Conceptually TME has its basis in embryology. The original hypothesis was that cancer spread will tend, initially at least, to remain within the embryologic lymphovascular hindgut "envelope" the mesorectum and mesocolon.

The corollary to the perfect specimen and cure is the perfect preservation of the layers surrounding the mesorectum which, are formed by the autonomic nerves and plexuses. The first obstacle is that few realistic photographs, sketches or diagrams have been published and visualisation and lighting low down in the pelvis is always problematic. Even when they are understood and visualised the difficulties inherent in preserving these nerves are due to the fact that they are actually adherent to the mesorectum at certain points where the dissection becomes particularly challenging.

The most important and most adherent areas are the so-called "lateral ligaments" – low down laterally and anterolaterally where the inferior hypogastric plexuses (virtually the pelvic sex-brain) tether the whole mesorectal package. When the specimen has been carefully released it lifts up in a somewhat spectacular fashion – hence the old idea that there are ligaments at these points. A lesser degree of adherence may be found at various other points and particular care is required anteriorly where the nerves are converging towards the bulb of the penis with a trapezoidal septum between them – Denovillier's "fascia"- which is in turn adherent to the anterior mesorectum and lower down in the prostate.

Key words: nerve, preservation, rectal cancer

STEPS OF THE OPERATION

The key principle is that dissection should only proceed in the areolar tissue plane (the "holy plane") within (and thus sparing) the autonomic nerve plexuses. Also outside the hind gut and therefore best preserved are the nonvisceral presacral fat pad (when present), the parietal sidewall fascia of the small pelvis, the vesicles, and the prostate in the male, and the vagina in the female. All of the dissection should be performed sharp with diathermy or scissors under direct vision with good light. Modern diathermy improvements such as "Triverse" and "Force Triad" (Valleylab) provide more precise dissection with minimum collateral damage and probable reduction in coagulation damage to the nerves.

Throughout, dedicated assistants should provide three-directional traction and counter-traction to open up the planes for the operator—diathermy can only be used safely when the areolar tissue is on stretch. Compared with traditional methods of manual extraction, the difference in time can be considerable. A careful TME plus pouch to anus reconstruction with careful nerve preservation takes 3 to 5 hours according to the detail of the patient’s build and the particular cancer; a conventional APE was often completed in 1 hour. "The devil is in the detail".

"Starting right”—the pedicle package—the clue to the top of the "holy plane"

Starting correctly involves three-directional traction between the mesocolon and retroperitoneum to identify the plane between the back of the pedicle package and the gonadal vessels, ureter, and preaortic sympathetic nerves— all of which must be carefully preserved.

The key to this phase is the recognition of the shiny fascial-covered surface of the back of the pedicle—like a tapering longitudinal "sausage" with the inferior mesenteric vessels within and their origins at the upper end. This must be gently lifted forward to open up precisely the key embryological plane. It is usual in open surgery to start on the left of the sigmoid mesocolon.

It is equally satisfactory, as commonly performed in laparoscopic surgery, to start on the right. If all this is done carefully a plexus of autonomic nerves including two preaortic mini-trunks splitting around the artery can be visualised and preserved. (Fig.1)
High Ligation of the Inferior Mesenteric Vessels (Figs. 2 and 3). With the pedicle package lifted gently forward the dissection behind it can be extended up to its proximal end; separate high ligations of the inferior mesenteric artery and vein can be performed with the pedicle controlled by the left index finger. The artery is taken 1 to 2 cm anterior to the aorta so as to spare the sympathetic nerve plexuses; (Fig. 1) the vein is divided above its last tributary close to the pancreas.

These two high ligations are an integral part of the otherwise avascular dissection, which needs to be developed upward extensively for a full mobilization of the splenic flexure if anastomosis low in the pelvis is planned. For APE the high ligation of the artery alone is required and the vein can be taken nearby.

The "Division of Convenience"

The sigmoid mesentery and the sigmoid colon are divided well above the cancer. This is an important step in every cancer dissection as optimal mobility of the top of the specimen facilitates gentle opening of the perimesorectal planes by traction and countertraction in any direction throughout the pelvic dissection – important for nerve preservation.

High Posterior Dissection

Forward traction demonstrates the shiny posterior surface of mesorectum within the bifurcation of the superior hypogastric plexus (Fig. 4). Recognition of this shiny fascial covering may precede the actual nerve identification. This plane is extended gradually downward toward and eventually beyond the tip of the coccyx, step by step as other sectors of the circumference are developed. Very long St. Marks or Reverse curve (Heald) St. Marks retractors (Bolton Surgical, Sheffield) are really crucial.

Lateral Pelvic Dissection

This involves forward extension of the plane around to the sides, gently easing the adherent hypogastric nerves laterally off the mesorectal surface under direct vision (Fig. 5 and 6). The freedom to lift the divided rectosigmoid forward often means that the tangentially running hypogastric nerves are first positively identified at this stage, the superior hypogastric plexus itself only becoming obvious proximal to the nerves after the areolar tissue plane has been dissected away from the shiny mesorectal surface on each side.

These nerves are far more important than hitherto appreciated because they subserve many of the functions of orgasm in both sexes, while the inferior, more distal inferior hypogastric plexus must be preserved to protect the more obvious and substantial parasympathetic function of erection.

The Nervi Erigentes or "Erigent Pillars" (Fig. 7) form posteroanterior lateral "pillars" on the pelvic sidewall. Cadaver dissections have led us all to be taught that the pelvic parasympathetic outflow is tripartite S2–3–4. However, to the surgeon there is no doubt that a recognizable landmark is often a single or bifid "pillar" comprising a nerve root arising from the front of the S3 component of the main sacral plexus (Fig. which is out of sight posteriorly). Possibly, the pillar-like appearance is in part due to the forcible forward traction on the prostate and bladder applied in order to see during an open operation, and this...
tends to bow the nerves medially and thus make them stand out so that they are more readily identified than in laparoscopic surgery.

This retraction does not occur to the same extent in a laparoscopic operation, which may account for the reported higher incidence of nerve damage. These pillars and the hypogastric plexuses curve medially (Fig. 8) toward the back of the prostate, where they form the neurovascular bundles, which taper toward the urethra at the apex of the prostate. Here they become the erectile nerves of the corpora cavernosa. The pillars or roots arise outside the parietal fascia that they penetrate obliquely as they curve toward the point of adherence to the anterolateral aspect of the mesorectum.

More anteriorly the plane is followed downward toward the vesicle laterally, with the expanding plexiform band of inferior hypogastric plexus behind but increasingly adherent to it. In essence, there is no actual ligament but an area of adherence between mesorectum medially and plexus laterally which tethers the rectum and mesorectum to the lateral wall at this critically important point: small branches of nerves and vessels penetrate through but none generally reaches more than 1 to 2 mm in diameter.

The key nerves entering and forming this flattened band from above are largely the sympathetic hypogastric nerves curving distally from the superior plexuses. From behind the "erigent" parasympathetic nerves come forward to it from the anterior aspect of the sacral plexuses, which are out of sight. The "neural T junctions" are the nearest structures to "lateral ligaments" that the most careful surgeons will find with precise dissection in the proper plane. Only rarely found by the surgeon during this dissection is the "middle rectal artery" (Fig. 9) which was, I believe, in past days usually a surgical "mistake - being most often in reality a lateral intra mesorectal artery.

The so-called "stalk" that used to be divided usually represented a "coning in" to the mesorectum and division of an artery which should have been encapsulated by the perimesorectal block dissection. Such "coning in" does, of course, imply a compromise of the oncological quality of the "block dissection" because it means that part of the distal mesorectum is being left in the pelvis.

**The Anterior Dissection—Denonvilliers Septum**

Dissection anterolaterally and anteriorly following the correct plane forward will, in the male, encompass the peritoneal reflection that remains on the specimen and thus allows positive identification of the backs of the seminal vesicles. Forceful forward retraction on these with a St. Mark’s retractor will facilitate the development of the areolar space between the vesicles and the smooth front of the mesorectal specimen (Fig. 10).

We call this smooth surface that is generally adherent to and clearly a part of the mesorectum Denonvilliers fascia or the rectogenital septum. As one works distally, there comes a point where this fascia must be divided transversely (Fig. 11) as it becomes adherent to the posterior capsule of the prostate. Particular care is necessary during...
this step to avoid damage to the neurovascular bundles (of Walsh) that constitute the distal condensation of the inferior hypogastric plexuses.

These are gradually intertwining with vessels to become the "neurovascular bundles of Walsh" which run posterolateral to the prostate. These various steps all complement each other — circumferentially, first in one segment and then in another — usually furthest advanced at the back. Hand in hand with the anterior dissection goes the development of the lateral sidewall dissection, first on the right, then on the left and so on with great care and gentleness.

The whole area of the rectoprostatic interface is a particular current challenge in technical surgery — both open and laparoscopic — especially because the neuro-vascular bundles posteriorly relative to the prostate (Fig. 12).

Dissection of the Most Distal Mesorectum

The anatomy of the insertion of the mesorectal "package" into the pelvic floor becomes difficult for the surgeon to grasp because of its inaccessibility behind the vesicles and prostate in the male and to a lesser extent behind the vagina in the female. The situation is further complicated by the fact that the levators are like a "flower pot" in continuity with external sphincter distally. Conceptually, and because of the distortion introduced by upward traction, surgeons tend to think of the pelvic floor as being much flatter than it really is in vivo, especially if an assistant applies upward pressure on the perineum.

If one doubts this, a careful look at the layers on a coronal MRI scan will make it evident. A clear three-dimensional perception of the now globular bilobed mesorectum in the depth of the pelvis and the surrounding neural lamella is the most elusive and challenging conceptual acquisition for the aspiring rectal cancer surgeon.

Partial Mesorectal Excision (i.e., High Anterior Resection and Mesorectal Transection)

While muscle tube margin may safely be reduced to 1 cm in the interest of anal conservation, we have always believed that, if less than a total mesorectal excision is contemplated, a minimum of 5 cm of mesorectum distal to the lower edge of the cancer must be dissected in the perimesorectal plane. If, therefore, after initial mobilization there is a clear 5 cm of mesorectum, then tapering into the mesentery, in the interest of making a more minor operation and a higher anastomosis, becomes acceptable.

The operation then becomes perimesorectal mobilization, mesorectal transection, anterior resection, and primary anastomosis for rectal cancers above around 12 cm. The absolute rule for all rectal cancers is that either 5 cm of mesorectum distal to the tumor or the whole mesorectum must be removed intact with the same preoccupation to achieve clear circumferential margins. The higher anastomosis and the reduction of risk to the nerves combines to make the PME operation significantly less major for the patient, and a temporary stoma may often be avoided in these higher tumours.
Identification of the Neurovascular Bundles behind the prostate and bulb of penis - The prone jack-knife position for the perineal phase of Abdomino-Perineal Excision (APE)

The author has been impressed in recent years by several advantages inherent in performing the perineal phase of the abdomino-perineal operation, when that is indeed necessary for the very lowest tumours, in the face down position. For the first time we have established that, if a marker clip is placed on the most distal component of the inferior hypogastric plexus towards the end of the abdominal phase, the downward path of these crucial nerves can be later identified from below. Success in this endeavour appears to require the removal of the coccyx which also facilitates precision in all of this final phase. Around the upper lateral (Fig. 13) corner of the prostate the nerve plexus becomes vascularised and intertwined with vessels, but does remain within a fascial sheath that courses down to become the nerve supply of the bulb and body of the penis. We believe that the routine visualisation of this lowest component of the nerve plexuses is one of the great challenges of the new century for the surgeon striving for better nerve preservation.

Courses down to become the nerve supply of the bulb and body of the penis. We believe that the routine visualisation of this lowest component of the nerve plexuses is one of the great challenges of the new century for the surgeon striving for better nerve preservation.

It is probable that the greater incidence of impotence after APE reflects the failure of most surgeons in the past to recognise these neurovascular bundles during the perineal phase.

CONCLUSION

Rectal cancer surgery is probably the most rewarding of all the challenges to the aspiring gastrointestinal surgeon. Arguably there is no cancer operation where proper decisions, the judicious selective use of adjuvant therapy, and, most of all, surgical skill of the highest order can bring so much benefit to the patient. Cancer cure, normality of bowel function, avoidance of a lifelong stoma, sexual function—all of these hang in the balance for the patient. The profession still has a long way to go in using its resolves to deliver what is possible and affordable to each person who hopes for an optimal outcome – the preservation of...
sexual function should have the highest priority in surgical teaching in the immediate future.

**SUMMARY**

**PREZERVACIJA AUTONOMNIH NERAVA U HIRURGIJI KARCINOMA REKTUMA- ZABORAVLJENI DEO TME**

Konceptualno totalna mezorektalna ekscizija (TME) se bazira na embriologiji. Originalna hipoteza navodi da će se karcinom inicijalno razvijati u okviru embrioloških granica limfovaskularnog "omotača" mezorektuma i mezokolna.

Ključne reči: nervi, prezervacija, karcinom rektuma

**FURTHER READING:**