The 'Holy Plane' of rectal surgery

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Keywords: rectal cancer; mesorectal excision; anterior resection; local recurrence

Based on Presidential Address to Section of Surgery, 7 October 1987

The surgical plane

For me surgery is primarily a craft and I see little shame in regarding a surgeon as a person who exists to do operations. Of course to know when not to do them and to be humane and honest with the patients is also of immense importance and there are many facets of our lives which perhaps transcend mere operative skill or technique. Nevertheless, this is the story of a simple artisan's pleasure in the actual style of performing an operation - in essence the way to use a pair of scissors to define and develop a plane in a precise manner. The unique nature of this skill and its difference from the skills of carving the Sunday joint provide an excellent excuse for all surgeons whose wives seem unimpressed by their efforts in this other important field. A surgical plane is a potential space between contiguous organs which can be reproducibly created by dissection. In many cases a clue to the existence of the plane is provided by a glimpse, through the window of its peritoneal covering, of **mobility** between (for example) a visceral structure (e.g. the mesorectum) and the somatic structures which surround it. It has long been a strong personal preference to find these planes around the gut and its derivatives with exasperating slowness. Thus, when armed with one of the early SPTU guns which Professor John Goligher had introduced to me, I set off on my 'Have gun, will travel' exploits. My desire to move the tissues back and forth in search of the perfect mobile lubricated plane led to real embarrassment with some of my host surgeons who supposed that some inexplicable and perhaps fatal 'fiddling inertia' had overtaken their guest who had after all been invited to 'fire the gun'. In developing these planes there are thus three basic principles:

(1) Recognition of mobility between tissues of different embryological origins.
(2) Sharp dissection under direct vision in a good light.
(3) Gentle opening of the plane by continuous traction with no actual tearing. 'The job of the Assistant is to put the tissues on stretch' (Lawrie)[1].

WITHIN THE HOLY PLANE

Rectal cancer: Scylla the rock (the tentacles of tumour within the mesorectum)

Stimulated by the arrival of the circular stapling devices and fear that lower anterior resections would lead to more local recurrences I extrapolated my child-like pleasure at pursuing planes into an almost pathological pre-occupation with extending them precisely around the mesorectum into the depths of the pelvis. The lower anastomosis, made possible by the 'guns', seemed to make total mesorectal excision - that is the removal of the whole visceral mesentery of the rectum - a logical extension of the radicality of low anterior resection which traditionally divides it and leaves a substantial circumferential and distal residue (Figure 1). This has now been used as the defined limit for all middle and lower third cancers undergoing restorative resection for over 9 years. It seemed that lymphatic extension might be the basis of a danger zone around the visible and palpable tumour - the variable resection of which might provide the explanation for the extraordinarily wide variation in reported local recurrence rates. More recently Williams[2] has emphasized this direct extension aspect and drawn attention to the very small margins of lateral clearance, amounting to only a few millimetres or less, which are commonplace in rectal carcinoma. In his multi-surgeon series the most exhaustive serial sectioning technique of the lateral margins of the specimen showed that 27% of rectal excisions had, if looked at carefully enough, gone *through* the edge or satellites of the tumour. All but one of these have already developed clinical local recurrence compared with only one out of 32 in whom there appeared to be a clearance, however small. It is apparent that both satellites and direct extension play a part, although, from the practical surgeon's viewpoint, this is of lesser importance than attempting to DEFINE AN OPTIMAL DISSECTION PLANE around the cancer which must clear all forms of extension and circumscribe predictably uninvolved tissues. Since the plane which surrounds the mesorectum is created by its separate embryological origin and the whole rectum and mesorectum are one distinct lymphovascular entity I have always argued that there is an inherent probability the tumour may initially tend to be confined within it. Pannett[3] in 1935, observing this tendency for even advanced tumours to be so contained, thought the pelvic fascia very important - 'an almost impenetrable barrier to the spread of carcinoma'. To me the more probable explanation is that the tumour is more apt to spread initially along the field of active lymphatic and venous flow. In my view the

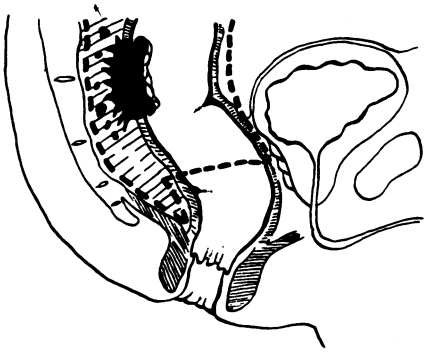

Figure 1. Diagrammatic representation of the Holy Plane, as published in the British Journal of Surgery in 1982

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fascia itself is 'impenetrable' only in the sense of being an avascular interface between viscus and soma - it is indeed the 'Holy Plane'. One of my former chiefs, Lawrie[1], used to teach that 'when you can make every operation the same you can start to learn something about it'. Pursuit of the 'Holy Plane' around the hindgut has enabled us to make every restorative rectal excision the same with only slight modification at the lower end for the abdomino-perineal case. The lowest part of the plane forms a 'waist' on the AP specimen which is rarely breached by the tumour so that the cone of excised levator muscle is seldom actually invaded. We can now make claims about the importance of the plane which go far beyond the original enterprise of reducing the number of permanent colostomies to less than 15%.

The analysis of results

The Basingstoke bowel cancer clinic

A British Health District with a catchment area of around 250 000 people provides a uniquely unselected random group of patients. Of all the rectal carcinomas referred to Basingstoke District Hospital or to me exactly 90% have been operated upon by myself. They have been monitored by a full time research person who knows all the Basingstoke patients personally, provides a shoulder to cry on, a telephone number to call, and a friendly link with the hospital for NHS and private patients alike. I would argue therefore that the completeness of the follow up and Mrs Sexton's personal knowledge of the patients provides data of a higher standard than can possibly be achieved in larger series. The clinic itself has been manned by myself and a Consultant Oncologist Dr R D H Ryall, and every one of the patients has been examined by both of us at various times. We have regarded pelvic examination by an experienced specialist as the most important aspect of the follow up. However, in addition, CEAs have been performed on every visit and increasingly liver ultrasounds have been used to detect recurrences as early as possible in the hope of being able to perform timely liver resections with our new CUSA ultrasound dissector. On the lifetables recurrence is indicated as an event if the CEA rises or if recurrence is suspected clinically or on any investigation. No patient has been lost to follow up and the computer is programmed to provide data and lifetables only to the last date when the status of every patient is known - a very demanding arrangement which allows no 'cheating' at all.

A 9 year cancer follow-up

During 1987 we re-analysed the figures for our anterior resections. They are not of course very different from the results we published in the *Lancet*[4] a year and a half ago. It is no exaggeration to say that the low local recurrence rate, which we had initially published in 1982[5] - has been the most exciting single development in my surgical life. Conversely however, I am aware more recently of a substantial growing away from low anterior resection because of high local recurrence rates[6] and recent publications reassert the depressing information that more than one half of all patients operated upon with rectal cancer 'for cure' will develop recurrence[7] and more than half of these will be in the pelvis[8]. Of 132 consecutive personal anterior resections classified at operation as 'curative' only 3 patients over the whole 9 year period have developed a local recurrence either at the anastomosis or within the pelvis, a cumulative predicted local recurrence rate of 3.3%. The spread of possible rates of clinically significant local recurrences at the 95% confidence level comes out at just over 0-5%, though we should be very fortunate or unfortunate to be at either of these extremes. Even if we re-classify as 'curative' the further 17 locally 'non-curative' operations (i.e. the only ones whose classification could possibly be argued about) the overall local recurrence rate still only rises to 5%.

It is necessary to record that washout of the rectal stump has been performed in every case and is regarded as a crucial and elementary precaution against implantation. There are of course many ways of doing an operation badly!

One other aspect of the management of rectal cancer is radiotherapy. During the years of this study Dr Ryall and I have moved to a point of extreme conservatism amongst those who believe that radio-therapy is indeed effective. We have restricted it to the locally palliative case without metastases but with obliteration of the 'Holy Plane'. In every case a 'trial dissection' which has demonstrated local inoperability has been the indication for high dose radiotherapy, to be followed 3 months later by a further attempt at anterior resection or abdomino-perineal excision.

The importance of local recurrence

Local recurrences are the most important reflection of surgical technique in cancer and the most direct measurement of the relevance of surgery to its control. Local disease is also the worst form of death for our patients - producing pelvic and perineal pain, foul discharge, faecal incontinence, swelling of the lower limbs, etc., all of which are largely absent from the last months of those who die of metastases. These words from the end of the last century describe the fate of all rectal cancer patients then:

> 'All carcinomas of the lower sigmoid and upper rectum are tabooed by all practical surgeons . . . on account of their inaccessibility. All are abandoned without hope to linger on for a few months until death relieves them of their loathsome condition.'
>
> (Maunsell, *Lancet* 1892;ii:473)

This remains true towards the end of this century for those who die of the primary or its residues, still according to Silen the majority group. We have no case in the curative group where local disease is the 'lead' recurrence and only 5 in any group where it has caused symptoms.

Dr Ryall[9], my oncological and radiotherapeutic colleague, frequently asserts that he has two totally different practices only a few miles apart - in the other local recurrence is a common problem which he grapples with regularly and for the most part ineffectually.

The two life tables (Figure 2) make a further fundamental point. Less local recurrences actually mean more long term survivals, i.e. most patients whose local recurrences are being prevented by improved technique were free of metastases at the time and are thus being converted to extra 'cures'. Less than 5% local recurrences means more than 75% long term 'cure' rates.

Exclusions from the anterior resection series, *including* those undergoing APE, amount to only around 15% of the referrals (Table 1) so that, like the

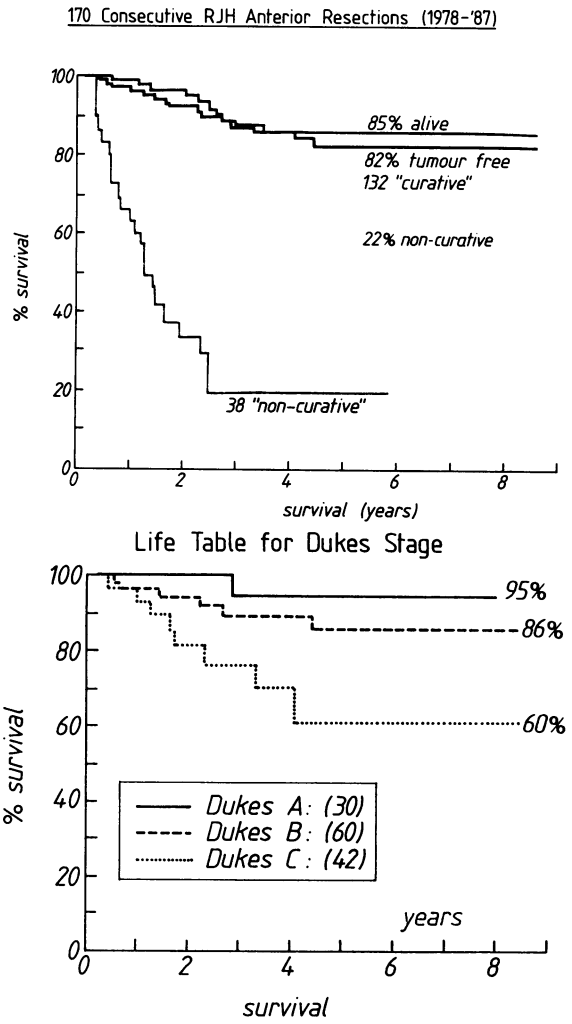

Figure 2. Survival and tumour-free survival. First graph shows Surgeon's classification into curative and palliative. Second graph shows survival according to Dukes Stage. TME makes most difference to 'C' cases.

Table 1. Two hundred and three consecutive personal rectal cancer referrals 1978-1987

Abdomino-perineal excision	20 (9.8%)
Hartmann's operation	3
No resection	2
Local excision	1
Refused operation	1
Anterior resection	176 (86.7%)

'non-curative classification' argument, the total exclusion effect is small and does not invalidate my main assertion that we are actually 'curing' three quarters of all rectal carcinomas without overt metastases at the time of surgery - simply by trying to do the surgery better and thus having fewer local recurrences.

'OUTSIDE THE HOLY PLANE'

Charybdis - the Whirlpool of the uncharted: autonomic nerve plexuses, internal iliac nodes and pelvic veins

The hypogastric plexuses

When one considers the care afforded to the recurrent laryngeal nerves by all surgeons and the relative importance of speech and the functions served by these nerves, at least to many people, then it is perhaps surprising that more attention has not been paid to them. As Sir Hugh Lockhart-Mummery puts it, and I have been *so* grateful to him for his help in many of these cases, it is all too easy to 'cut the top off a nerve kinked up by traction'. To avoid doing this it is essential to see the presacrals and to try to see the nervi erigentes and then to cut just within them and gently push them away laterally. We divide the peritoneum to enter the 'Holy Plane' either on the left or the right side of the mesentery - custom seems to dictate that one should start on the left, when my first step is always to identify the left presacral nerve. There are in reality two virtually bloodless planes, one inside and one outside the inferior hypogastric plexus. This is surely a strong argument on its own for not using the traditional 'manual extraction' technique since this can not possibly take account of which of the two planes is being entered, and the operator is likely to emerge with varying amounts of the inferior hypogastric plexus attached to the specimen . . . and the patient's masculinity hanging in tatters on his pelvic sidewall!

Thus the plane is easy and clear posteriorly and entirely safe but it becomes more difficult laterally as one works forward into the anterior 180° of the circle of dissection. It is sensible therefore, to start by developing it with great care within the bifurcation of the presacral nerves and then to follow the back of the mesorectum down to the pelvic floor and right forward to the anorectal junction. Manual extraction can, in my view, be compared with thrusting ones hand into a delicate electronic instrument and wrenching out an offending part without looking for and disconnecting the wires going into it or protecting those around it. Another reason why manual extraction is likely to be inferior to this precise technique is that it may tear into the edge of the tumour. Harry Bacon[10], many years ago, made the crucial point that the planes at the edge of a malignant tumour split more readily than those through healthy tissues. A further important point is that many patients have bled to death from torn veins in the pelvis, but it is my clinical impression that they will very rarely do so from a cut vein. The St Mark's retractor with added illumination is a great help and various modifications of this idea have been used. The whole problem of lighting remains a major challenge. Throughout the dissection it is the outer margin, distal or lateral, of the fatty mesorectum which provides the clue to the safe plane.

The odd bilobed appearance of the correctly mobilized mesorectum is due to the fact that it is 'in situ' grooved centrally by the ano-coccygeal raphe - if you have not seen this 'bilobed lipoma' you have not done a 'total mesorectal excision' (Figure 3). The two lobes reflect the paired concavities created by the levator ani muscles. The nerves are easy to preserve high up where the presacrals come down across the aortic bifurcation, relatively easy across the sides of the pelvis but extremely difficult where the middle rectals come medially into the mesorectum. It is important to work from the presacral hollow forwards around the pelvic side wall so as to 'set up' the lateral ligament division for later - again the clue is the margin of the mesorectum. If you look carefully at the pelvic side wall you can usually see the nervi erigentes behind the presacral in the same fascial plane curving tangentially round the mesorectum to form a neuro-vascular confluence posterolateral to the vesicles.

Professor Patrick Walsh who I visited at the Johns Hopkins in Baltimore, has helped me substantially

Figure 3

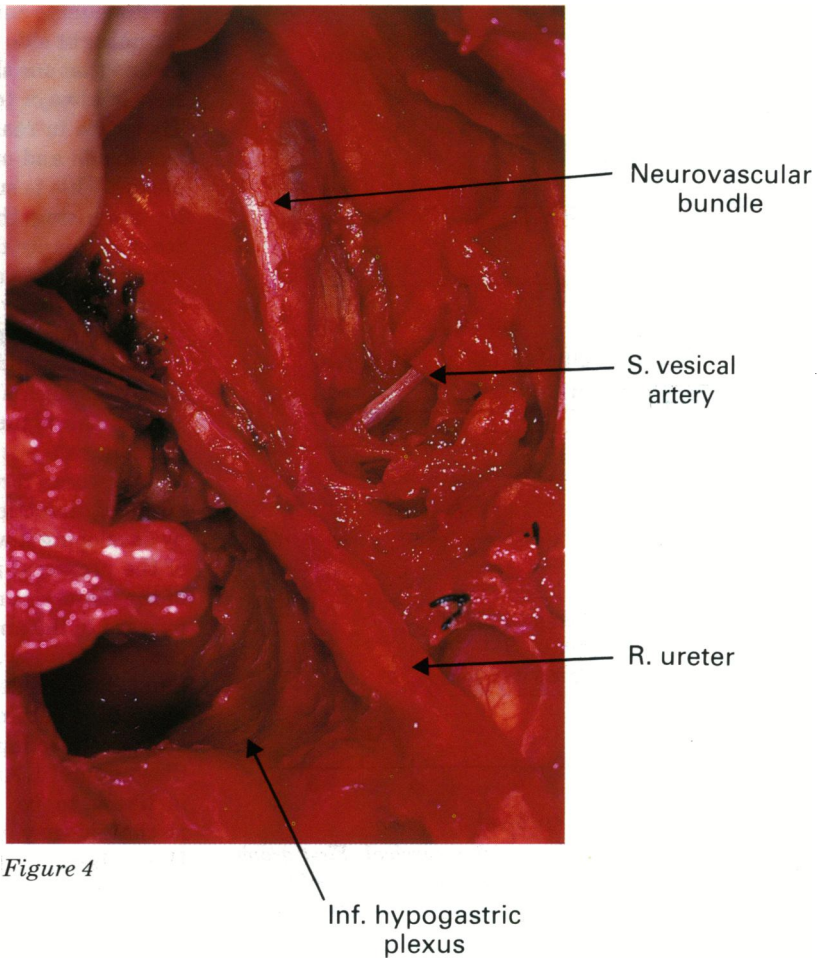

Figure 4

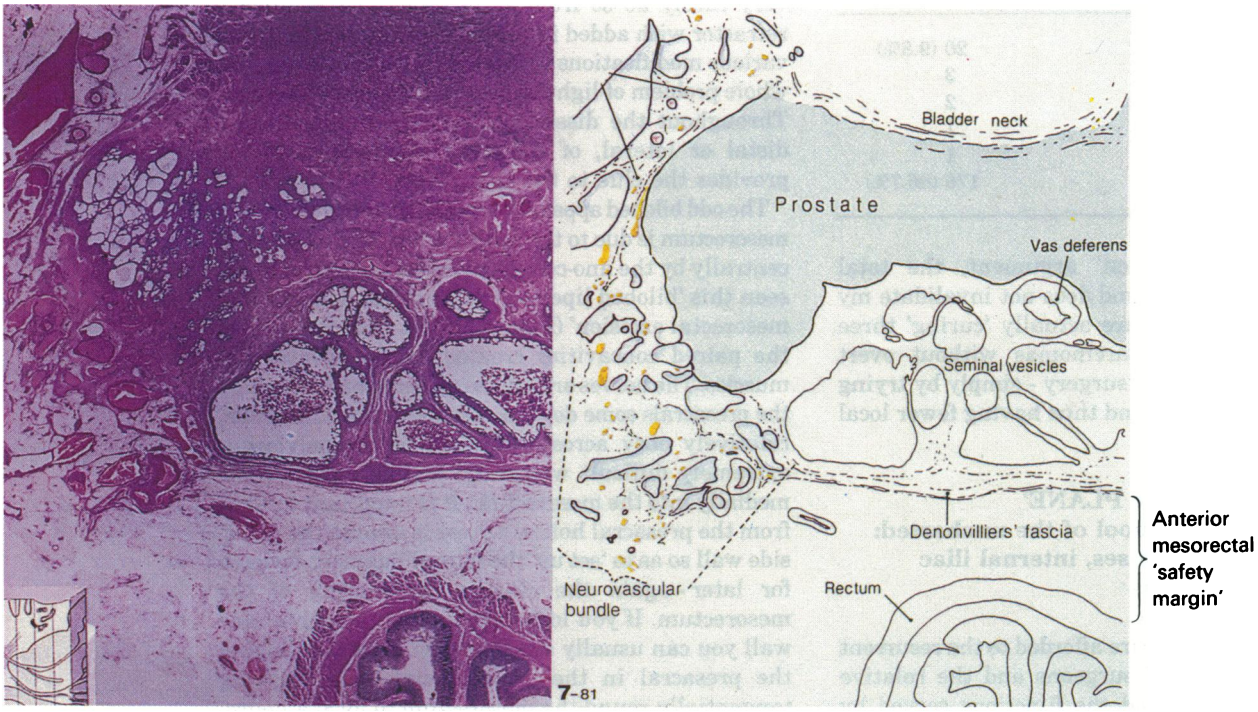

Figure 5

to understand how I have injured the nerves although he does not see them at the point where we do. He is the acknowledged 'High Priest' of radical prostatectomies and succeeds in removing both the prostate and the vesicles and yet leaves his patients capable of erection in almost 90% of cases. He does this because he has recognized and can readily identify in every case a neurovascular bundle, formed by the confluence of the presacral and nervi erigentes, running across the back of the lateral edge of the vesicles, bladder neck and the prostate and entering the corpora cavernosa (Figures 4 and 5). Preserve this and everything else in the area can go - the neural connections to penis and bladder safely preserved. Professor Walsh also sounded a note in my mind when he pointed out that the main reason for other urologists *not* doing radical prostatectomy was that most patients were rendered impotent and yet the specimens were not made more 'radical' thereby: odd scraps only of nerve could be found clinging to the capsule. Surely this is a further example of Sir Hugh Lockhart Mummery's concept of 'cutting the tops off the nerves'. There is a clear parallel in rectal excision, and Slack[11] at the Middlesex similarly looked carefully at the surface of excised anterior resection and APE specimens for 'tops' of nerves and correlated these with damaged function postoperatively.

In a small number of extended rectal resections I have found opening up Professor Walsh's plane[12] which is lateral to the prostate very useful indeed in establishing the course of the nerves - it is the plane we all remember where one pushes a swab down on each side before performing a retropubic prostatectomy - in my younger hands often tearing a thin walled vein in the process. In its lateral wall is obturator internus and the obturator vessels and nerve. It may be easier to think of the surgical anatomy after developing the two planes as two compartments created by a neurovascular diaphragm passing from lateral to medial at the level of the base of the prostate and carrying all the genito-urinary supply-line. In this diaphragm from before backwards are the vas, the superior vesical artery, the ureter and the inferior hypogastric plexus and penetrating the latter in an irregular manner the inferior vesical and the middle rectal vessels (Figure 4).

In a difficult case or extended resection I believe it may be valuable to find them in the anterior compartment, visualize the ureter, divide the vas and the superior vesical artery to open up the pelvis, and thus see them throughout their course. Everything in the roofs of the ureteric tunnels can be safely divided - and the vasa also mark a safe plane. Previous extended dissections in which positive identification of the nerves had not been performed have, in my hands, almost invariably produced impotence and serious bladder dysfunction.

The picture is further constructed by Professor Walsh's beautiful transverse section (Figure 5) which shows the nerves at the lateral edge of Denonvillier's fascia and also demonstrates the substantial extra anterior clearance of the cancer to be obtained by staying in front of the fascia - a further important part of 'total mesorectal excision'.

Practicalities of avoiding damage to the neurovascular confluence

It is thus logical in the routine case, before we tackle the danger area at 10 o'clock or 2 o'clock on our journey round the rectum to recommence the dissection in the midline anteriorly where the nerves will not be endangered. Since we are doing a cancer operation we should cut the peritoneum anterior to the peritoneal reflection and resect this with the rectum. If we cut straight on to the vesicles we find an essentially bloodless plane between them and the fascia of Denonvillier and we can proceed down anterior to this until it comes forward to become somewhat adherent to the prostate, when we must cut through it to liberate the lower third of the rectum anteriorly.

We now turn to our two 'STALKS', i.e. lateral ligaments, middle rectal vessels, etc. at 2 o'clock and 10 o'clock. In the outer substance of these lie the nerves.

A good deal of confusion exists about where they should be cut and what, if anything, should be done with the vessels. Mr Ian Todd[13] has suggested that, if you can put a clamp on them you are too close to the growth, i.e. not far enough out. Whilst I am not generally keen on clamping them (they usually require nothing doing to them anyway) I fear that this guideline might lead to the plexuses being cut unnecessarily by some surgeons since they curve across medially only just beyond them. I would argue that it is reasonable to cut them just outside what one judges to be the edge of the mesorectum rather than to risk damage by cutting them perfectly flush laterally. There must however be no substantial fatty or lymphatic residues on the side wall and the growth must be safely out of the way when we put a finger and thumb across them.

The ultra-low stapled anastomosis

A few more scissor cuts in the 'Holy Plane' and the rectum and mesorectum are now attached to the pelvic floor only by a clean tube of anorectal muscle which can then be cross-clamped, washed out, and divided with a knife and/or scissors. It is then purse-stringed over and over with 0 prolene taking mucosal edge, muscularis mucosae and a thin rim of muscularis propria. The clue to the lower stapled anastomosis is the upward traction by the clamp or alternatively a fist or hand pushing up the anal canal from below. The latter routine, i.e. cut right across and use a fist - is in my revised view to be preferred in the very low case with a narrow pelvis, as so much of the room is taken up by the clamp and the risk of slippage and consequent soiling is avoided.

As one tries harder however with lower and lower tumours it becomes apparent that the same plane goes on and on and on - in five cases, admittedly with some difficulty we have gone so low that there has been squamous mucosa in the lower doughnut. In one we actually emerged through the anal skin and spoiled the anus and the operation in the process. If we keep on going we arrive eventually at the inter-sphincteric groove which we all feel when we do a rectal examination. The crucial determinant factors

Figure 3. The bilobed appearance of the correctly mobilized mesorectum - the 'bilobed lipoma'

Figure 4. The inferior hypogastric plexuses and neurovascular bundles exposed during an extended pelvic dissection for cancer (after radiotherapy to a previously inoperable case)

Figure 5. Transverse section of Denonvillier's Fascia and the relations of the neurovascular bundles at the level of the seminal vesicles (by courtesy of Professor Patrick Walsh and the Journal of Urology)

are a flexible pelvic floor, a good fist pushing up from below, and of course it is easier in the female.

Ileo-anal anastomosis

The ultra-low development of these planes into the intersphincteric groove led naturally to the idea of stapling an ileal pouch to the internal sphincter within the pubo-rectal sling. This was first performed in Basingstoke in 1981 as an alternative to sleeve anastomosis[14]. Brummelkamp from Amsterdam published a similar series shortly afterwards[15], and more recently the improved resting anal pressures that result have been demonstrated by Johnston[16] whose department in Leeds now favours this method for the anastomosis. They now provide a scientific explanation for our claim that mucus leakage at night was less of a problem if one avoided the sleeve. Healing by first intention is more likely with a direct stapled anastomosis whilst the shrivelled sleeve is avoided with its inevitable fibrosis and probable sepsis. Only in the last two years have these ideas started to make some impact on 'pouch' surgery, but there is probably more to be gained by avoiding stretching of the sphincter, fibrosis and sepsis, than there is in developing the design of the pouch.

The functional results of anastomosis of either colon or pouch to the anus itself with more motivated patients almost always repay the technical efforts involved although there is sometimes an adaptation period of many weeks or even months. Apart from any other considerations the excision of the anal sphincters for what the courts deemed inadequate reasons has already led to successful court cases in the USA. We generally follow the Americans, though happily some years behind in such matters, but we should start to question precisely WHY we are removing the sphincters in each case.

Non-malignant disease

Let us next consider the use of the 'Holy Plane' in diseases other than cancer. The division of the inferior mesenteric artery in a cancer case is usually a high tie but not a pre-aortic strip so that the sympathetic plexuses are preserved. The inferior mesenteric vein is taken high up at its termination in the splenic vein at the lower border of the pancreas which gives a good deal more length to the mobilized splenic flexure for the low case. In benign conditions we can take the superior rectal vessels beyond the pelvic brim and well forward. The nerves are, if we follow our previous principles, just as safe as in the St Marks' style of 'close dissection' within the mesorectum which is apt to bleed a great deal. I have preferred to enter the same plane as in cancer - the visceral/somatic plane - but to do so well forward, behind the upper third of the rectum - after division of the superior rectal vessels. The proximal side of the divided superior rectal artery can be used to open the plane in the midline posteriorly whilst the rectum is pulled forwards. It is also advisable to stay close in laterally so as to give the nerves in the danger position a wider berth than in cancer. Anteriorly we cut straight down on to the rectum behind Denonvillier's fascia and leave the fascia and the peritoneal reflection in the patient.

The planes can then be carried down to the intersphincteric groove, as just described.

Between Scylla and Charybdis

I would like to think that this small personal series may help to contribute to our understanding of the true nature of rectal cancer: that it is, of all the common cancers, the one that can most often be cured with a surgical clearance of only a few millimetres. Furthermore I believe that we can claim that local recurrence is a surgical complication that can be almost entirely eliminated.

Mixed metaphors are a Presidential prerogative: the plane 'holy' for the surgeon, Homer's Scylla and Charybdis for the penalties of straying. The metaphor provides value comparisons too: the satellites and outcrops of tumour are the invisible but lethal outlying rocks around the headland of the cancer. To touch them is to ensure ultimate destruction, fast or slow. Overwhelmingly my most important message is that rectal cancer is unique in that the rocks do indeed cluster round the headland with a navigable channel outside them. Beyond that channel Charybdis, the Whirlpool is imperfectly charted but infinitely preferable to the rocks. Navigating inside it guarantees unimpaired potency and bladder function - often valuable prizes indeed.

Pilotage of this difficult passage requires, above all, practice and experience. Britain, alone in the Western World with few surgeons and liberal referral patterns, has an opportunity to lead the world in exploiting the only 'high tech' instrument we can now afford - a long sharp pair of scissors.

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