The Origin of Brachytherapy
For Prostate Cancer
The Early 20th Century
The Origin of Brachytherapy
The Early 20th Century
Melbourne, Australia, 1905
Radium implant for breast cancer
The Origin of Brachytherapy
For Prostate Cancer
The Early 20th Century
CLINICAL INVESTIGATION

DAWN OF PROSTATE BRACHYTHERAPY: 1915–1930

JESSE N. ARONOWITZ, M.D.

Departments of Radiation Oncology and Urology, Upstate Medical University, State University of New York, Syracuse, NY

Purpose: To investigate the origins of prostate brachytherapy.
Methods and Materials: A review of contemporary journals and texts was conducted.
Results: Prostate brachytherapy was performed frequently by leading urologists before 1930. Both temporary and permanent implant techniques were developed using radium and radon through intracavitary and interstitial approaches. Transperineal implantation of permanent sources was first performed 80 years ago.
Conclusion: Prostate brachytherapy has its origins in the early part of the last century. © 2002 Elsevier Science Inc.

Prostate neoplasms, Radium, Brachytherapy, History of medicine.

INTRODUCTION

The past decade has witnessed widespread acceptance and use of prostate brachytherapy. Interest in the procedure first appeared almost 90 years ago, and noted clinicians performed hundreds of implants in the first quarter of the 20th century.
THE HOPKINS EXPERIENCE

Hugh Hampton Young is best known for developing the radical perineal prostatectomy in 1904. He achieved remarkably high cure and low mortality rates with the procedure (4). Most patients with prostate cancer were diagnosed in an advanced stage, however, so surgical candidates were uncommon. Moreover, many patients were too frail to withstand the rigors of surgery. Consequently, he rarely performed the procedure for which he is most famous. Most patients underwent palliative measures to relieve bladder outlet obstruction. An alternative curative therapy applicable to most patients was needed.

Young’s interest in radium was stimulated by the 1913 report of Pasteau and Degrais (5) of transurethral radium therapy (6). It is likely that he was also influenced by the striking success achieved by his Hopkins colleague, Howard Kelly, in treating “hopeless” gynecologic tumors. Young soon obtained 102 mCi of radium for the treatment of urologic malignancies. The shortcomings of the French transurethral technique were soon apparent; radium solely deployed in the urethra injured its mucosa without adequately treating the periphery of the gland. Young therefore developed a complex system of intracavitary therapy, alternating applications in the urethra, bladder, and rectum. An external radium pack was sometimes suspended 3 in. from the perineum, lower abdomen, or sacrum. The tumor was

The role of radiotherapy in Young’s practice evolved and expanded. Radium therapy was combined with deep roentgen-ray therapy (9). It was also used as an adjuvant to surgery, applying radium to the prostate bed after incomplete resection. Palliation of painful metastases was achieved by radium packs or roentgen-ray teletherapy.

Young (6) initially reported dramatic results, with “amazing resorption of extensive carcinomatous involvement of prostate and seminal vesicles ... in the majority of cases,” resulting in the “disappearance of pain and obstruction ... which is indeed remarkable.” The response to therapy was particularly gratifying because his radium patients had advanced disease (90% had seminal vesicle involvement and 15% had palpable invasion of the rectal wall). His system of rotation of treatment portals and scrupulous avoidance of site re-irradiation limited toxicity. Although he preferred surgery for “early” disease (tumor palpably limited to the prostate and proximal seminal vesicles), he performed radical prostatectomy an average of once a year (10). Radium was used far more frequently: 66 times in the first 2 years.
Fig. 1. Record of a course of intracavitary brachytherapy as delivered by Hugh Hampton Young. (a) Map of prostate and seminal vesicles as determined by rectal examination. Parallel lines indicate regions of induration, and cross-hatch indicates stony hardness. (b) Record of rectal applications. (c) Record of urethral, bladder neck, and trigonal applications. (d) Palpable findings 10 months after therapy completion. From Young (8), public domain.
Fig. 2. Transrectal intracavitary application using an applicator and fixation device of Young’s design. From Young (8), public domain.
Improvement of Navigation: Augmented reality
Fig. 3. Insertion of an emanation-tipped needle using a transperineal approach, under guidance of a finger in the rectum.
From Young (8), public domain.
3D Live Imaging & Volume Navigation

3D

sagittal

coronar

transversal
Image Guided Implantation
THE MEMORIAL EXPERIENCE

Shortly after assuming leadership of New York’s Memorial Hospital, James Ewing recruited a cadre of surgeons to explore radium’s therapeutic potential in malignancy (12). Among them was a urologist, Benjamin Stockwell Barringer.

The defining feature of the Memorial program was the use of radon. William Duane, a Boston physicist, was commissioned to construct a radon extraction plant. During his tenure as an assistant of the Curies, Duane had devised a technique to harvest “emanation” (radon), the first daughter product of radium (13). Radon is therapeutically equivalent to radium, but because of its much shorter half-life (days vs. 1600 years), it possesses distinct clinical advantages. Radon occupies a much smaller volume per unit of activity; instead of the 5-mm diameter capsules used by Young, radon could be enclosed in 1-mm needles, applicable for interstitial use. Additionally, because radon sources become inert within weeks (rather than millennia), they can be permanently implanted. Memorial’s entire radium stock was kept in the extraction plant; only the harvested radon was used therapeutically. It was captured in glass capillary tubes 0.3 mm in diameter, which were inserted into metal capsules or needles for intracavitary or interstitial application.

Radon 1mm needles

Interstitial use
Fig. 4. Radiograph of pelvis demonstrating position of intraprostatic gold-sheathed radon ("emanation") seeds. This patient had undergone several implants. From Barringer (19), public domain.
Fig. 5. Barringer’s work is commemorated by the Barringer Medal, awarded since 1955 for research contributing to the advancement of clinical urology (32). (a) Barringer’s image is on the face of the medal. (b) Symbols of radioactivity, as well as “seeds” and an implanting trocar, appear on the medal’s reverse. Reproduced with permission from the American Association of Genitourinary Surgeons.
problem, Memorial physicist Gioacchino Failla developed tiny gold-encapsulated seeds (18). The 0.30-mm gold casing filtered nearly all the electrons and softer \( \gamma \)-rays; the exiting \( \gamma \)-rays were more penetrating, distributing the dose more homogenously. The 6-mm-long gold seeds each contained 1.5–2.0 mCi of radon. Typically, four needles would permanently embed up to 20 seeds in a fanned array (19). A typical implant delivered 4000 mCi-h. Implants were repeated every few months until the desired palpable results were achieved (Fig. 4).

RISE AND FALL OF RADIUM IMPLANTS

Beginning in 1915, Young (6) and Barringer (15) each performed hundreds of prostate implants. The early results were extremely encouraging, with dramatic improvement in urinary and erectile function and general well-being. Other urologists adopted their procedures. Bumpus (Mayo Clinic) (20) and Watson (Buffalo) (21) each reported on more than 100 prostate implants. The minutes of professional societies recorded the experiences of other urologists (22, 23). Hundreds of American hospitals, clinics, and physicians acquired radium, and commercial radon seed manufacture made brachytherapy accessible to many others. A total of 80,000 patients underwent some form of radium therapy in 1931 alone (24). A manual titled “Radium in General Practice” instructed nonurologists in the technique of prostate implantation (25).

Few practitioners, however, acquired the experience and skills necessary to deliver effective therapy with acceptable toxicity. Even Young and Barringer faced insurmountable problems. Achieving a satisfactory distribution of sources without direct visualization proved elusive (26), and both Young and Barringer experimented with open techniques (Young through the perineum, Barringer through the bladder). Attempts at combining implantation with external irradiation (27) or castration (19) were disappointing. Recognizing the difficulties inherent in managing advanced disease, they became advocates of screening for prostate cancer (10, 28).

Radium therapy for prostate cancer was eventually abandoned because few recipients remained free of their disease (19). Surgery became established as the preferred treatment for organ-confined disease. Following the work of Huggins et al. (29), castration replaced radium therapy for palliation of locally advanced disease. Eventually, Barringer was the only remaining brachytherapy advocate, claiming that implantation was as effective as prostatectomy with lower mortality (30). Young barely mentioned the procedure he pioneered in his autobiography (31).

Young and Barringer’s groundbreaking brachytherapy work is largely forgotten (Fig. 5). Fifty years would elapse before the closed transperineal implant would be resurrected (32). However, with the development of effective screening programs, computer-based dosimetry, advanced imaging technology, and more suitable radionuclide agents, prostate brachytherapy would experience a renaissance.
Brachytherapy History in Offenbach
History of Brachytherapy in Offenbach

Radium - Lieferungen

1. 27. April 1914 46,69 mgr a 358 K = 16715.--- K
   Metallhülse und Bleikapsel
   15.---

2. 30. April 1914 37,15 mgr a 358 K = 13299.70
   Metallhülse und Bleikapsel
   15.---

3. 25. Juni 1914 17,52 mgr a 358 K = 6272,16

VIERTER BAND:
DAS VERKEHRSWESEN - DIE GROSZFABRIKATION

---

139
508
appor
t

CONDI
à été complé

Market demand and Pricing

### TABLE 5.1
Prices for 1 g of $^{226}\text{Ra}$ at the Beginning of the Twentieth Century

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S. Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1902</td>
<td>3,000.00</td>
</tr>
<tr>
<td>1904</td>
<td>18,600.00</td>
</tr>
<tr>
<td>April 1906</td>
<td>50,000.00</td>
</tr>
<tr>
<td>August 1906</td>
<td>70,000.00</td>
</tr>
<tr>
<td>December 1906</td>
<td>90,000.00</td>
</tr>
<tr>
<td>1911</td>
<td>120,000.00</td>
</tr>
<tr>
<td>1914</td>
<td>150,000.00</td>
</tr>
</tbody>
</table>

Sum of 36.317.00 Mark x 6 €/M = ca. 220.000 € !!!
CONDITIONS D'ETUDES. Le rayonnement du tube de l'appareil à été comparé au rayonnement de l'éclat du Laboratoire. L'appareil était dans une boîte de terre. 

RESULTAT:

L'appareil tube de rène N° 4661 contient 17,5 mm de 

(du - sept, cent quatre-vingt-dix)

(1). La valeur ainsi calculée peut être acceptée avec connaissance mais elle ne comporte pas la même précision que la mesure directe du rayonnement limite, laquelle ne peut être faite qu’un mois après la préparation de l’appareil. Pour un appareil constitué par un tube de platine, une correction est faite afin de tenir compte de l’absorption des rayons par le platine. L’épaisseur admise est mm. nombre donné par 

Le Directeur du Laboratoire. 

M. Curie
Offenbach IRT Statistics

1994-2012: 14250 Implants (91 Publ.)

1998-2012: 9755 Prostate Implants (37 Publ.)
Prostate Cancer
Max & Min
Pre-treatment volume: 500.7 ml
100% = 12 Gy
Post-treatment volume after 8 weeks: 107.3 ml
Volume = 22.0 ml