

Modern Prostate Brachytherapy

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Abstract

Of all the treatment options available for men with organ-confined prostate cancer, brachytherapy—permanent implantation of radioactive seeds into the prostate gland—is the least disruptive for the patient, both physiologically and practically. Early brachytherapy represents the oldest technique for delivering radiation to the prostate gland, preceding external beam therapy of the prostate by several decades.

Although there have not been, and are not likely to be, any definitive randomized studies comparing radical prostatectomy, external beam radiotherapy, and brachytherapy, treatment decisions will continue to be made on the

basis of patient and physician preferences in conjunction with clinical probabilities. Long-term results in this series show that monotherapy with seed implants achieved disease-free survival of 66%; moreover, 79% of patients with higher grade disease who were treated with a combination of brachytherapy and external beam radiation also experienced long-term disease-free survival.

The following article provides a brief historical review of prostate brachytherapy, rationale for treatments, patient selection criteria, up-to-date implant techniques, and long-term (12-year) outcome results. (CA Cancer J Clin 2000;50:380-393.)

Introduction

The last decade has seen remarkable growth in a form of prostate radiation therapy called *brachytherapy* or seed implantation, where tiny radioactive sources are implanted transperineally into the prostate gland. Increasingly, the procedure is playing a major role in the treatment of clinically localized prostate cancer. Indeed, analyses of Medicare data show that brachytherapy is apparently replacing radical prostatectomy as the treatment of choice for early-stage prostate cancer.¹

Brachytherapy is considered to have several advantages over radical prostate surgery. These include:

1. It is a simple, cost-effective outpatient procedure that can typically be

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performed in less than one hour.

2. It is a minimally invasive procedure requiring no incisions or sutures.

3. The anesthesia of choice is spinal, making prostate brachytherapy safer for men who may be considered at increased risk for general anesthesia.

4. Bleeding is generally unworthy of notice.

5. Recovery is rapid, allowing most men to return to work or resume usual activities within a day or two. In contrast, men who undergo radical prostatectomy require weeks of recovery.

6. Lifestyle changes, frequently required after a radical prostatectomy, are uncommon after a seed implant.

When compared with external beam radiation therapy, the spatially controlled radiation deposited by modern brachytherapy is considered to have the following advantages:

1. Using real-time ultrasound imaging, radiation sources can be placed safely and accurately, ensuring that the therapeutic dose delivery is confined to the prostate gland.

2. The low-energy radioactive sources, such as Iodine-125 (I-125) or Palladium-103 (Pd-103), have limited tissue penetration. This allows for a sharp drop-off of the radiation dose at the edge of the gland, limiting radiation delivery to normal tissues and minimizing potential treatment-related complications.

3. Prostate gland movement that can significantly affect the accuracy of external beam therapy and compromise both prostate and normal-tissue doses is generally not a factor during implantation with real-time ultrasound imaging.

4. Radiation exposure to physicians, nursing personnel, and family members is negligible.

5. A single outpatient treatment for placement of an implant as monotherapy is convenient, taking little of the patient's time compared with a protracted seven-week course of external beam radiation.

6. The precision and conformation of the brachytherapy dose to the gland allows for administration of a radiation dose roughly 50% to 100% greater than that which can be safely delivered by conventional or conformal external beam therapy. This is especially important, as increasing evidence shows that local tumor control improves with the amount of radiation delivered.^{2,3}

Taken together, the advantages of brachytherapy compared with other treatments for prostate cancer are substantial. This article provides a brief historical review of prostate brachytherapy, rationale for treatments, patient selection criteria, description of current implant techniques, and long-term (12-year) outcome results.

History of Brachytherapy

Reports documenting efforts to eradicate prostate cancer through the local application of radioactive isotopes date back to the turn of the twentieth century. At that time, the prostate was irradiated by temporarily inserting a capsule containing the long-acting radioisotope Radium-226 into the prostatic urethra.⁴ This early technique of brachytherapy represents the oldest technique for delivering radiation to the prostate gland, preceding external beam therapy of the prostate by several decades, and antedating modern prostate cancer surgery.

In 1915, Barringer at New York's Memorial Hospital (now Sloan Kettering Cancer Center), inserted Radium needles into the prostate.⁵ He described the procedure as follows: "These needles are 4-6 inches long and are inserted through the perineum into the prostate or further into the vesicles. A finger in the rectum is used to guide the needles." He concluded that, "Early cases showed a marked regression of the prostatic lump and in some cases complete disappearance of these."

In the 1950s and 1960s, Flocks (Uni-

versity of Iowa) injected a solution of colloidal radioactive Gold-198 into the prostate glands of patients with inoperable prostate cancers.⁶ Although the published results in a large number of patients suggested low mortality and morbidity, the technique was not widely used. Around the same time period, Carlton (Baylor) used a combination of external beam radiation and Gold-198 seed implantation for advanced prostate cancers.⁷

OPEN IMPLANT TECHNIQUES

Nevertheless, real interest in prostate brachytherapy did not occur until the 1970s when Whitmore described his

great appeal. Conceptually, a highly confined dose of radiation was delivered to the prostate gland, sparing the juxtaposed bladder and rectum from undue radiation damage. But, free-hand needle and seed placements all too often resulted in inconsistent dose distributions not recognized or appreciated until post-operative imaging was performed. Consequently, some areas of the gland received more radiation than planned (“too hot”) while other areas received less radiation than intended (“too cold”). The “too hot” segments often led to serious complications, while the often sublethal radiation delivered to the “too cold” areas resulted

For patients, it is much more desirable to spend only three hours in an outpatient surgical center for a seed implantation than to undergo major abdominal or perineal surgery requiring weeks of recovery, or similarly, to submit to protracted daily radiation treatments, lasting several weeks.

open implant technique using the radioisotope I-125.⁸ The isotope was contained in miniature, sealed titanium cylinders tailored to fit into and be administered by needles. The technique involved open surgery to achieve retropubic exposure of the prostate and to allow pelvic lymph node dissection. The prescribed dose of radiation was based on a nomogram derived from external beam and early brachytherapy planning concepts. The implant needles holding the I-125 seeds were inserted “free-hand” into the prostate without any imaging device for guidance while the index finger of one of the operator’s hands was in the rectum to help verify the needle depth.

The open implant procedure had

in a high rate of local failure. Moreover, some investigators incorrectly advocated brachytherapy for patients with bulky, advanced lesions that were incurable with any therapy,⁹ which confounded already variable results.

In the late 1960s, Bagshaw and others began publishing results of treatment of prostate cancer with newly emerging, megavoltage external beam radiation technology.¹⁰⁻¹³ Their data demonstrated that external radiation therapy could cure prostate cancer by the delivery of high doses of radiation to the prostate gland. This form of radiation and Young’s newly developed technique of removing the prostate surgically soon became the preferred treatments for prostate cancer; in-

terest in prostate brachytherapy gradually declined.¹⁴

This was where things stood until 1983, when Holm, a urologist from Copenhagen, Denmark, published his technique of implanting the prostate gland with radioactive seeds transperineally.¹⁵ The seed-bearing needles were guided into precise positions in the prostate gland by transrectal ultrasonography. His novel and elegant technique has been shown to be generally reproducible and yielded clinically meaningful results. Holm went on to train Ragde (senior author of this article) in prostate brachytherapy.

In 1985, Ragde performed the first prostate seed implantation in the US at Northwest Hospital in Seattle. Two years later, he performed the first Pd-103 implantation for prostate cancer and established a national brachytherapy implant course. His unswerving commitment to development of this modality, namely radioactive seed implantation for treatment of prostate cancer, as well as dedication to the training of other physicians in the technique, soon led to a resurgence of interest in prostate brachytherapy.

Current Brachytherapy Technique

Holm's technique of prostate seed implantation represents—even in the era of advanced radiotherapy techniques (see page 349 for more on external beam radiation therapy), such as three-dimensional conformal radiotherapy, intensity modulated radiation, and proton beam therapy—the most conformal form of radiotherapy possible. This is due to the high precision with which the seeds can be placed within the prostate gland, as well as the relatively low energy of the radioisotopes used. No other form of radiation therapy has been better able to localize a high radiation dose within the prostate while minimizing the dose outside the gland.

The procedure is minimally invasive and is readily accomplished in an outpatient setting. It is well tolerated and has a high level of patient acceptance. For patients, it is much more desirable to spend only three hours in an outpatient surgical center for a seed implantation than to undergo major abdominal or perineal surgery requiring weeks of recovery, or similarly, to submit to protracted daily radiation treatments, lasting several weeks. Another benefit of seed implantation is the rapid recovery. Patients may return to their usual daily activities within a day or two.

HIGH-DOSE RATE BRACHYTHERAPY

Another form of brachytherapy that has been used to treat prostate cancer is high-dose rate (HDR) brachytherapy. A limited number of centers in the US use this technique, which employs high activity Iridium-192, usually in combination with a course of external beam radiation. A robot assists in moving the radioactive sources through plastic catheters inserted in the prostate. As the radioactive source is *removed* from the patient at the end of each HDR treatment, the procedure is termed *temporary* brachytherapy. It is not possible to deliver an adequate radiation dose in a single session, and several administrations are required.

The technique is associated with several problems, such as difficulty achieving optimal catheter stabilization and faultless movement of the sources through the prostate. Because of these concerns, combined with the lack of long-term outcome results with HDR brachytherapy treatment in prostate cancer, we have elected, both at Northwest Hospital in Seattle, Washington, and at Southwest Oncology Center in Scottsdale, Arizona, not to employ temporary implants at this time. Therefore, prostate brachytherapists at our institutions use permanent implants with I-125 or Pd-103. The physical character-

Table 1

	Size (mm)	Half-life	Energy	Half-value Layer
I-125	0.8 x 4.5	60 days	28 KeV	2 cm Tissue
Pd-103	0.8 x 4.5	17 days	21 KeV	1.6 cm Tissue
I-125: Iodine-125 Pd-103: Palladium-103				

istics of these isotopes are shown in Table 1.

A THREE-STEP PROCESS

Modern prostate brachytherapy consists of a three-step process: Treatment planning, operative seed insertion, and a post-procedure evaluation of the implant to verify that the radiation dose delivered was optimal. At our centers, both the preliminary work-up and postoperative evaluations are done in the physician's office.

Planning the Implant

The primary purpose of implant planning is to assure a systematic approach to the individual patient, wherein a thorough evaluation of prognostic variables, comorbidity factors, and patient preferences all play a part in determining what would be the most suitable therapy. The treatment plan has three components: Patient selection, isotope selection, and seed mapping.

Patient Selection: Patients selected for seed implant alone, as for radical surgery, must have strong clinical evidence of organ-confined disease. Although no generally accepted criteria for determining organ-confinement exist, increasing evidence suggests that clinical stage, Gleason score, and serum prostate specific antigen (PSA) assembled into predictive algorithms, such as the Partin Tables, may be helpful in identifying patients at risk for extra-pro-

static disease. Our practice also uses an artificial neural network based on our published 10-year observed outcome results.¹⁶ Designed by the XAIM Corporation,[®] the network has proved helpful in predicting long-term results for the individual patient.

In general, we recommend seeds alone for patients with biopsy Gleason scores less than 7, pretreatment PSA values less than or equal to 10 ng/ml, and non-palpable or small solitary lesions less than 2 cm in largest dimension. For patients with Gleason scores of 7 or greater, pretreatment PSA values over 10 ng/ml, and/or nodules greater than 2 cm in size, we believe the risk of extra-prostatic disease increases. For such patients, we frequently recommend a combination of external beam radiation and radioactive seed implantation. Other factors such as patient age, the number of positive biopsy cores, amount of tumor in each core, as well as the presence or absence of perineural invasion may also play a role in treatment selection.

For patients with several high-risk factors, neoadjuvant/adjvant androgen ablation therapy may be added. Neoadjuvant androgen ablation may also be utilized to reduce glandular volume, particularly when the ultrasound images show a moderate amount of pubic arch overlaying the gland, which will interfere with needle insertion. Patients considered at risk for post-implant urinary retention may also be placed on a three-month

Table 2
Selecting Therapy According to Patient Factors

	Monotherapy	Combination Therapy
Nodule	None or Small	Large or Multiple
Gleason Score	2-6	7-10
PSA	≤10 ng/ml	> 10 ng/ml
Biopsy	Unilateral Disease	Bilateral Disease or Locally Extensive
Prostate Volume	< 60 cc	<60 cc
Urinary Flow Rate	> 15 cc /sec	>15 cc/sec

course of androgen deprivation prior to placement of the implant. Patient selection factors are listed in Table 2.

Isotope Selection: Permanent implants, used as monotherapy or in combination with external beam radiation, employ one of two established low-energy radiation sources. They are Iodine-125 (I-125) and Palladium-103 (Pd-103). Both are sealed within minute biocompatible titanium cylinders. The titanium cylinders remain forever in the prostate while the radioactivity decays to an inert state over several months. The main difference between the two isotopes is half-life, the time required for a 50% reduction in the radiation dose. The half-life, in turn, affects the initial dose rate of the implants: I-125, with a half-life of 60 days, emits radiation at 8 to 10 cGy per hour at the time of the actual implant. Pd-103, with a half-life of 17 days starts out at 20 to 24 cGy per hour.

Based on animal models and radiobiological principles, our early protocols recommended Pd-103 for higher grade (Gleason score, greater than 6) tumors, although this concept has never been validated clinically. Recent evidence suggests that I-125 and Pd-103 have equal tu-

morcidal effect through the range of Gleason grades.¹⁷

Seed Mapping: For the volume study, patients are placed on the exam table in the dorsal lithotomy position. The body halves should appear symmetrical when bisected in the mid-sagittal plane. Attention to detail is important so that the individual patient's positions are readily reproduced in the operating room. The ultrasound probe, when inserted into the rectum should be perpendicular to the perineum, and the prostate gland images should be centered within the template outline on the monitor without compressing or distorting the gland. It then becomes a straightforward process to reproduce a similar arrangement in the operating room. We believe dose calculation is best performed in an inexpensive office setting rather than intraoperatively with the patient under anesthesia.

During the transrectal ultrasound volume study, a series of cross-sectional images of the prostate gland are obtained at 5-mm intervals from apex to base, including the seminal vesicles. These cross-sectional ultrasound images are entered into a treatment-planning computer to be digitized and reassembled into a three-di-

mensional rendition of the gland that corresponds to its true anatomical structure. The radiation oncologist determines the number of seeds, seed activity, and their placements within the prostate in compliance with the prescribed total dose.

The treatment planning system is interactive, allowing the radiation oncologist to observe resultant changes in isodose distribution that occur with changes in seed positioning. Lastly, a dose-volume histogram (DVH) is constructed and evaluated to verify the adequacy of the plan. The end result is a unique and individualized treatment plan that specifies the number of seeds and their position within the gland.

INTRAOPERATIVE SEED PLACEMENT

At our facilities at Northwest Hospital and at the Southwest Oncology Center the entire seed implant procedure generally takes 45 minutes, and the total patient stay in the ambulatory surgery center, about three hours. The patient is anesthetized and placed in the dorsal lithotomy position, duplicating the office volume-study position. The ultrasound probe with its attached template is inserted into the rectum at a 10-degree downward angle to the operating table to align the long axis of the probe with the slightly downward direction of the rectum. The probe is adjusted so that the cross-sectional images correlate with the pre-plan volume study images. Once the probe is in the appropriate position, it is locked to the operating table by a stabilizing device. The probe rests in a "stepper," which permits precise forward and backward movements of the transducer in 5-mm increments, providing sonographic images of the gland from its base to apex. It also provides sagittal views of the prostate to assure correct depth placement of the implant needles.

The prostate is a very mobile and malleable organ, and real-time monitoring of the needle insertion is of utmost importance. Any deviation and internal

distortion should be recognized and corrected for.

At the end of the procedure, the overall implant quality is evaluated by both ultrasound and fluoroscopy, and additional seeds may be placed as deemed necessary. Patients leave the operating room with an indwelling Foley catheter in the bladder, which is removed when the anesthesia wears off.

Upon discharge from the outpatient facility, most patients resume their customary daily activities within a day or two. Postoperative medications generally include an antibiotic, a nonsteroidal anti-inflammatory agent, and an alpha-blocker.

EVALUATION OF IMPLANT QUALITY

Implant quality is assessed using a three-dimensional reconstruction of the implant based on computed tomographic (CT) images obtained within 16 hours of the implant. The CT images document seed positions in relation to the prostate and adjacent structures, which permits computation of the aggregate dose meted out to both the prostate and surrounding structures. The CT-defined images are overlaid with isodose curves and a DVH constructed to verify adequacy of treatment and compliance with the planned implant.

POST-IMPLANT FOLLOW-UP

Our patients are generally evaluated every three to six months the first year, and annually thereafter. The follow-up includes clinical evaluation and serum PSA measurement. The necessity for additional studies is dictated by patients' symptoms and signs.

Outcome Evaluation and Definitions

The American Society for Therapeutic Radiology and Oncology (ASTRO), defines biochemical (PSA) failure as three consecutive PSA increases measured six months apart.¹⁸ In addition, we also consider a positive needle biopsy taken

18 or more months post-implant a local failure, and a positive bone/CT scan as distal failure.

Results with Prostate Brachytherapy: 12-Year Experience¹⁹

At Northwest Hospital, 229 patients with stage T1/T3, low-to-high Gleason grade prostate cancer underwent prostate implants with I-125 or Pd-103 between January 1, 1987 and September 1, 1989. Patients, whose median age was 70 years (range, 53 to 92 years), were divided into two groups based exclusively on clinical stage and Gleason grade. Pretreatment PSA measurement was obtained in all patients but did not impact upon the treatment group assignment.

Group 1 consisted of 147 lower stage/grade patients treated with an implant alone (monotherapy); and Group 2 comprised 82 patients deemed to have higher risk of extra-prostatic extension of the malignancy. Group 2 patients, in addition to receiving a seed implant, were also treated with 45 Gy external beam radiation to the pelvis (combination therapy). None of the patients underwent operative staging, and none received concurrent androgen manipulation.

Fourteen patients were lost to follow-up: Seven by death from non-cancer causes within 18 months post-implant, and seven because of incomplete PSA follow-up, leaving 215 patients for complete evaluation. The median duration of post-treatment follow-up was 110 months.

The observed disease-free survivals of the two groups combined at 12 years was 70%; 66% in the monotherapy group and 79% in the combination therapy group. Figures 1, 2, and 3 show the disease-free survival results graphically.

TREATMENT-RELATED MORBIDITY

Complications were not specifically addressed in this study cohort, as the majority of patients had undergone previous

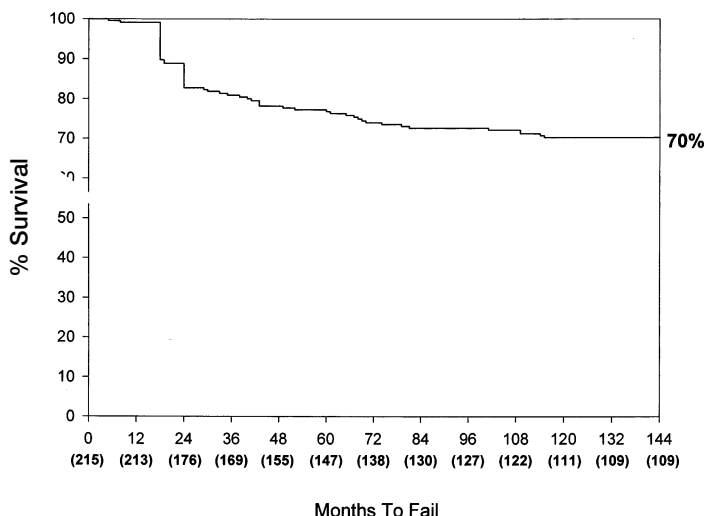
morbidity evaluation. However, our clinical experience with over 4,000 patients treated shows that most implant patients experience some degree of irritative and/or obstructive urinary tract symptoms lasting for a couple of weeks to months. The symptoms are generally mild, but may be a bother to patients who expect rapid recovery and return to pre-implant health.

Urinary retention requiring intermittent or long-term catheterization is uncommon, occurring in fewer than 5% of brachytherapy patients. It has been noted that a subset of patients presenting with enlarged glands and pre-existing urinary obstructive symptoms are particularly prone to develop acute retention.^{20,21} It has been our experience that urinary obstructive symptoms immediately after seed implantation are caused primarily by the mechanical trauma of the implantation rather than from the radiation. Radiation-induced symptoms may appear similar, but generally do not appear until several days after the implant. Symptoms generally peak about seven to 10 days after Pd-103 implants and 14 to 21 days after an I-125 implant. Large glands, which require greater numbers of seeds, may be subjected to more trauma from needle punctures than smaller glands.

Impotence

Previous studies on post-implant morbidity established that the risk of impotence increased with age and averaged 30% for all ages.²¹⁻²³ It has been our experience that post-implant erectile dysfunction may be largely related to age and degree of pre-treatment erectile competence.²⁴ Patients younger than 60 years of age, who claimed sexual fitness prior to the implant, generally maintained their sexual competence postoperatively; in contrast, about 20% of patients between 60 and 70 years of age who claimed to be sexually active before the implant suffered erectile dysfunction after the procedure. The sex-

Figure 1
Disease-Free Survival According to Years Since Implant:
Entire Cohort



Disease-free survival (DFS) versus years from implant for the entire cohort using the ASTRO failure criteria (observed DFS through year 10 projected to year 12). The numbers of patients who were available for evaluation (at risk) are shown in parenthesis (12-year DFS, 70%).

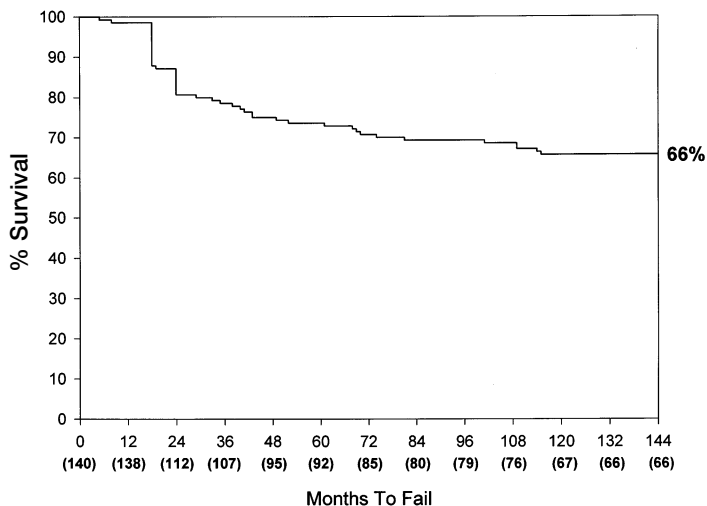
ual dysfunction rate appeared similar for patients treated with seeds alone and with combination therapy.

Likewise, we discovered early on that patients without a prior transurethral prostate resection (TURP) have little or no risk of becoming incontinent of urine. In patients with a TURP history, however, the incontinence rate at our institution was 24%.²⁵ This led us to modify our implant technique by shifting some of the central seeds away from the urethra in TURP patients, which appears to have largely eliminated this unfortunate side effect.²⁴

Discussion

With increasing life expectancy and widespread use of serum PSA measurement as a screening test, cancer of the prostate has become one of the most commonly observed malignancies in American men and one of the most frequent causes of death from cancer.²⁶ In the pre-PSA era, the majority of prostate tumors were clinically and pathologically advanced, whereas most prostate cancers diagnosed today are likely to be of a lower grade and confined to the prostate, lending themselves to potentially better cure rates by locally directed treatments.²⁷ That this may also affect the mortality

Figure 2
Disease-Free Survival According to Years Since Implant:
Monotherapy (Group 1)



Disease-free survival (DFS) versus years from implant for Group 1 (monotherapy) using the ASTRO failure criteria (observed DFS through Year 10 projected to Year 12). The numbers of patients who were available for evaluation (at risk) are shown in parenthesis (12-year DFS, 66%).

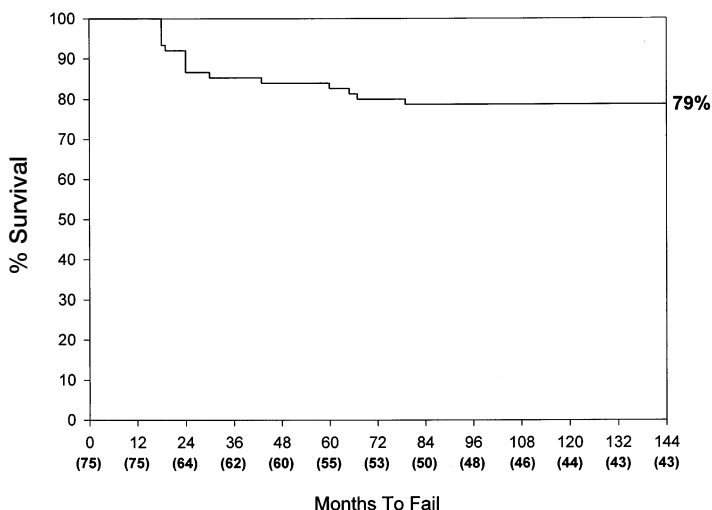
rates of the disease is evidenced by a recent study from Tyrol, Austria, documenting a full 40% reduction in prostate cancer mortality attributable to early detection and treatment.²⁸

Common management strategies for clinically localized prostate cancer include radical prostatectomy, external beam radiation, and brachytherapy. Over the years, each has been anointed and embraced with varying degrees of enthusiasm. However, in the absence of outcome data from randomized clinical trials it has been impossible to determine which is the more effective and better-tolerated treatment. Since the necessary randomized trials are unlikely to be conducted, at least in the near term, treat-

ment decisions will continue to be made on the basis of patient and physician preferences in conjunction with clinical probabilities.

It is now generally accepted that a patient's PSA level may be used to determine disease extent, assist in selecting the most suitable treatment, and after completion of therapy, signal a treatment failure years before it becomes clinically evident. Considering this great modern-day dependence on PSA as a diagnostic and prognostic tool, it becomes important to emphasize that clinical use of PSA is of recent origin, and no treatment modality today can claim long-term results without PSA evidence. This observation means that only a handful of institutions in the

Figure 3
Disease-Free Survival According to Years Since Implant:
Combination Therapy (Group 2)



Disease-free survival (DFS) versus years from implant for Group 2 (combination therapy) using the ASTRO failure criteria (observed DFS through Year 10 projected to Year 12). The numbers of patients who were available for evaluation (at risk) are shown in parenthesis (12-year DFS, 79%).

US can lay claim to long-term follow-up of patients treated for clinically localized prostate cancer. Northwest Hospital in Seattle, Washington is one such institution with PSA records dating back to 1985.

The brachytherapy study reported here, based on thousands of PSA determinations and a high post-implant biopsy rate, documents that interstitial radiation is an effective treatment for early-stage prostate cancer. Brachytherapy achieves long-term disease-free survival rates that are comparable to the best results reported from radical prostatectomy series, and substantially better results than reported from conventional external beam therapy.²⁹⁻³¹

At 12 years, 70% of the patients

treated at Northwest Hospital were clinically and biochemically disease-free; 66% with monotherapy, and 79% with combination therapy.¹⁹ The substantially better outcome results in the high-risk patients compared with those in the low-risk group initially suggested implant underdosage. However, when repeat prostate biopsies on the failed patients proved largely negative—suggesting that we were dealing with distal failure—we had to look elsewhere for an explanation.

The most likely reason for the higher failure rate in the low-risk monotherapy group is that a large number of those patients today would fall into a high-risk category: More than 80% of the patients had palpable disease; the PSA levels, above 10 ng/ml in substantial numbers,

were not considered in the risk assessment; and several pathologists reviewing some of our pre-implant prostate biopsies have come to the conclusion that many of them were under-graded.

Thus, we have some evidence that the Gleason grade was underestimated in many of our "low-risk" patients, which may be the reason for the higher disease-free survival rate in the high-risk group. The 79% clinical and biochemical disease-free survival in our high-risk group—to our knowledge, the best long-term results ever reported for such an unfavorable prognostic group of patients—suggests that the addition of external beam radiotherapy to the prostate, periprostatic tissue, and seminal vesicles may increase the likelihood of cure in patients with more aggressive disease.

None of the Northwest Hospital brachytherapy patients were treated with hormones. Results from studies of complete androgen blockage added to external beam radiotherapy for locally advanced disease are encouraging.³² Perhaps trimodality therapy—hormones for downgrading, plus external beam radiotherapy added to boost brachytherapy—would further benefit high-risk patients.

With increasing numbers of patients treated, there has been a concomitant increase in technology: Advances have been developed in treatment planning systems, stabilizers, steppers, needles, and isotopes. These advances may permit even more precise placement of seeds and more consistent dosimetry, perhaps leading to a higher cure rate. Alternately, the downside of increased numbers of patients is the possibility of treatment by less experienced brachytherapists. The implants described in this article were performed by an experienced team. With the exponential growth of the procedure, less experienced teams and practitioners might obtain less favorable outcomes.

To fully sanction a new therapy requires proof that the success and risks of

the new procedure are at least comparable to treatments already in use. With the data presented here and those previously published, it is possible to reach the conclusion that the efficacy of prostate brachytherapy compares favorably with results reported from modern surgical and external beam series. Brachytherapy also demonstrates fewer side effects and complications.

In the pre-PSA era, the majority of prostate tumors were clinically and pathologically advanced, whereas most prostate cancers diagnosed today are likely to be of a lower grade and confined to the prostate, lending themselves to potentially better cure rates by locally directed treatments.


A recent forecast by the American Urological Association based on Medicare data suggests that prostate brachytherapy may replace radical surgery as the treatment of choice for organ-confined prostate cancer.¹ This conclusion is reasonable. There are ample precedents in medicine: When a treatment becomes less invasive, less deforming, and less costly—both in terms of monetary and lifestyle impact—and yet accomplishes the same goals as more radical interventions, that treatment will be favored by patients.

As an example, one can look at the evolution of treatments for another glandular, hormonally responsive tumor, breast cancer. In the late 1970s, women elected to forgo the extensive radical mastectomy for breast conservation ther-

apy, i.e., minimal surgery with follow-up radiation to the breast. Now, breast conservation therapy is considered the gold standard for women with localized breast cancer, obviating the need for the more extensive surgery that often led to permanent disfigurement and other disagreeable consequences.

Conclusions

Modern prostate brachytherapy with permanent implants is a minimally invasive procedure that affords excellent

outcome results and is associated with minimal morbidity. It offers the prostate cancer patient a practical alternative to surgery and external beam radiation therapy. We predict continued growth of brachytherapy as a curative treatment for prostate cancer. As the population continues to age, clinicians in all fields will increasingly encounter patients who have questions about treatment for prostate cancer. We hope this article will provide them with useful information, which they may share with their patients. 

This article is dedicated to
Gerald Murphy, MD:
Scientist, colleague, and friend.

Great men are meteors that consume themselves to light the earth.

Thomas Hardy—*The Dynasty*

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