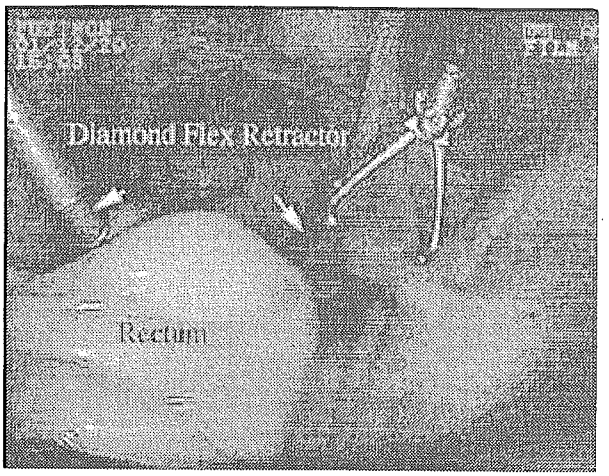

Figure. 5. The soft pre-sacral connective tissue on the left side is dissected and passed through the contra-lateral cavity. Through this hole the Diamond Flex Retractor is inserted behind the rectum. The tip of the Diamond Flex Retractor is flexed and lifted up the rectum.

3.7 Lymph node dissection around the root of Inferior Mesenteric Vein (IMA) is performed and is continued to the root of left colic artery once this is confirmed.

3.8 Left colic artery is taped and is cut at the nearby lesion.

3.9 A low tie is performed with clips and IMA is divided here.

3.10 Left colon, from sigmoid to the splenic flexure, is mobilized by division of its peritoneal attachments with diathermy scissors and Laparoscopic Coagulating Shears.

3.11 Mesorectum is mobilized posteriorly and laterally into the soft presacral connective tissue with diathermy scissors.

3.12 Superior hypogastric plexus and hypogastric nerve is carefully preserved during the procedure. When the dissection proceeded down to the peritoneal reflection, the uterus is controlled with the uterine manipulator.

3.13 After getting better view, the diathermy scissors and Laparoscopic Coagulating Shears cut the peritoneal reflection that is prolonged on either side of the base of the mesorectum and mesosigmoid are divided.

3.14 A tetoron tape with dull needle which is designed in Fujita Health University is passed through the 12mm working trocars (Fig. 6-1,2). It is passed through behind the rectum in the sagital plane 2-3cm below the palpable lower edge of the primary lesion, the rectum is ligated with and the tape fixed by clips (Figures 7-1,2). By the grasping tape, the rectum is managed and the mesorectum is irrigated with Laparoscopic Coagulating Shears.

3.15 The other tape which is taken measure of the distal line of resection and is cut.

3.16 The remnant rectum is irrigated with 2 l of distilled water from anal side by a newly inverted Irrigation system. The sponge cytodiagnosis in the distal rectal mucosa

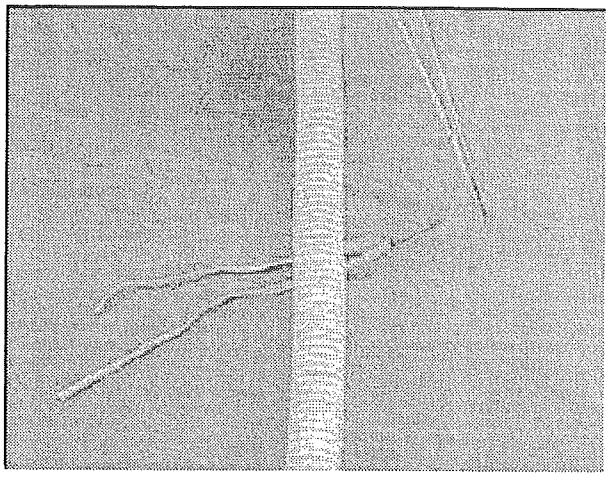

Figure.6-1. Demonstrating the procedure by a model (please consider a tube as the rectum): A needle is passed under the tube with tape and thread of the needle and cut.

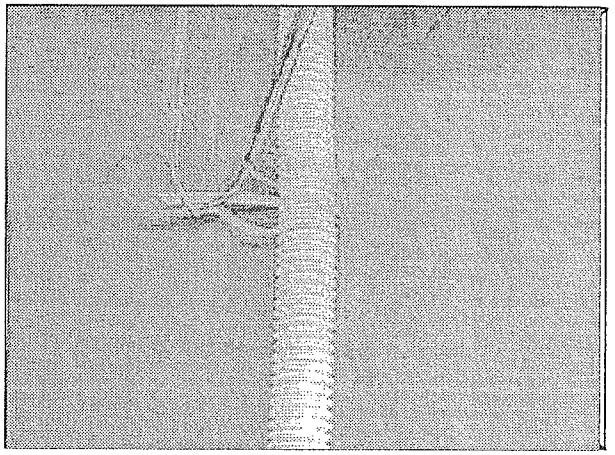

Figure.6-2. the edge of the tape is grasped with forceps and pulled trough the loop and then tied up. By the grasping tape the tube can be managed.

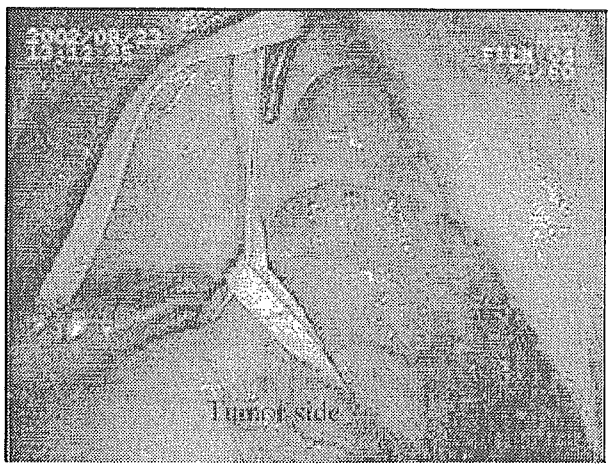

Figure.7-1. The procedure is now performed in the real pelvis. A needle is passed behind the rectum, an this is ligated with the tape and fixed by clips. A needle is passed through and behind the rectum.

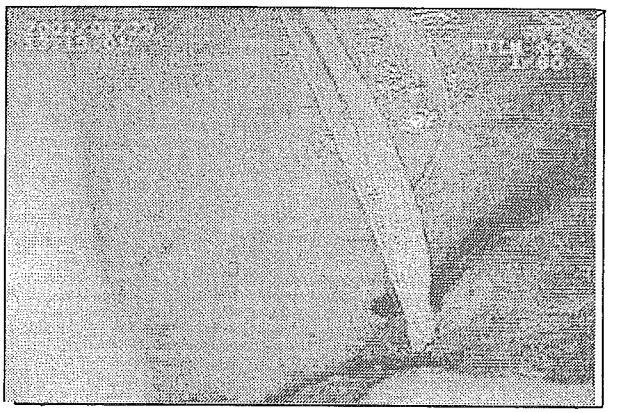

Figure.7-2. the tape is ligated with forceps and fixed by clips.

is performed after this irrigation,

3.17 The rectum is divided by the ENDO-stapler (Figure 7-3). The excised colorectum is taken out through the small incision. An anvil head is fitted to the proximal colon and the colon is returned into the abdomen (Figure 7-4). Double stapling technique is being performed.

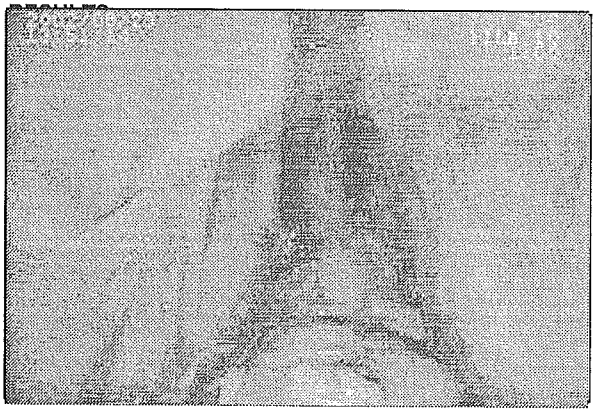

Figure.7-3. After the remant rectum is irrigated with a 2lcc of distilled water from anal side by a newly inverted irrigation system. Grasping and lifting the tape, the rectum is divided by ENDO-stapler.

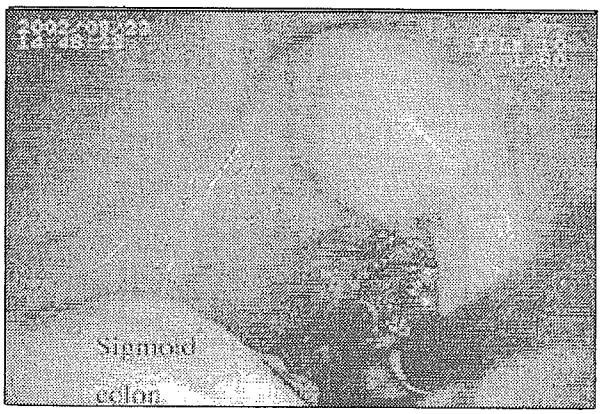

Fig.7-4. An anvil head is fitted to the proximal colon and returned into the abdomen. Double stapling technique is being performed.

Between 1996 and 2003, 203 patients had laparoscopic assisted cororectal surgery. 44 patients of 203 patients were rectal disease and were performed with these surgical techniques. In a further case, these techniques have been gotten a better view of the pelvis and have gotten a safer procedure at the pelvis. The result of the sponge cytodiagnosis was negative for neoplastic cells. There were no operative significant complications especially intestinal injury and unexpected bleeding. Also local recurrence and post site recurrence were none.

DISCUSSION

We have done laparoscopic surgery for colon disease since 1996. Although being cautious, laparoscopic procedure of rectal disease had to be modified because this one in an indistinct view at the narrow space of the pelvis has the possibility of making a trauma to bowel with the forceps used or an unexpected bleeding. For these reasons we had to create several techniques to get a better view of the pelvis. With these techniques we performed laparoscopic surgery for colorectal cancer type T1 or T2, as well as surgery for benign rectal disease.

In female cases, the pelvic space was closed by uterus; therefore it was necessary to add on port. It must be said that to operate in a narrow space was extremely difficult, more taking in account the added forceps; as a result of these problems, we had to lift up the uterus using uterine manipulator and a thread with a straight needle. Using uterine manipulator, it made us able to control it between left and right side, as a result it was easier to use the device to move the lesion that was tense. It must be emphasized that this technique needs the support of an assistant to control uterine manipulator. We usually used uterine manipulator when it was necessary to do an anterior resection and a severe adhesiotomy had to be done.

Another technique has been performed that the uterus was fixed to the abdominal wall using a straight needle with a thread. This technique was careful of a bleeding from the uterine vessel a needle was passed through the broad ligament or the myoma and it was impossible to tense the mobilized tissue. This technique was used for the purpose of getting a better view of the pelvis when the benign rectal disease was operated.

Diamond Flex Retractor 45 was used for the purpose of tending between mesorectum and presacral fascia to mobilize the connective tissue and getting a view behind the mesorectum. It follows that this method was minimized to grasp the rectum with the intestinal forceps and was shorter operative time by getting a better view. The result could decreased complications of the intestinal injury with intestinal forceps .

Our technique for the anterior resection in the cancer was based on non–touch isolation technique which avoid to the intestinal injury by numerous grasping of the intestine or the lesion while getting a better view of the pelvis and excluding a tumor cell before division of the rectum.

The reported having used a vessel clump clip when the rectum was irrigated. But the technique was often removed the clip and couldn't retract a bowel with grasping a vessel clump clip and then mobilize the mesorectum.

However a tetoron tape with dull needle which was designed in Fujita health university can use to assist bowel retraction and rectal manipulation and irrigate the rectum ,and even if it can use in the narrow pelvic space according to guide a dull needle behind mesorectum carefully.

The technique can prove the results of that the sponge cytodiagnosis is no tumor cells and our techniques of the narrow apace for the rectal disease is no operative significant complications especially intestinal injury and unexpected bleeding. We expected that these techniques could decreased complications that traumatized the grasping intestine with intestinal forceps and they would prevent implantation to the anastomosis and would be able to operate safely even in the narrow apace.

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Gadolinium Enhanced Endorectal Coil and Air Enema Magnetic Resonance Imaging as a Useful Tool in the Preoperative Examination of Patients with Rectal Carcinoma

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ABSTRACT

Background/Aims: In the present study, we attempted to evaluate the usefulness of gadolinium enhanced endorectal coil and air enema magnetic resonance imaging with slice adjustments in patients with rectal carcinoma.

Methodology: The subjects were patients with rectal cancer from June 1997 to September 1999 who were examined with a 1.5 Tesla magnetic resonance device. Buscopan was administered both intravenously and intramuscularly to reduce motion artifacts. Imaging sequences were obtained for T1 weighed, T2 weighed and T2 fat-saturated images. Slice thickness was 5mm and interslice gap 3mm. Endorectal coil insertion and air enema technique were performed with slice adjustments.

Images were interpreted according to the criteria of the TNM classification. Lymph node metastasis was diagnosed as positive when the lymph nodes exceeded 5mm in diameter. Histological and magnetic resonance findings were compared, and diagnostic accuracy was calculated.

Results: Fifty-four consecutive patients were included in this study (37 male, 17 female). There were 10 early cases and 44 advanced cases of rectal cancer. Images with an endorectal coil were obtained in 4 patients. Fifty patients underwent air enema technique. The depth of tumor invasion was accurately diagnosed in all 4 patients undergoing endorectal coil examination.

On air enema study, magnetic resonance imaging correctly staged the depth of invasion in 41 of 50 patients (82.0%). Overstaging was seen in 8 of 50 patients (16%), however, only one patient (2.0%) was understaged. Overall accuracy, overstaging and understaging rates were 83.3% (45/54), 14.8% (8/54), and 1.8% (1/54), respectively. On endorectal coil study, accurate diagnosis of lymph node metastasis was obtained in 3 of 4 (75.0%) patients. On air enema study, an accurate diagnosis of lymph node metastasis was obtained in 36 of 50 (72.0%) patients, yielding 75.0% sensitivity and 73.1% specificity. Overall magnetic resonance imaging findings of lymph node metastasis resulted in 72.2% (39/54) diagnostic accuracy, yielding sensitivity of 75.0% (18/24) and specificity of 73.3% (22/30).

Conclusions: We conclude that gadolinium enhanced endorectal coil and air enema magnetic resonance imaging is promising for preoperative evaluation of patients with rectal carcinoma.

KEY WORDS:
Magnetic resonance imaging; Rectal cancer

ABBREVIATIONS:
Magnetic Resonance Imaging (MRI)

INTRODUCTION

Magnetic resonance imaging (MRI) is widely accepted as a useful tool in the preoperative evaluation of patients with rectal carcinoma. MRI for rectal carcinoma was initially reported by Butch in 1986 (1). Subsequently, several additional techniques have been advocated to improve diagnostic accuracy. The technical refinements include endorectal coil (2), rectal balloon (3), additional slices (4) and gadolinium enhancement (5). In the present study, we attempted to evaluate the usefulness of gadolinium enhanced endorectal coil and air enema MRI with slice adjustments in patients with rectal carcinoma.

METHODOLOGY

Patients with rectal carcinoma undergoing MRI preoperatively from June 1997 to January 2000 were included in this study. Bowel preparation was performed with laxatives and enemas from the day before MRI examination. Images were obtained with a Magnetom VISION™ 1.5 Tesla superconducting apparatus (Siemens, Germany).

The patient was placed in a prone position. Buscopan (20mg N-Butyl-Joscina-Bromure) was adminis-

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ness and availability. Its accuracy is not significantly different from that of endorectal MRI (9). In earlier studies comparing endorectal ultrasonography, CT and MRI, their diagnostic accuracy was not significantly different with regard to extension into perirectal fat, adjacent organs, pelvic wall or lymph nodes (10-12). However, either CT scan or MRI could not discriminate the degree of tumor invasion confined within the rectal wall (1).

On the other hand, endorectal ultrasonography can discriminate the rectal wall into five to seven layers (13-16). In comparisons between endorectal ultrasonography and magnetic resonance imaging, the initial results showed that diagnostic accuracy was similar for staging rectal cancer (17). In later studies comparing endorectal ultrasonography and pelvic phased array coil MRI, MRI was not better than ultrasonography as expected. Also, in comparisons between endorectal ultrasonography and endorectal coil MRI, there were no statistically significant differences with regard to the accuracy of evaluation of depth of tumor invasion and lymph node metastasis (5,6,9,18). Meyenberger *et al.* (18) indicated that ultrasonography could distinguish between T1 and T2 tumors, however, endorectal MRI could not discriminate between them even with gadolinium enhancement. Drew *et al.* (5) studied imaging with an endorectal coil with gadolinium enhancement and concluded that this technique was still inaccurate for early rectal carcinomas. Although there is no significant difference between endorectal ultrasonography and endorectal MRI in staging rectal carcinomas, endorectal ultrasonography is superior to endorectal MRI in discriminating rectal wall layers. However, we experienced a flat type tumor in which the submucosal layer was clearly demonstrated using a prostate-use endorectal coil with gadolinium enhancement and the tumor was diagnosed as an intramucosal carcinoma.

The endorectal coil was more easily applicable to flat type tumors than protruded type tumors. This might be the reason why the endorectal coil could not discriminate the rectal wall layers accurately in most rectal tumors in spite of its high resolution. Proper contact of the endorectal coil with the tumor is mandatory for accurate staging of the depth of tumor invasion by endorectal coil MR imaging. We could discriminate between T1 and T2 using the air enema technique even with the 1.5 Tesla device used.

Figure 3 shows clearly that the tumor invaded into the propria muscle layer with air enema and slice adjustment. The use of antiperistaltic agents both intravenously and intramuscularly might be beneficial to suppress motion artifact. The concomitant use of gadolinium enhancement could clearly delineate the high intensity submucosal layer and the low intensity band of proper muscle layer, leading to discrimination between T1 and T2 stage tumors.

With regard to the diagnosis of lymph node metastasis, there are several issues for concern. In the previous reports, the degree of lymph node swelling, shape of lymph nodes and heterogenous texture with enhancement were regarded as the criteria for lymph node metastasis. Regarding the size of lymph nodes, cut-off values ranged from 5 to 8mm (4,6,19-22). In imaging studies, metastatic lymph nodes should be contained in slices and intersected through a certain plane exceeding the cut-off value. If the slice interval is narrow, swollen lymph nodes are more accurately recognized. Gualdi *et al.* reported their experience of an endorectal coil with 4-mm interval and 0.4-mm gap. Their diagnostic accuracy for lymph node metastasis was 73%. Sensitivity and specificity were 81% and 66%, respectively. Drew *et al.* reported their results of an endorectal coil with a 7-mm interval and 3-mm gap, with the criteria for lymph node metastasis of diameter greater than 5mm and a heterogenous pattern (5). Their diagnostic accuracy for lymph node metastasis was 70%. Sensitivity and specificity were 58% and 76%, respectively.

Although both studies were similar in the background setup, sensitivity was lower in the latter study, suggesting that the slice interval may be a determinant factor for the diagnostic power.

Kim *et al.* reported other criteria for lymph node metastasis of heterogenous texture, irregular margin and diameter greater than 3mm (23).

Their sensitivity, specificity and accuracy were 78.5%, 41.9% and 63%, respectively. However, with a phased array coil, Hadfield *et al.* reported sensitivity, specificity and accuracy were 57%, 88%, and 76% with the criterion for lymph node metastasis of size more than 5mm.

In rectal carcinomas, many preoperative examinations are performed using different criteria. From these observations, we could not help considering that the criterion itself was not a key to detect metastatic lymph nodes. Similar discussions have been reported about the definition of cervical lymph node metastasis (24-26), and van den Brekel reported that occult cervical lymph node metastasis was seen in over 15-20% of patients with head and neck tumors, and concluded that the main cause of false radiologic findings was our inability to formulate precise radiologic criteria (26). It is obviously difficult for us to assess it as good or bad.

In the present study, false-negative results were seen in 6 of 54 patients (11.1%). Although to detect these occult lymph node metastases is impossible at present, further efforts should be made to improve the diagnostic accuracy of MR imaging in preoperative evaluation of rectal carcinomas.

CONCLUSIONS

Although the number of patients examined with an endorectal coil was small, good apposition of the endorectal coil to the tumor could provide more detailed information on the depth of tumor invasion. It was also proven that the air enema technique could provide sufficient diagnostic staging accuracy with a possibility of discriminating between T1 and T2 tumors. Further refinement and unification are mandatory to improve diagnostic accuracy.

We conclude that gadolinium enhanced endorectal coil and air enema MRI is promising for preoperative evaluation of patients with rectal carcinoma.

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FOOTNOTE

This study was presented as a podium presentation at the 18th Congress of the International Society of University Colon and Rectal Surgeons. July 23-26, 2000. Sao Paulo, Brazil.

tered both intravenously and intramuscularly to reduce motion artifacts.

Imaging sequences were obtained as follows: T1 weighed image (TR 11 ms, TE 550 ms), T2 weighed image (TR 3000 ms, TE 100 ms), T2 fat-saturated image (TR 3500 ms, TE 100 ms). The matrix size was 256x192 for T1 weighed images and 256x256 for T2 weighed images. Slice thickness was 5mm and inter-slice gap 3mm.

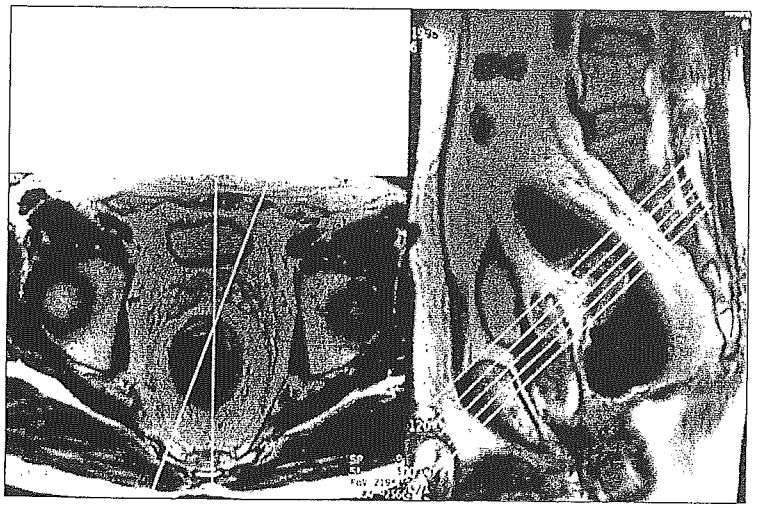

FIGURE 1 Slice adjustments.

TABLE 1 Staging Criteria according to TNM Classification

T1	Tumor confined to mucosa and submucosa
T2	Tumor confined to propria muscle
T3	Tumor penetrates propria muscle with or without fat invasion
T4	Tumor invading the surrounding organs
N0	No lymph node metastasis
N1	Less than 3 metastases seen
N2	More than 4 metastases seen

Endorectal Coil Insertion

We employed two types of endorectal coil. One was a disposable coil for the prostate and the other was a disposable endorectal coil for the colon and rectum (Medrad, Pittsburgh, Pennsylvania, USA). Evaluation of the correct positioning of the coil in the rectal ampulla was made by radiolucent observation. The endorectal coil was always lubricated with lidocaine gel before being introduced. The quantity of insufflated air ranged from 50 to 90 cc. Then the patient was placed on a stretcher and transferred to the MR room.

Air Enema Technique

Air enema study was performed by inserting a urinary balloon catheter via the anus with the patient lying on the MR table. Then, 100mL of air was sufflated into the rectum. Then about 10mL of air was also sufflated to fill the balloon to avoid slippage of the catheter. It was also used as a landmark of the anal canal.

Slice Adjustments

The depth of tumor invasion was assessed by intersecting the tumor-bearing rectum perpendicularly to minimize the lateral spreading effect. Lymph node assessment was made with former images and axial planes from the level of the anus including the iliac vessels bilaterally as shown in **Figure 1**. Imaging Criteria Images were interpreted according to the criteria of the TNM classification. The depth of tumor invasion was expressed as T stage, and was classified into four categories. Lymph node metastasis was diagnosed as positive when the lymph nodes exceeded 5mm in diameter. N stage was also categorized into three categories **(Table 1)**.

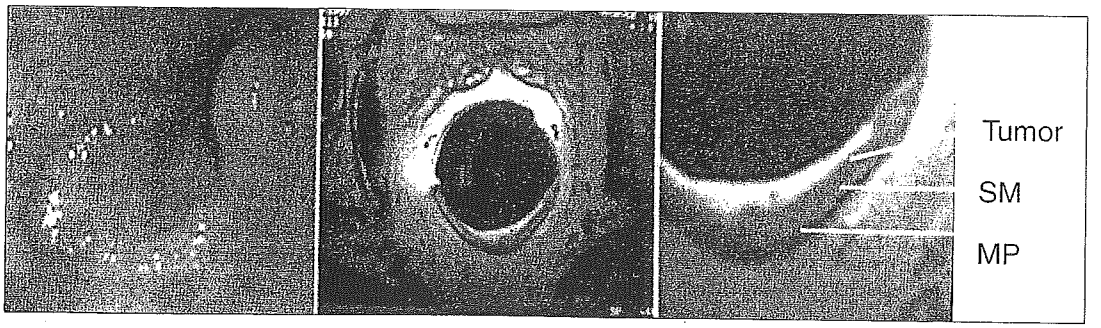

FIGURE 2
A case of early type tumor diagnosed as confined within the mucosa by means of prostate-use endorectal coil. **Left:** Endoscopic image; **Middle:** MR image; **Right:** Magnified MR Image of the lesional
SM: Submucosal layer; MP: Proper muscle layer.

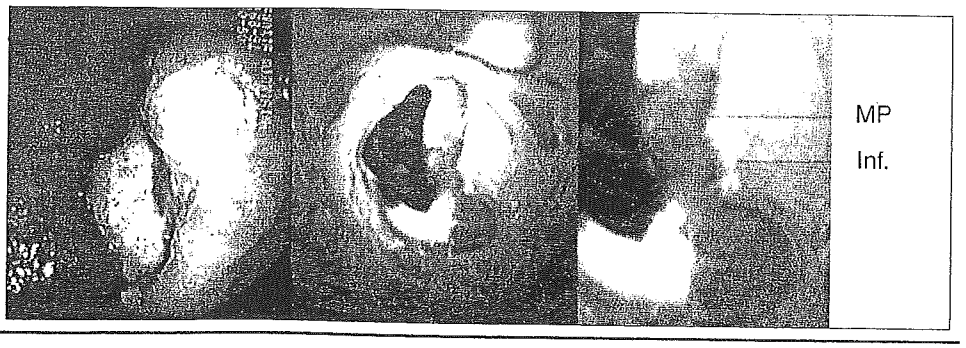

FIGURE 3 A case of advanced tumor diagnosed as T3 tumor by means of colorectal-use endorectal coil. **Left**: endoscopic image; **Middle**: MR Image; **Right**: magnified MR Image of the lesion; MP: proper muscle layer; Inf: infiltration of the tumor into perirectal adipose tissue.

Comparisons between Histological and MR Findings

Representative sections of the resected specimens were stained with hematoxylin and eosin, and evaluated for the depth of tumor invasion and lymph node involvement according to the TNM classification. Histological and MR findings were compared, and diagnostic accuracy was calculated.

RESULTS

Fifty-four consecutive patients were included in this study (37 male, 17 female). There were 10 early cases and 44 advanced cases **(Table 2)**. Images with an endorectal coil were obtained in 4 patients. Fifty patients underwent air enema study.

Depth of Tumor Invasion

The depth of tumor invasion was accurately diagnosed in all 4 patients undergoing endorectal coil examination. Two of 4 patients had an early tumor and were examined with a prostate-use endorectal coil. The remaining 2 patients with an advanced tumor were examined with a colorectal-use endorectal coil. In the cases with an early tumor confined within the mucosa, the gadolinium enhanced submucosal band was well preserved **(Figure 2)**.

In advanced tumors, disruption of the proper muscle layer with low intensity was clearly demonstrated and the tumor was defined as T3 **(Figure 3)**. The prostate-use endorectal coil was difficult to insert and place properly, so we gave up using this instrument in the vast majority of other patients having a protruded type tumor, even if it was assumed to be an early type tumor. Furthermore, the colorectal-use endorectal coil was a newly developed instrument, and was used in only two patients in this study period.

On air enema study, MRI correctly staged the depth of invasion in 41 of 50 patients (82.0%). Overstaging was seen in 8 of 50 patients (16%), however, only one patient (2.0%) was understaged. Overall accuracy, overstaging and understaging rates were 83.3% (45 of 54), 14.8% (8 of 54), and 1.8% (1/54), respectively **(Tables 2 and 3)**. With the air enema technique, we experienced a case in which discrimination between T1 and T2 was possible **(Figure 4)**.

TABLE 2 Distribution of Cases by T Stage according to Histopathological and Magnetic Resonance Imaging Findings

Histological examination	Total	Magnetic resonance imaging T1	T2	T3	T4
pT1	9*	9*	0	0	0
pT2	5	1	2	2	0
pT3	36*	0	0	30*	6
pT4	4	0	0	0	4

*: Including cases with endorectal coil.

TABLE 3 Overall Comparative Results of Histopathological and Magnetic Resonance Imaging Findings

		ERC (4)	AE (50)	Overall (54)
Tumor invasion	Accuracy	100% (4/4)	82.0% (41/50)	83.3% (45/54)
	Overstaged	0% (0/4)	16.0% (8/50)	14.8% (8/54)
	Understaged	0% (0/4)	2.0% (1/50)	1.8% (1/54)
Lymph node metastasis	Accuracy	75.0% (3/4)	72.0% (36/50)	72.2% (39/54)
	Sensitivity	0% 0	75.0% (18/24)	75.0% (18/24)
	Specificity	75.0% (3/4)	73.1% (19/26)	73.3% (22/30)
	PPV	0% 0	72.0% (18/25)	69.2% (18/26)
	NPV	100% (3/3)	76.0% (19/25)	78.6% (22/28)
	TP	0	18	18
	TN	3	19	22
	FP	1	7	8
	FN	0	6	6

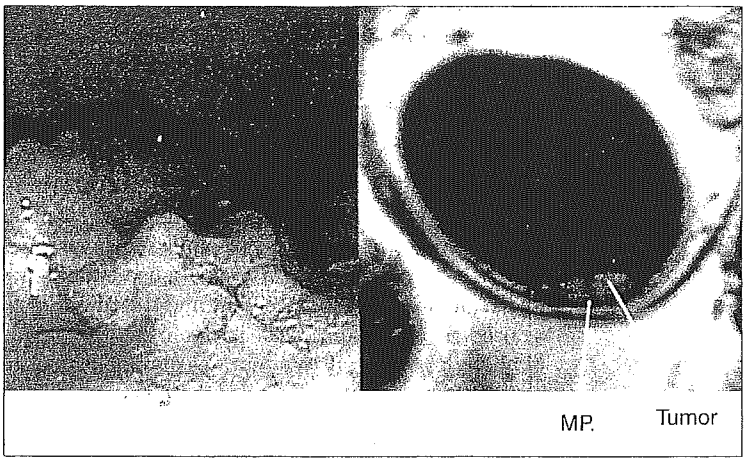

FIGURE 4 A case of T2 tumor examined by air enema technique. **Left**: endoscopic image; **Right**: MR image of the lesion; MP: proper muscle layer.

Lymph Node Metastasis

On endorectal coil study, accurate diagnosis of lymph node metastasis was obtained in 3 of 4 (75.0%) patients. These 3 patients were diagnosed as true-negative cases. The remaining patient was positive for lymph node metastasis on MRI, although the pathologic result was negative for metastasis.

On air enema study, an accurate diagnosis of lymph node metastasis was obtained in 36 of 50 (72.0%) patients. False-positive and false-negative results were noted in 7 patients and 6 patients, yielding 75.0% sensitivity and 73.1% specificity. Positive predictive value was 72.0% and negative predictive value was 76.0%. Overall MRI findings of lymph node metastasis resulted in 72.2% (39/54) diagnostic accuracy. There were 8 cases of false-positive and 6 cases of false-negative results, yielding sensitivity of 75.0% (18/24) and specificity of 73.3% (22/30), respectively.

Positive predictive value was 69.2% (18/26), and negative predictive value was 78.6% (22/28).

DISCUSSION

CT scan, endorectal ultrasonography and MRI are useful tools for preoperative staging of rectal carcinomas. These preoperative examinations showed superior accuracy to clinical examination (6). Rectal cancer is one of the tumors suitable for MRI assessment, because it is fixed in the pelvic cavity and not affected by respiratory movement (7,8).

As far as locoregional staging is concerned, ultrasonography is also a useful modality, and is more useful than MRI from the standpoints of cost-effective-