Diseases of the Colon & Rectum

Technical Notes

Total Mesorectal Excision: The Unrecognized Pelvic Plane

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Total mesorectal excision for low rectal cancers has been shown to reduce local recurrence rate after curative operation to < 5 percent. The lack of anatomic appreciation of the mesorectum is an important cause of inter-surgeon variability in the outcome of rectal cancer surgery. Surgical illustrations depicting the mesorectal anatomy, however, are less than accurate. Basic surgical concepts must be illustrated correctly to be learned correctly. True-to-life illustration is the only way the learner can appreciate the actual situation and improve his/her surgical results. We describe the mesorectal anatomy with correlation to computerized tomography scans of the *in vivo* rectum to further illustrate the technique of total mesorectal excision in rectal cancer surgery. [Key words: Total mesorectal excision; Rectal cancer; Surgical technique]

The introduction of a standardized operation, total mesorectal excision (TME), for low rectal cancer has been shown to reduce local recurrence rate after curative operation to < 5 percent without the use of adjuvant radiotherapy.[1,2] A well-conducted, anatomic dissection of the "mesorectal plane" can only be achieved with sound knowledge of the anatomic relations of the rectum to the sacrum. Although the superior results of TME dissection are widely known, the technical aspects of the dissection itself are not as well illustrated. This failure of accurate diagrammatic depiction may have been the cause of inaccurate surgical dissection, increased local recurrence, and misunderstanding regarding distal mesorectal tumor deposits. Troublesome bleeding and damage to the inferior hypogastric plexus also are companions of inaccurate dissection techniques.

All published illustrations by surgeons depicting the mesorectum were drawn with the pelvis in the upright position and the sacrum as a smooth curve (Fig. 1). However, TME is performed with the patient in the Trendelenburg position. This is not just a theoretic problem. Surgical dissection proceeding according to the "usual" illustrations will involve dissection along the gradual curve of the sacrum only (Fig. 1). The radiologic imaging (Figs. 2A and B) shows that TME dissection must proceed in two different planes at approximately right angles rather than in a gradual curve. The "horizontal plane" is formed by the curve of the sacrum, whereas the "vertical plane" is formed by the pelvic floor (levator muscles) and the coccyx. We call these two planes the sacral plane and the pelvic plane respectively. The vertical take-off or pelvic plane is extremely important but is not well illustrated. This pelvic plane is normally 4-cm to 6-cm long, and inaccurate dissection of this plane is a major cause of increased local recurrence in rectal cancer surgery. Nonappreciation by pathologists of the existence of this vertical take-off is the probable cause of mislabeling "distal" mesorectal deposits.

Heald *et al.*[3] first reported the presence of isolated adenocarcinoma deposits in the mesorectum distal to the apparent lower edge of the tumor, suggesting that these microscopic foci might be responsible for

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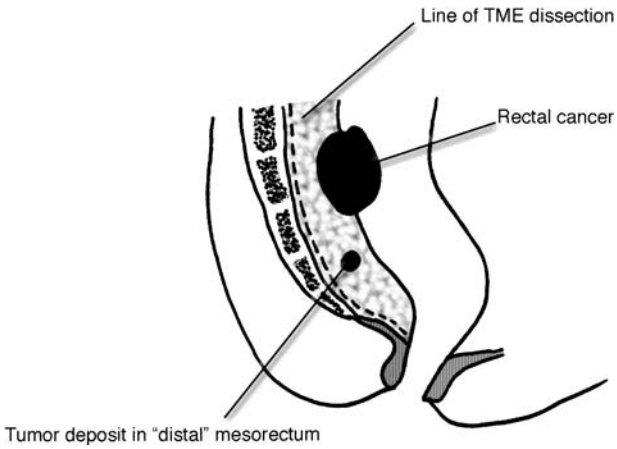


Figure 1. "Usual" illustration of TME dissection shows the pelvis in the upright position. Note that the line of dissection along the sacrum and pelvic floor is depicted as a smooth curve in contrast to the radiologic imaging in Figure 2.

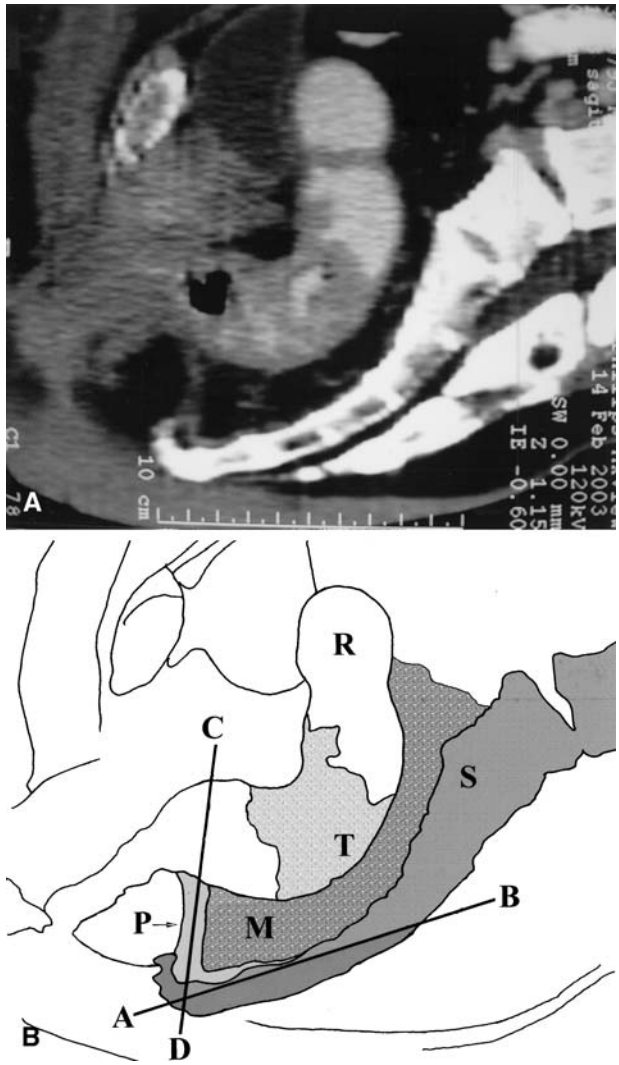


Figure 2. Midsagittal CT scan of pelvis (A) and line drawing of the same scan (B), showing rectum (R) filled with contrast containing tumor (T). Line AB represents the horizontal or sacral plane drawn through the axis of the sacrum (S), whereas line CD represents the vertical or pelvic plane drawn through the pelvic floor (P). Note the angulation between the two lines. The rectum is separated from the sacrum by the mesorectum (M).

pelvic recurrences after conventional anterior resections. The presence of mesorectal tumor extension distal to the tumor mass also has been "demonstrated" by other investigators.[4,5] However, these studies looked at the distal tumor spread in resected specimens and conclusions about the actual *in vivo* relationship between the tumor deposits and the main tumor cannot be accurately inferred from studies of *ex vivo* specimens. Although some investigators attempted to address this by fixation of the resected specimens on cork boards before fixation as a means of minimizing postfixation shrinkage of the specimen, the stretched out tissue on a board bears no resemblance to the actual anatomic configuration of the tumor and its metastatic deposits in the pelvis. Also, stretching of the specimen during the process of rectal mobilization could lead to a distortion of the rectum and the mesorectum, further confounding the interpretation of the extent of distal mesorectal spread in the resected tissue. Indeed, a poor correlation has been observed between the measurements taken *in situ* and the measurements by the pathologist in the resected specimens.[5]

In vivo CT scan clearly demonstrates that the corresponding segment on the mesorectum of a particular point on the rectal wall may fan out because of the angulation of the coccyx and the pelvic floor (Figs. 3A and B). This is analogous to the inner and outer tracks at the corner of a race course. Because of this "cornering effect" of the mesorectum at the pelvic take-off, the corresponding segment of the mesorectum may appear to be distal to the rectal wall. Therefore, distal mesorectal metastatic nodules may represent spread into the corresponding segment of the mesorectum rather than a true distal spread. A line of resection indicated by E-G-F in Figure 3B would include the primary tumor and the metastatic nodule in the corresponding segment of the mesorectum. However, if the line of resection is taken at P-Q (Fig. 3C) without appreciating the *in vivo* anatomy of the mesorectum, the metastatic deposit in the mesorectum would have been left behind, leading to inadequate surgical resection. This

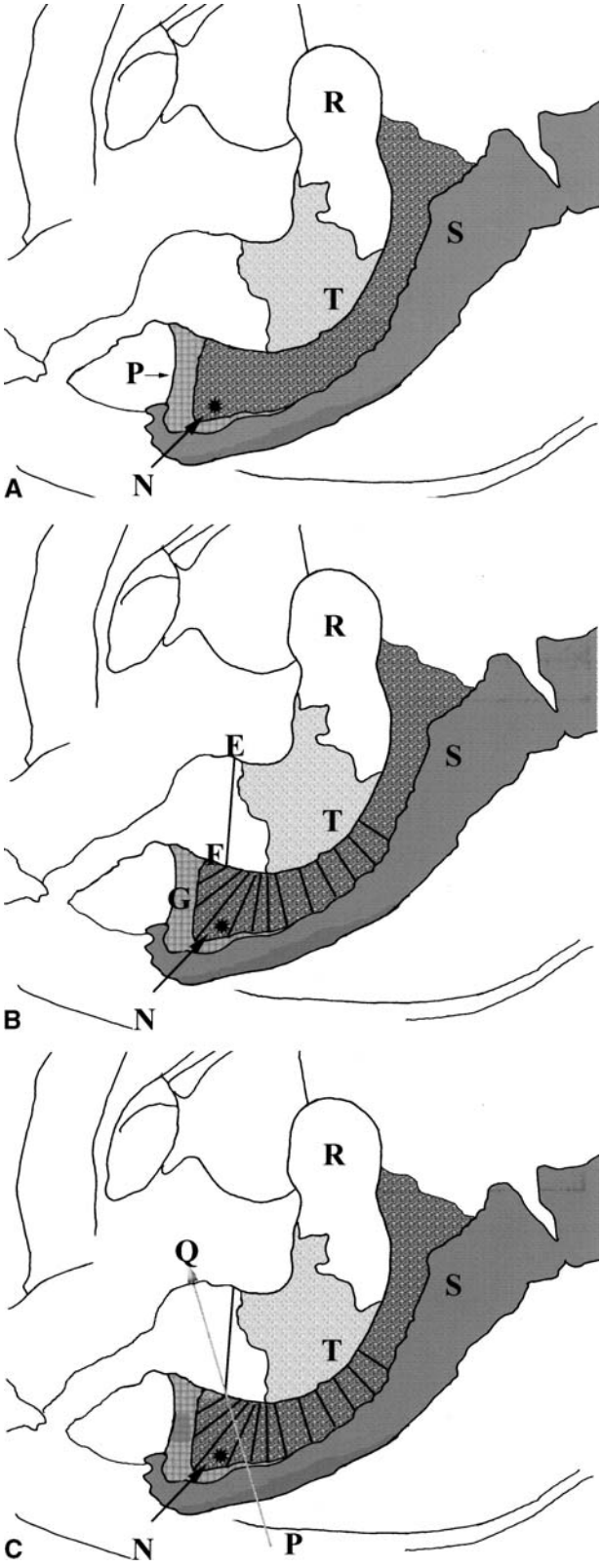


Figure 3. A. Line drawing of midsagittal view of the pelvis showing rectal tumor (T) with metastatic nodule (N) in mesorectum. This appears to be "distal" to the level of tumor. B. Solid lines in the mesorectum are drawn perpendicular to the surface of the tumor (T). Because of the curvature of the sacrum (S) and the angulation formed by the pelvic floor, fanning out of the distal mesorectum occurs. Tumor deposits in the mesorectum will appear to be distal to its corresponding portion of the rectum. Taking this into account, a line of resection indicated by EGF would encompass the metastatic nodule and the primary tumor. C. However, if the line of resection is taken at PQ from premature "coning in," the metastatic deposit in the mesorectum would have been left behind leading to inadequate surgical resection.

concept has a crucial part to play during TME surgery as well. A lack of appreciation of this angulation results in premature "coning in" during mesorectal dissection, leading to increased risks of local recurrence.

This lack of anatomic appreciation of the fanning out of the mesorectum is an important cause of intersurgeon variability in the outcome of rectal cancer surgery.[6–8] Therefore, basic surgical concepts must be illustrated correctly to be learned correctly. True-to-life illustration is the only way the learner can appreciate the actual situation and improve his/her surgical results. The vertical take-off plane when well appreciated will enable the surgeon's mesorectal dissection to soar to greater heights.

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Invited Commentary

To the Editor—I write this commentary as the originator of the term TME (total mesorectal excision) and as the publisher of the first even more inadequate version of Figure 1. I applaud this necessary attempt to address the communication challenges implicit in explaining to a young surgeon the "TME concept." Even the form of the excised specimen defies both description in words and illustration on paper. Only rotation of the specimen in many planes on video or film clip, preferably three-dimensional, can convey its complex shape. The TME concept in my brain was initiated because of my passion, as a simple surgeon, for following avascular planes. It crystallized with the realization that both the existence of the planes and the substantial improvement in oncologic results stemmed from the fact that the rectum, mesorectum, pedicle, and indeed the whole left colon were the embryologic "hindgut"—a midline derivative with a single midline lymphovascular supply. As my colleague, Darren Gold, recently commented, "It is no wonder there are surgical planes there because the whole gut came right out and went back in again in utero." These ideas held out the distinct possibility that this cancer with its special proclivity for lymphovascular spread might retrace the steps of embryology, which might in turn point to a better plan for better surgery.

How to describe the practicalities—that is the question! I was once greatly indulged by the Editor of the *Journal of the Royal Society of Medicine* and was allowed to use the somewhat exotic title, "the holy plane of rectal surgery." Throughout the world, this metaphor has helped to communicate to surgeons the importance of fastidious oncologic dissection around an embryologically defined envelope of tissue. The mesorectal "buttocks" have in the same way played a communicating role at workshop level, although seldom in print. I believe that surgeons will similarly identify with the term "vertical lift off" from Professor Seow-Choen and his colleagues' valuable article. It may take the reader a little longer to get his or her head around the authors' "horizontal" and "vertical planes." They will be helped if they visualize a sagittal section through the patient whose Trendelenburg position makes the levators vertical and the sacrum horizontal. Progress during surgery starts along the horizontal plane and the more difficult distal dissection continues forward in the authors' vertical or pelvic plane: vertical take off. Completion of this demands lateral dissection of considerable difficulty. This includes liberation of an untorn mesorectum from its area of adherence to the inferior hypogastric plexuses: the area of the so-called lateral ligament. Surgeons in the past so often used their finger here to create a bundle, which seemed to deserve the term ligament. In reality, when they did this they often tore into the mesorectum, so that the bundle contained an artery, which they wrongly called middle rectal. It was most often intramesorectal, and the anatomy book description was wrong; there generally is no artery coming from the internal iliac at this level.

Other important concepts also are highlighted in this article. It points to the differences between the relative positions of tumor and node "*in vivo*" and in the pinned out specimen of classic histopathology. Axial slicing of the unstretched and unopened specimen is a step in the right direction, and modern magnetic resonance imagining may go a long way toward positional correlation between patient and path-lab and toward surgical realization of the special dangers of "coning in" to the mesorectum posteriorly.

Some may find the authors' race track analogy difficult, but there is little doubt that some of the importance of TME stems from encompassing deposits that appear distal in specimens but were sitting "*in vivo*" close behind the primary cancer. Similarly the failure of the surgeon to appreciate the "fanning out" of the mesorectum distal to the pelvic parasympathetic nerves is a risk factor for coning into the mesorectum lower down with consequent risk of oncologic failure.

Total mesorectal excision is now widely accepted as a surgically definable "building block" in rectal cancer surgery—of all the aspects of modern therapy still perhaps *the* most important. Surgery, however, is a pragmatic craft in which the colloquialisms of the artisan may convey more than the exactitude of the scientist. This article adds these new terms to holy plane, coning in, and erigent pillars: vertical take off, mesorectal fanning out, and cornering effect. Al-

though of little interest to the modern multidisciplinary cancer scientist in general, these ideas will strike many a chord among practical surgeons whose toil in the depths of the pelvis may thus be encouraged to "soar to greater heights."

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The Authors Reply

To the Editor—We are thrilled that Professor Heald, a giant of a surgeon, has taken so much interest in our ideas. In truth, we agree entirely with his sentiments. Modern surgery has started to take a turn in which the use of nonsurgical techniques to boost the "less than ideal" results has been imprinted on the minds of surgeons. There is still much to be said for the days of clinical medicine and surgery. The apprenticeship system in which surgeons are taught by observation and then to think about what one had seen and done and then to reflect on these must never be lost. Surgery must not be learned just from books or text. Surgical frontiers must still be explored by each succeeding generation of surgeons. There is still much to learn.

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