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Radical Pelvic Surgery with Preservation of Sexual Function

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Recent neuroanatomical findings make it possible to identify the pelvic plexus and branches that innervate the corpora cavernosa intraoperatively. These anatomical principles have been used to modify standard radical prostatectomy and cystoprostatectomy to prevent postoperative sexual dysfunction. Radical retropubic prostatectomy has been performed on 320 men, who have been followed for 1–5 years after surgery; 74% of these men are now potent after surgery. Positive surgical margins were present in 10% of the cases; the actuarial overall local recurrence at 5 years (with or without distant metastases) is 10%. These results are consistent with past experience and data reported elsewhere in the literature. Radical cystoprostatectomy has been performed on 25 men over the past 5 years. Pathologic evaluation of all specimens demonstrated negative surgical margins, no patient has developed local recurrence, and of the patients who had cystectomy alone, 83% are now potent after surgery. With application of these principles to colorectal surgery, similar favorable impact on quality of life with improved surgical accuracy may be possible.

IN THE PAST, sexual dysfunction was a common complication that occurred after radical pelvic surgery of all types: radical prostatectomy, radical cystoprostatectomy, and abdominoperineal resection. Yet despite the common occurrence of this complication, up until recently it was not clear why impotence occurred or how it could be prevented. In 1982, Walsh and Donker demonstrated that impotence that often followed radical prostatectomy occurred secondary to injury to the branches of the pelvic plexus that innervate the corpora cavernosa, and they proposed minor modifications in the surgical procedure to avoid this complication.[1] These modifications were based on sound anatomic and pathologic principles.[2,3] Over the past 6 years, these modifications have been employed extensively during radical prostatectomy[4–9] and cystoprostatectomy.[10–11] This manuscript outlines the anatomic considerations necessary for preservation of sexual function, the surgical technique and results with radical prostatectomy and cystoprostatectomy, and the potential application of this knowledge to rectal resection.

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Anatomical Considerations

Penile erection is mediated by a coordinated vascular and neurologic event that results in increased inflow of blood to the corpora cavernosa, dilation of venous sinusoids within the penis and decreased venous outflow from the corpora cavernosa. The neurologic input is primarily

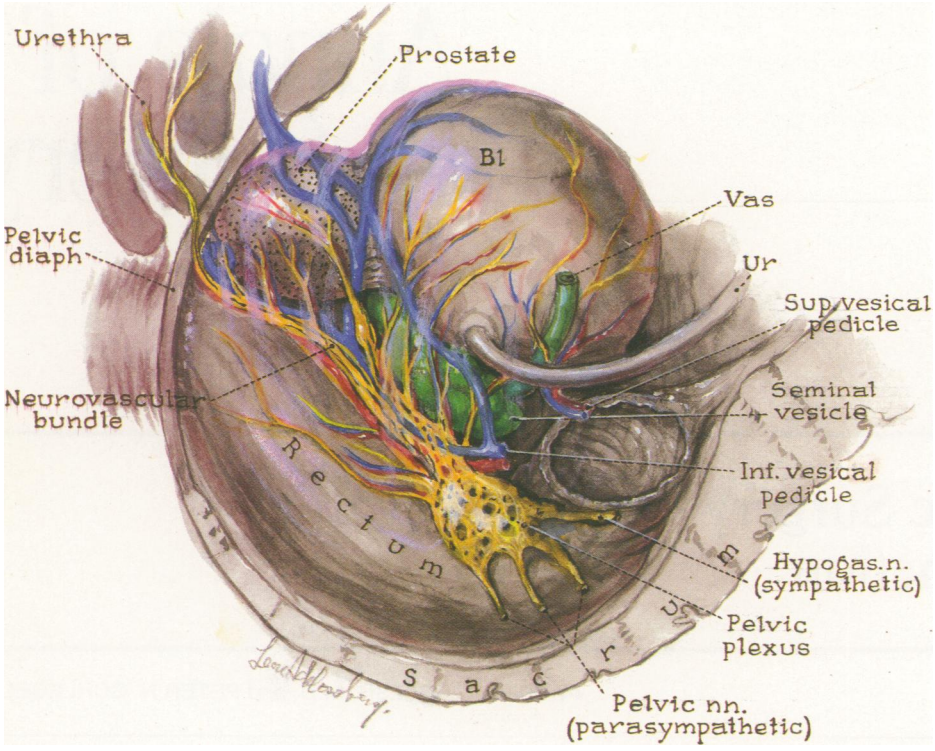

FIG. 1. Lateral view of pelvic organs and neuroanatomy in man as reconstructed based on cadaveric dissections (reprinted with permission from J Urol 1987; 138:1402–1406).

from the parasympathetic component of the autonomic nervous system. Emission and ejaculation are mediated predominantly by sympathetic nerves that travel from the thoracolumbar region of the spinal cord along the sympathetic ganglia and down the hypogastric nerves to the pelvic plexus.

A detailed understanding of the exact location of the pelvic plexus and the important branches that provide innervation to the corpora cavernosa has only recently been possible.[1-3,11,12] The pelvic plexus is formed by parasympathetic visceral efferent preganglionic fibers (the pelvic nerve or nervi erigentes) that arise from the sacral center (S2 to S4) and sympathetic fibers arising from the thoracolumbar region via the hypogastric nerve (Fig. 1). The pelvic plexus is located retroperitoneally on the lateral wall of the rectum 5–11 cm from the anal verge with its midpoint related to the tip of the seminal vesicle. It forms a fenestrated rectangular plate situated in the sagittal plane. Branches from the pelvic plexus provide innervation to the rectum, bladder, prostate, seminal vesicles, urethra, and corpora cavernosa. The cavernous branches travel a direct route from the pelvic plexus toward the posterolateral base of the prostate, gradually coalescing from a group of fibers approximately 12 mm wide to a more organized bundle approximately 6 mm wide at the level of the prostate. At this point, the cavernous nerves travel in association with the capsular arteries and veins of the prostate in the lateral pelvic fascia outside the prostatic capsule and outside Denonvilliers' fascia. They ascend at the level of the apex of the prostate posterolateral to the urethra, where they penetrate the urogenital diaphragm. Note that the bulk of the pelvic plexus is located lateral and posterior to the seminal vesicles. Thus, the seminal vesicles can be used as a landmark intraoperatively to identify the pelvic plexus, which is imbedded in thick fascia and perforated by branches of the inferior vesical artery and vein that supply the rectum, bladder, and prostate. Also, the cavernous nerves can be identified intraoperatively as they travel posterolateral to the prostate on the anterolateral surface of the rectum by their rather constant association with the capsular arteries and veins of the prostate. This association of the cavernous nerves with the capsular vessels of the prostate, termed the neurovascular bundle, provides the macroscopic landmark that aids in the identification of these microscopic nerves.[2,4,12]

Clinical Material

During the past 6 years, over 500 men with Stages A and B adenocarcinoma of the prostate have undergone radical retropubic prostatectomy, and 25 patients have undergone radical cystoprostatectomy using the surgical technique described above. Clinical staging and pathologic

evaluation of the specimens were performed as described previously.[5,11] All pathologic specimens were coated with India ink, step-sectioned, and evaluated carefully for extent of tumor penetration, the presence of positive surgical margins, and extension of tumor to the seminal vesicles and pelvic lymph nodes. All patients have been followed carefully with at least semi-annual examinations for local recurrence and distant metastases. Postoperative sexual function was evaluated by interviews with the patient and his partner. Potency was defined as the ability to achieve an erection sufficient for vaginal penetration and orgasm. In previous studies we have determined that sexual function returns gradually during the first year after surgery.[8,10] Thus, the minimum follow-up interval to determine whether a patient is potent is 1 year.

Operative Technique for Radical Retropubic Prostatectomy and Cystoprostatectomy

Based upon the above findings, it is now possible to identify the location of the pelvic plexus and cavernous nerves intraoperatively and to make an informed decision as to whether it is safe to preserve these anatomical structures or necessary to excise them widely with the specimen. In all surgical procedures for cancer, the major goal is excision of all tumor. Preservation of sexual function is of secondary consideration. Previously, impotence after radical prostatectomy occurred secondary to injury to the branches of the corpora cavernosa at one of three steps during standard radical prostatectomy: 1) apical dissection with transsection of the urethra, 2) separation of the prostate from the rectum, and 3) division of the lateral pedicle.[1,2] There is no evidence that the neurovascular bundles were completely resected during standard radical prostatectomies.[2,7,8] Instead, they were inadvertently or unknowingly injured during steps that were performed rather blindly and bluntly without precise identification and resection of the neurovascular bundles that are intimately associated with the rectum posterolaterally.

In 1979, the anatomy of the dorsal vein complex and Santorini's plexus was clarified, and modifications in the surgical procedure were proposed that reduced blood loss and improved surgical exposure.[13] These changes have made it possible to visualize the neurovascular bundles intraoperatively. Previously, many surgeons dreaded this operation because of the profound blood loss encountered when the dorsal vein complex was transected at the apex of the prostate. Now, however, once the exact anatomy of the dorsal vein is understood, it is possible to ligate and accurately control bleeding from this complex. After a bloodless field is achieved, the urethra is transsected and the prostate is separated from the rectum in the midline. At this point, the neurovascular bundles are identified, a step that was not performed previously. Here the surgeon determines the proximity of the neurovascular bundles to the tumor and decides whether they must be excised or can be safely preserved without compromising the cancer operation. If the decision is made to excise the neurovascular bundle on the side of the tumor, the neurovascular bundle on the contralateral side can usually be preserved. Actually, with wide excision of the neurovascular bundle it is now possible to obtain wider soft tissue margins than were previously attained with standard radical prostatectomy.[6-9] The specific operative steps in this surgical procedure have been detailed elsewhere.[2,3,14]

In patients undergoing radical cystoprostatectomy, the usual bilateral pelvic lymph node dissection is performed, the ureters are divided, the obliterated umbilical and superior vesical arteries are transsected, and the plane between the bladder and rectum is developed by incising the peritoneum at the apex of the rectovesical cul-de-sac. Once this has been accomplished, the surgeon may remove the specimen in a retrograde fashion using the steps described above for radical retropubic prostatectomy.[4,10,11] Alternately, the dissection can continue from above with ligation of the posterior pedicles along the lateral surface of the seminal vesicle, thus avoiding injury to the pelvic plexus.[11]

Results Following Radical Prostatectomy

Preservation of Sexual Function

Follow-up evaluation was made of 320 men who have been followed from 1 to 5 years postoperatively. Of these 320 men, 259 were potent before surgery and had sexual partners. After surgery, 74% (192) are currently potent. Potency, which is defined as the ability to achieve an erection that is sufficient for vaginal penetration and orgasm, returns gradually during the first 2 years after surgery.[8] Potency correlated with both the age of the patient and the stage of the disease (Table 1). Thus, potency returned in 93% of patients with Stage A1 disease, 72% of those with Stage A2, 92% of those with B1 N, 72% of those Stage B1, and 56% of those with Stage B2. The tumor was confined within the capsule in virtually all men with Stage A1 disease, so it is reasonable to assume that neurovascular bundles can be preserved completely in almost all men with this stage of disease. This factor is responsible for the excellent return of sexual function among patients with Stage A1 disease. Conversely, the reduced rate of potency in men with Stage B2 disease indicates that attempts at resection of more advanced tumors result in greater injury to the cavernous nerves. In cases where it was necessary to excise one neurovascular bundle (69%), after surgery, these men are now potent.[6] Thus, one can conclude that potency can be maintained after radical prostatectomy even when it is necessary to excise one neurovascular bundle widely. The information listed in Table 1 is useful

TABLE 1. *Influence of Age and Clinical Stage on Postoperative Potency in 320 Men Followed for at Least 1 Year*

Clinical Stage	Age (years) 30–39	40–49	50–59	60–69	70–75	Total
A1	—	100% (2 of 2)	90% (9 of 10)	100% (3 of 3)	—	93% (14 of 15)
A2	—	—	90% (9 of 10)	57% (4 of 7)	0% (0 of 1)	72% (13 of 18)
B1N	100% (2 of 2)	80% (4 of 5)	97% (30 of 31)	92% (11 of 12)	0% (0 of 1)	92% (47 of 51)
B1	—	79% (11 of 14)	82% (42 of 51)	65% (39 of 60)	20% (1 of 5)	72% (93 of 130)
B2	—	67% (2 of 3)	68% (15 of 22)	40% (8 of 20)	—	56% (25 of 45)
Total	100% (2 of 2)	79% (19 of 24)	85% (105 of 124)	64% (65 of 102)	14% (1 of 7)	74% (192 of 259)

for preoperative advising of patients, based on their age and the stage of their lesion, as to the likelihood of sexual function returning after surgery.

Cancer Control

For more than 80 years, radical prostatectomies were performed without knowledge of why impotence occurred or how it could be prevented. Thus, it is not surprising that this innovation in surgical technique might raise the question of whether cancer control has been compromised. At the outset, it should be clear that this is a total radical prostatectomy, not a lumpectomy. If the operation is performed correctly, it should be either as effective as or more effective than previous attempts at removing tumor that used a less anatomic approach, that relying mainly on blind, blunt dissection. As outlined previously, the cavernous nerves are located outside the capsule of the prostate and Denonvilliers' fascia.[1,2,12] This is the first principle from which this procedure was devised. Consequently, if one knew that all tumor was located intracapsularly, it should be possible to preserve sexual function in all such patients without injury to these nerves. However, despite current attempts at staging prostatic cancer, the tumor frequently penetrates through the prostatic capsule into adjacent soft tissue. In the past, during standard radical perineal prostatectomies, the lateral pelvic fascia was reflected off the prostate in an effort to avoid injury to the dorsal vein of the penis and to Santorini's plexus.[2,7–9] Thus, the excellent long-term control of disease that has been reported after radical perineal prostatectomy has been achieved without routine resection of the lateral pelvic fascia and neurovascular bundle. Also, the descriptions of radical retropubic prostatectomy available in standard textbooks provide no evidence that the neurovascular bundles were completely resected during the retropubic approach. These observations have been confirmed by examining specimens removed by the standard radical retropubic approach.[2,7] However, one of the advantages of the anatomical approach to radical prostatectomy is the accurate control of blood loss, which provides a clear surgical field. When this technique is used, all structures are clearly visualized, and a deliberate decision can be made, based on the operative findings, as to whether the structures can be preserved or must be resected more widely with the specimen. In this manner, a wider margin of resection can be achieved than was possible using blunt dissection.[6]

Ever since this new surgical approach was developed, the pathologists at The Johns Hopkins Hospital have carefully examined all step-sectioned radical prostatectomy specimens. Early in our experience, they compared prostatic specimens removed by the standard radical perineal technique, the standard radical retropubic technique, and the nerve-sparing modification to determine the amount of periprostatic tissue and skeletal muscle that was removed.[2] These findings confirmed the anatomical observations mentioned above and suggested that less periprostatic tissue and skeletal muscle was removed with the radical perineal approach than with either retropubic approach, but that none of the techniques appeared to compromise the adequacy of the removal of limited cancer of the prostate. We subsequently evaluated pathologic specimens from the first 100 consecutive patients who underwent nerve-sparing radical retropubic prostatectomy.[5] Although 41% of the patients had established capsular penetration, only seven had positive surgical margins. All seven of these patients had extensive extraprostatic involvement by tumor, and five had involvement of the seminal vesicles and poor prognostic findings. In none of these cases were the surgical margins positive only at the site of the nerve-sparing modification. On the basis

TABLE 2. *Pathologic Findings in 414 Consecutive Radical Prostatectomies*

Clinical Stage	Number of Patients	Pathologic Findings: Organ Confined (%)	Capsular Penetration (%)	Seminal Vesicle Involvement (%)	Positive Surgical Margin (%)	Positive Lymph Nodes (%)
A1	16	94%	6%	0%	0%	0%
A2	40	83%	17%	15%	15%	10%
B1N	78	82%	18%	3%	3%	0%
B1	196	65%	35%	10%	9%	3%
B2	84	29%	71%	31%	19%	23%
Total	414	64%	36%	13%	10%	7%

of these findings, there was no indication that the nerve-sparing modification compromised the adequacy of the removal of cancer, which was determined primarily by the extent of the tumor rather than the operative technique. Recently we reviewed the pathologic findings in 414 consecutive radical prostatectomies performed for clinical Stage A and B carcinoma[9] (Table 2). Ten per cent of the patients had positive surgical margins. The frequency of positive surgical margins was always the same or less than the percentage of patients with positive seminal vesicles, and was very similar to the percentage of patients with positive lymph nodes. These data appear to confirm our initial impression that patients with positive surgical margins have extensive disease and are in a very high risk group for the subsequent development of distant metastases. It is likely that no surgical procedure will eliminate all tumor in this small, unfavorable subset of patients. Two recent studies from other institutions have confirmed these findings.[15,16]

The true efficacy of this procedure will be established only when long-term follow-up evaluations have been performed to determine whether the control of local disease and distant metastases is similar to that achieved with standard radical prostatectomy. Because adjunctive therapy does not influence long-term tumor-free survival, we have avoided the use of adjuvant radiotherapy or hormonal therapy, and we will be able to evaluate the true impact of radical prostatectomy alone on the control of prostatic cancer. Because the clinical course of prostatic cancer patients can be protracted and because 15-year tumor-free survival must be demonstrated before one can categorically conclude that a patient is cured, it will take many years to make a final judgment. However, an earlier, more sensitive predictor of cancer control is the rate of local recurrence. Schellhamer has reported a 10% rate of local recurrence for patients with clinical Stage A and B disease during the first 5 years, and with a longer follow-up of up to 15 years, the total failure rate increased to only 15%; 75% of the local failures were seen during the first 5 years, with the other 25% presenting in the subsequent 5 years.[17] We have recently evaluated the actuarial 5-year local failure rate of the 320 patients of this series who have been followed from 1 to 6 years. The actuarial overall local recurrence (with or without distant metastases) at 5 years is 10%[18] (Fig. 2). Of the ten patients who developed local recurrence, one patient had tumor pathologically confined to the prostate, seven patients had tumors that had established penetration through the prostatic capsule into soft tissue with or without positive surgical margins, one patient had microscopic involvement of the seminal vesicles, and one patient had positive lymph nodes. Four of these ten patients also had distant metastases. In five of the ten cases, the neurovascular bundle was partially or completely excised on the side of the lesion in an attempt to obtain a wider surgical margin. Based

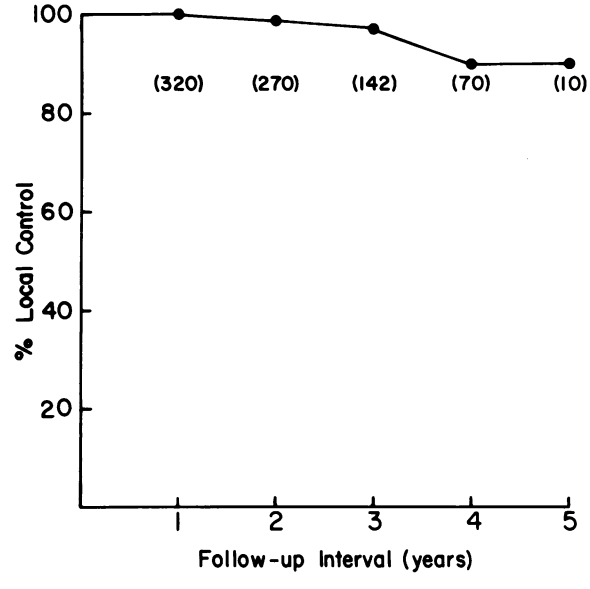

FIG. 2. Actuarial local control following radical prostatectomy in 320 men with Stages A and B adenocarcinoma followed for 1 to 6 years. Local failures include patients who also develop distant metastases.

upon our experience prior to the development of the nerve-sparing technique, approximately 10% of the patients treated at this institution develop local recurrence as the first sign of failure during the first 5 years after surgery. Consequently, the results of using this new technique are thus far consistent with our past experience and the experience reported in the literature. However, longer follow-up of this group of patients will be necessary to confirm these findings.

Results of Radical Cystoprostatectomy for Bladder Cancer

Over the past 5 years, 25 men who were potent before surgery have undergone radical cystoprostatectomy for the treatment of invasive transitional cell carcinoma of the bladder.[11] Pathologic evaluation of all specimens demonstrated negative surgical margins, and no patient has developed local recurrence of tumor. Of the patients who had cystectomy alone, 83% are potent. Of patients who also underwent urethrectomy, after surgery, all are now able to achieve erections, and 40% achieve erections that are sufficient for intercourse. The potent patients in this group had the urethrectomy performed 4–15 months after the cystectomy.

Discussion

Based upon new neuroanatomical observations, in the vast majority of patients, it is now possible to perform radical prostatectomy and cystoprostatectomy with preservation of sexual function without apparent compromise to the cancer operation.

Sexual dysfunction after major operations on the rectum is also a severe and rather common complication. During excision of the rectum for cancer or, more rarely, inflammatory disease, injury to the pelvic plexus and cavernous nerves can induce erectile impotence, ejaculatory dysfunction, or bladder dysfunction. In a review of the literature, erectile dysfunction occurred in 45.7% of 641 men undergoing either abdominoperineal resection of the rectum for cancer, sphincter-saving resection of the rectum, or synchronous combined excision of the rectum for cancer[19–37] (Table 3). In men who underwent low anterior resection for cancer, erectile impotence occurred in 15.1%. Ejaculatory dysfunction occurred in 35% and 44% of these two groups, respectively. It is well-recognized that sexual dysfunction after rectal resection for inflammatory bowel disease is less common. This is illustrated in a recent review of the literature in which it was reported that erectile dysfunction occurred in only 4.7% of 1300 men who underwent rectal excision for inflammatory disease, and ejaculatory dysfunction occurred in 6.2%[23,24,29–31,38–52] (Table 4).

Based upon the anatomical studies outlined in this manuscript and the experience with radical prostatectomy and cystoprostatectomy, it is now possible to perform successful cancer operations on the prostate and bladder with preservation of sexual function in the majority of patients. As in radical prostatectomy, it may not be necessary in all cases to excise the autonomic innervation to the corpora cavernosa during rectal resection for cancer. Postoperative potency after rectal resection does not necessarily correlate with the amount of nerve tissue excised with the specimen.[53] Since the nerves necessary for sexual function are not usually excised, but may be injured during rectal resection, awareness of the relationship of the pelvic plexus and cavernous nerves may allow excision of the rectum with preservation of sexual function. Greater awareness of the structures adjacent to the rectum may also allow for improved margins of resection when it is not possible to spare these neurovascular structures because of tumor invasion, as has been our experience with radical prostatectomy.

There are several anatomical regions where injury to the nerves important for sexual function may occur during rectal surgery. Injury to the hypogastric nerves in the retroperitoneal space along the peritoneal reflection of the sigmoid mesentery may result in ejaculatory dysfunction. Excessive traction on the rectum with anterior displacement of the rectum secondary to mobilization posterior to the rectum may result in neurapraxia or avulsion of sacral roots 2, 3, and 4. Depending on the severity of injury, this could result in temporary or permanent bladder and/or erectile dysfunction. These injuries may be prevented by recognizing this possibility and avoiding excessive traction.

Direct injury to the pelvic plexus may occur during ligation of the rectal stalks containing the middle hemorrhoidal vessels. These vessels usually enter the rectum near the pelvic plexus, which, as we have shown, forms a fenestrated plate lateral to the wall of the rectum in the sagittal plane. Depending on the location of the tumor, it may be possible to merely divide the lateral ligaments on the edge of the mesorectum, as Heald recently advised,[54] without injury to the pelvic plexus. As described earlier in this manuscript, the location of the pelvic plexus may be identified intraoperatively by its relationship to the tips of the seminal vesicles. If there appears to be tumor invasion into the region of the pelvic plexus unilaterally, then wide excision of the lateral pelvic fascia (posterior pedicles of the bladder and prostate), including the pelvic plexus and branches of the inferior vesical pedicle, may be intentionally performed. Experience with radical pros-

TABLE 3. *Sexual Dysfunction after Rectal Resection for Cancer*

Source	Procedure	Impotence (No. of Patients)	Ejaculatory Dysfunction (No. of Patients)	Unspecified Sexual Dysfunction (No. of Patients)	Comments
Santangelo[19]	APR	4 of 9 (44%)	6 of 9 (67%)		All patients < 60 years old
	HAR (>10 cm)	0 of 4 (0%)	1 of 4 (25%)		
	LAR (<10 cm)	4 of 12 (33%)	7 of 12 (58%)		
Kinn[20]	LAR/APR	3 of 10 (30%)	8 of 10 (80%)		APR *vs.* LAR not specified LAR < 10 cm from dentate line
Fegiz[21]	LAR	36 of 73 (49%)	12 of 37 (32%)		
	APR	18 of 30 (60%)	11 of 12 (92%)		
Hjortrup[22]	LAR (4–6)	0 of 18 (0%)			All patients < 65 years old
	LAR (7–12)	1 of 3 (33%)			
Neal[23]	APR			13 of 18 (72%)	6 of 13 part impot or weak ejac
	SSR			12 of 20 (60%)	5 of 12 part impot or poor ejac
Balslev[24]	APR	27 of 93 (29%)	30 of 93 (32%)		10 of 27 "reduced potency"
	LAR (6–11)	3 of 17 (18%)	6 of 17 (35%)		all 3 "reduced potency"
Danzi[25]	APR	10 of 22 (45%)	14 of 22 (64%)		4 of 10 partial impotence
Williams[26]	SSR	5 of 20 (25%)	7 of 20 (35%)		mostly LAR, 1 difficulty maintaining an erection
	APR	11 of 17 (65%)	12 of 17 (71%)		3 difficulty maintaining erection
McDonald[27]	LAR (>10)	0 of 7 (0%)			indications for surgery not specified
	LAR (5–10)	2 of 8 (25%)			
	LAR (<5)	2 of 6 (33%)	3 of 6 (50%)		
DeBernardinis[28]	LAR	23 of 45 (51%)	25 of 45 (56%)		
	APR	20 of 39 (51%)	27 of 39 (69%)		
Williams[29]	LAR	0 of 5 (0%)	2 of 5 (40%)		
	SCE	2 of 4 (50%)			
Yeager[30]	APR	3 of 20 (15%)	5 of 20 (25%)		
Fazio[31]	APR	1 of 7 (14%)	2 of 7 (29%)		
	LAR	1 of 6 (17%)	2 of 6 (33%)		
Weinstein[32]	APR			12 of 12 (100%)	erectile, ejaculatory or orgasmic dysfunction included
	LAR			2 of 10 (20%)	
Devlin[33]	APR/LAR	31 of 60 (52%)			Combined APR, LAR series, homosexuals excluded.
Bernstein[34]	APR	93 of 122 (76%)			Compiled data from 10 clinics with different results (53–100%)
Waugh[35]	SSR	6 of 93 (6%)	9 of 93 (10%)		
Goligher[36]	SCE	20 of 45 (44%)			Only patients < 60 years old included
	APR	27 of 36 (75%)			
	SSR	12 of 14 (86%)			
Jones[37]	APR	est. 95%			
Totals	APR/SSR/SCE*	255 of 572 (44.6%)	93 of 291 (32%)		
	LAR**	13 of 86 (15.1%)	21 of 50 (42%)		

* Includes 3 studies which combine APR and LAR results.
** Also includes HAR and very low anterior resection (<5 cm).
LAR = low anterior resection.
HAR = high anterior resection.
APR = abdominoperineal resection.
SSR = sphincter-saving resection of rectum (usually synchronous combined excision of rectum).
SCE = synchronous combined excision of rectum.

tatectomy has shown that it is possible to preserve erectile function, and therefore possibly bladder function, despite wide unilateral resection of these nerves.

Injury to the cavernous nerves during perineal dissection of the rectum may result in erectile dysfunction, as well. After division of the rectourethralis muscle in the

TABLE 4. *Sexual Dysfunction after Rectal Resection for Inflammatory Bowel Disease*

Source	Procedure	Impotence (No. of Patients)	Ejaculatory Dysfunction (No. of Patients)	Comments
Berry[38]	Proctec	0 of 64		Mean age of 41 years
Bauer[39]	Proctec	1 of 388 (0.3%)	4 of 388 (1%)	See also Bauer, 1983[41]
Leicester[40]	Proctec	2 of 23 (8%)	3 of 23 (12%)	
Neal[23]	Proctec	0 of 33 (0%)		
Bauer[41]	Proctec	2 of 135 (1%)	4 of 135 (3%)	(Different patients)
Balslev[24]	Proctec		1 of 7 (14%)	
Williams[29]	Proctec	0 of 3 (0%)		
Yeager[30]	Proctec	1 of 25 (4%)		
Fazio[31]	Proctec	0 of 9 (0%)		
Corman[42]	Proctec	0 of 76 (0%)		
Burnham[43]	Proctec	30 of 128 (23%)		14/88 < 45 years old 16/30 > 45 years old complete and partial erectile impotence
Gruner[44]	Proctec/IRA	0 of 23 (0%)	15 of 82 (18%)	ileorectal anastomosis
	Proctec/ileo	11 of 82 (13%)		"disturbed" erection or ejac
Davis[45]	APR	0 of 8 (0%)		age 12–50 years old
May[46]	Proctec	5 of 46 (11%)	8 of 46 (17%)	
Watts[47]	Proctec	7 of 41 (17%)	9 of 41 (22%)	6 of 8 impotent > 50 years
VanProhaska[48]	Proctec	0 of 79 (0%)		
Donovan[49]	Proctec	0 of 20 (0%)		
Bacon[50]	Proctec	1 of 39 (3%)		
Stahlgren[51]	APR	0 of 25 (0%)	5 of 25 (20%)	Unspecified "partial impairment" of sexual function
Turnbull[52]	APR	1 of 53 (2%)	2 of 53 (4%)	
Totals	Rectal excision	61 of 130 (4.7%)	50 of 800 (6.2%)	

Protec = proctectomy.
IRA = ileorectal anastomosis.
Ileo = ileostomy.
APR = abdominoperineal resection.

midline anterior to the rectum, the neurovascular bundles may be seen in association with the lateral prostatic fascia coursing from the urethra along the posterolateral surface of the prostate. These neurovascular bundles are anterolateral to the rectum. Excessive use of cauterization or blind blunt dissection in this region may result in injury to these nerves.

It is important to remember that during any pelvic operation, ligation of the anterior division or distal branches of the internal iliac artery may result in vasculogenic impotence, especially if bilateral ligation of the internal pudendal vessels occurs.

Conclusion

There is an aphorism that states, "You only see what you look for and you only look for what you know." This saying applies to the pelvic plexus and cavernous nerves, which in the past were concealed by the dense pelvic fascia and intertwining branches of the inferior vesical vessels. However, with the identification of macroscopic landmarks it is now possible to identify these structures intraoperatively and to make an informed decision as to whether or not these structures need to be sacrificed or whether they can be safely preserved during the dissection. Based on our present experience with men undergoing radical retropubic prostatectomy and radical cystoprostatectomy, this knowledge has enabled sexual function to be preserved in a majority of patients, and at the same time, has enabled the surgeon to provide wider margins of excision where necessary. With wider application of these principles to colorectal surgery, similar favorable impact on quality of life and improved surgical exposure may be possible.

References

1. Walsh PC, Donker PJ. Impotence following radical prostatectomy: insight into etiology and prevention. J Urol 1982; 128:492–497.
2. Walsh PC, Lepor H, Eggleston JC. Radical prostatectomy with pres-

ervation of sexual function: anatomical and pathological considerations. Prostate 1983; 4:473–485.
3. Lue TF, Seeineh SJ, Schmidt RA, et al. Neuroanatomy of penile erection: its relevance to iatrogenic impotence. J Urol 1984; 131: 273–280.
4. Walsh PC. Radical retropubic prostatectomy. *In* Walsh PC, Gittes RF, Perlmutter AD, Stamey TA, eds. Campbell's Textbook of Urology, 5th ed. Philadelphia: WB Saunders, 1986; 2754–2775.
5. Eggleston JC, Walsh PC. Radical prostatectomy with preservation of sexual function: pathological findings in the first 100 cases. J Urol 1985; 134:1146–1148.
6. Walsh PC, Epstein JI, Lowe FC. Potency following radical prostatectomy with wide unilateral excision of the neurovascular bundle. J Urol 1987; 138:823–827.
7. Walsh PC, Epstein JI. Radical prostatectomy with preservation of sexual function: impact on cancer control. *In* Paulson DF, ed. Problems in Urology. Philadelphia: JB Lippincott Co, 1987; 42–52.
8. Walsh PC. Radical prostatectomy, preservation of sexual function, cancer control: the controversy. Urol Clin N Am 1987; 663–673.
9. Walsh PC. Preservation of sexual function in the surgical treatment of prostatic cancer: an anatomic surgical approach. *In* DeVita VT, Hellman S, Rosenberg SA, eds. Important Advances in Oncology. Philadelphia: JB Lippincott, 1988; 161–170.
10. Walsh PC, Mostwin JL. Radical prostatectomy and cystoprostatectomy with preservation of potency: results utilizing a new nerve-sparing technique. Brit J Urol 1984; 56:694–697.
11. Schlegel PN, Walsh PC. Neuroanatomical approach to radical cystectomy with preservation of sexual function. J Urol 1987; 138: 1402–1406.
12. Lepor H, Gregerman M, Crosby R, et al. Precise localization of the autonomic nerves from the pelvic plexus to the corpora cavernosa: a detailed anatomical study of the adult male pelvis. J Urol 1985; 133:207–212.
13. Reiner WG, Walsh PC. An anatomical approach to the surgical management of the dorsal vein and Santorini's plexus during radical retropubic surgery. J Urol 1979; 121:198–200.
14. Walsh PC. Technique of radical retropubic prostatectomy with preservation of sexual function: an anatomic approach. *In* Skinner DG, Lieskovsky G, eds. Diagnosis and Management of Genitourinary Cancer. Philadelphia: WB Saunders 1988; 753–778.
15. Catalona WJ, Dresner SM. Nerve-sparing radical prostatectomy: extraprostatic tumor extension and preservation of erectile function. J Urol 1985; 134:1149–1151.
16. Wahle SM, Fallon B, Reznicek MJ, Platz CE. Incidence of surgical involvement with various forms of radical prostatectomies. J Urol 1988; 139:479A.
17. Schellhammer PF. Radical prostatectomy: patterns of local failure and survival in 67 patients. Urol 1988; 31:191–197.
18. Kaplan EL, Meier P. Non-parametric estimation from incomplete observations. J Am Stat Assn 1958; 53:457–481.
19. Santangelo ML, Romano G, Sassaroli C. Sexual function after resection for rectal cancer. Am J Surg 1987; 154:502–504.
20. Kinn A, Ohman U. Bladder and sexual function after surgery for rectal cancer. Dis Colon Rectum 1986; 29:43–48.
21. Fegiz G, Trenti A, Bezzi M, et al. Sexual and bladder dysfunctions following surgery for rectal carcinoma. Ital J Surg Sci 1986; 16: 103–109.
22. Hjortrup A, Kirkegaard P, Friis J, et al. Sexual dysfunction after low anterior resection for midrectal cancer. Acta Chir Scand 1984; 150:687–688.
23. Neal DE. The effects on pelvic visceral function of anal sphincter ablating and anal sphincter preserving operation for cancer of the lower part of the rectum and for benign colorectal disease. Ann R Coll Surg Engl 1984; 66:7–13.
24. Balslev I, Harling H. Sexual dysfunction following operation for carcinoma of the rectum. Dis Colon Rectum 1983; 26:785–788.
25. Danzi M, Ferulano P, Abate S, Califano G. Male sexual function after abdominoperineal resection for rectal cancer. Dis Colon Rectum 1983; 26:665–668.
26. Williams NS, Johnston D. The quality of life after rectal excision for low rectal cancer. Br J Surg 1983; 70:460–462.
27. McDonald PJ, Heald RJ. A survey of postoperative function after rectal anastomosis with circular stapling devices. Br J Surg 1983; 70:727–729.
28. DeBernardinis G, Tuscano D, Negro P, et al. Sexual dysfunction in males following extensive colorectal surgery. Int Surg 1981; 66: 133–135.
29. Williams JT, Slack WW. A prospective study of sexual function after major colorectal surgery. Br J Surg 1980; 67:772–774.
30. Yeager ES, Van Heerden JA. Sexual dysfunction following proctocolectomy and abdominoperineal resection. Ann Surg 1980; 191:169–170.
31. Fazio VW, Fletcher J, Montague D. Prospective study of the effect of resection of the rectum on male sexual function. World J Surg 1980; 4:149–152.
32. Weinstein M, Roberts M. Sexual potency following surgery for rectal carcinoma: a follow-up of 44 patients. Ann Surg 1977; 185:295–300.
33. Devlin HB, Plant JA, Griffin M. Aftermath of surgery for anorectal cancer. Br Med Jour 1971; 3:413–418.
34. Bernstein WC, Bernstein EF. Sexual dysfunction following radical surgery for cancer of the rectum. Dis Colon Rectum 1966; 9: 328–332.
35. Waugh JM, Miller EM, Kurzweg FT. Abdominoperineal resection with sphincter preservation for carcinoma of the midrectum. Arch Surg 1954; 68:469–485.
36. Goligher JC. Sexual function after excision of the rectum. Proc Royal Soc Med 1951; 44:824–827.
37. Jones TE. Complications of one-stage abdominoperineal resection of the rectum. JAMA 1942; 120:104–107.
38. Berry AR, Campos DR, Lee ECG. Perineal and pelvic morbidity following perimuscular excision of the rectum for inflammatory bowel disease. Br J Surg 1986; 73:675–677.
39. Bauer JJ, Gelernt IM, Salk BA, Kreel I. Proctectomy for inflammatory bowel disease. Ann Surg 1986; 151:157–162.
40. Leicester RJ, Ritchie JK, Wadsworth J, et al. Sexual function and perineal wound healing after intersphincteric excision of the rectum for inflammatory bowel disease. Dis Colon Rectum 1984; 27:244–248.
41. Bauer JJ, Gelernt IM, Salky B, Kreel I. Sexual dysfunction following proctocolectomy for benign disease of the colon and rectum. Ann Surg 1983; 197:363–367.
42. Corman ML, Veidenheimer MC, Coller JA. Impotence after proctectomy for inflammatory disease of the bowel. Dis Colon Rectum 1978; 21:418–419.
43. Burnham WR, Lennard-Jones JE, Brooke BN. Sexual problems among married ileostomists. Gut 1977; 18:673–682.
44. Gruner OPN, Naas R, Fretheim B, Gjone E. Marital status and sexual adjustment after colectomy: results in 178 patients operated on for ulcerative colitis. Scand J Gastroenterol 1977; 12:193–197.
45. Davis JP, Jelenko C. Sexual function after abdominoperineal resection. South Med J 1975; 68:422–426.
46. May RE. Sexual dysfunction following rectal excision for ulcerative colitis. Brit J Surg 1966; 53:29–30.
47. Watts JM, deDombal FT, Goligher JC. Long-term complications and prognosis following major surgery for ulcerative colitis. Br J Surg 1966; 53:1014–1023.
48. Van Prohaska J, Siderius NJ. The surgical rehabilitation of patients with chronic ulcerative colitis. Am J Surg 1962; 103:42–46.
49. Donovan MJ, O'Hara ET. Sexual function following surgery for ulcerative colitis. N Engl J Med 1960; 262:719–720.
50. Bacon HE, Bralow SP, Berkley JL. Rehabilitation and long-term survival after colectomy for ulcerative colitis. JAMA 1960; 172: 324–328.
51. Stahlgren LH, Ferguson LK. Influence on sexual function of abdominoperineal resection for ulcerative colitis. N Engl J Med 1958; 259:873–875.

52. Turnbull RB, in discussion, Coleman ST, Eckhert C: Preservation of rectum in familial polyposis of the colon and rectum. AMA Arch Surg 1956; 73:635–653.
53. Smith PH, Ballantyne B. The neuroanatomical basis for denervation of the urinary bladder following major pelvic surgery. Brit J Surg 1968; 55:929–933.
54. Heald RJ. Presidential Address, Section of Surgery, Royal Society of Medicine, London, October 7, 1987.

Discussion

Dr. Ruben F. Gittes (La Jolla, California): It is a privilege, indeed, for me to stand here and congratulate Dr. Patrick Walsh on what has to be a very singular combination of original personal research and subsequent technical contributions in the field of pelvic surgery.

It is certainly marvelous to have seen within a 10-year period the elucidation of the anatomy and physiology of penile erection. The anatomy of that area has been dissected; the physiology has been unscrambled.

We have all known for years that dissection around the rectum might or might not impair potency, depending on how wide the dissection is. What happened? How much research was actually carried out to find the relation between that pararectal tissue and the penile function of erection?

In some cases, after radical prostate surgery, the patients claimed to be potent. Other urologists wrote that off as wishful thinking or inadequate cancer surgery. Actually, these cases were exceptions to the rule and were noted by Dr. Patrick Walsh. He turned to intensive studies in the anatomic laboratory with Professor Pieter Donker. They did something that could have been done a hundred years ago but wasn't. Now we are the beneficiaries of it today. It is remarkable and a very useful step forward for us urologists and pelvic surgeons.

I would like to point out that this anatomic knowledge dovetails with our new knowledge of the physiologic mechanisms of erection, which have been elucidated in other laboratories. Today, even if the pelvic nerves are cut, we can promise the patient a very good chance of achieving erections.

You have heard of the use of papaverine self-injections. These are no humbug. A patient who is terribly worried about radical surgery and his future potency can now be reassured—first, that he may have surgery that will spare his nerves, if possible, and second, that if the worst happens, he has recourse to self-injections that restore erectile potency.

I believe that it is nothing short of amazing that we have had this progress. I am here to congratulate Dr. Walsh and to point out to this audience what a great achievement this has been.