

# HDR Brachytherapy – Patient Information



**Eckert & Ziegler**  
*Contributing to saving lives*

# About Brachytherapy

Cancer is a term used for diseases in which abnormal cells divide without control and then invade other tissues. This disease can affect many different organs in the human body. Cancer DNA is more sensitive to radiation than those of normal cells. Therefore, radiation kills cancer cells directly and normal tissue in the region is able to repair itself and recover. Common teletherapy (from the Greek: tele = long) treatment of cancer involves delivering the radiation externally to the patient's body using different types of specialized external equipment, such as a linear accelerator.

Brachytherapy (from the Greek: brachy = short) works in a different way. It is a well established form of internal radiation therapy that uses radioactive sources positioned directly into or around the tumor. In comparison to external beam radiation therapy, brachytherapy delivers a higher dose of radiation to specific sites in the body because this technique targets the tumor and minimizes radiation to the surrounding healthy tissue. For the patient, this means shorter treatment periods, fewer side effects and a faster recovery.

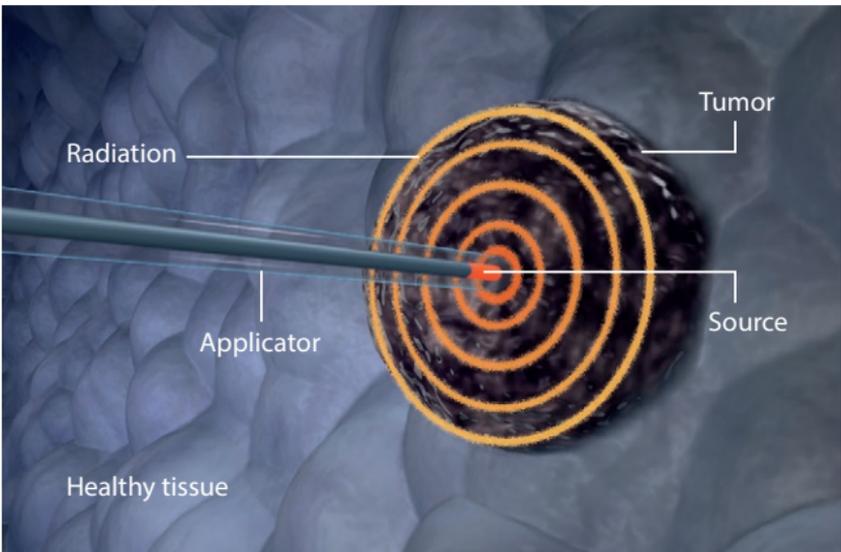


Figure 1: Localised radiation to tumor cells via brachytherapy

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There are two methods of brachytherapy delivery; temporary irradiation from a removable source or continuous irradiation from permanently implanted sources.

In temporary brachytherapy, sources are placed in or close to the tumor for a specified time (usually a few minutes) and removed again afterwards. The actual duration of the treatment depends on many different factors such as the required intensity of the dose delivery as well as the type, the size and the position of the tumor.

Permanent brachytherapy means that small radioactive seeds or implants (smaller than a grain of rice) are placed into the tumor or treatment site, where they remain permanently. The radiation dose emitted from the radiation source falls over weeks or months to almost zero. Finally the seeds remain inactive with no lasting impact in the treatment site. Permanent brachytherapy is used for the treatment of prostate cancer.

Brachytherapy can be used either alone or in combination with other types of treatment. Sometimes it is used after surgery to ensure that all cancer cells are eliminated. It can also be used in conjunction with external beam radiation.

# About HDR Brachytherapy

High dose rate (HDR) brachytherapy allows radiation oncologists to deliver the radiation quickly, mostly as an outpatient procedure. The two main methods of HDR brachytherapy delivery are interstitial treatment and intracavitary treatment.

During interstitial radiation treatment, applicators such as needles or catheters are inserted in or adjacent to the tumor. Sometimes, surgical procedures are used to place catheters directly into the tumor.

During intracavitary brachytherapy, a device, such as a tube or applicator is placed in a body cavity, e.g. the cervix or vagina.

The Radiation Oncologist will develop a specific prescription for how the radiation will be administered and what doses of radiation are necessary to achieve successful treatment, for each individual patient. If you are receiving brachytherapy, the physician will also be responsible for the placement of the applicator or applicators at the target site. Imaging procedures like computed tomography (CT), ultrasound (US) or magnetic resonance imaging (MRI) are used to ensure the correct placement of these devices (see figure 3).

A Medical Physicist qualified in radiation dosimetry takes the prescription written by the radiation oncologist and creates the best treatment plan to ensure the tumor gets the optimized dose of radiation while minimizing the radiation to normal tissue.

As a team, the Oncologist and Physicist will ensure that the treatments are properly customized for each individual patient.

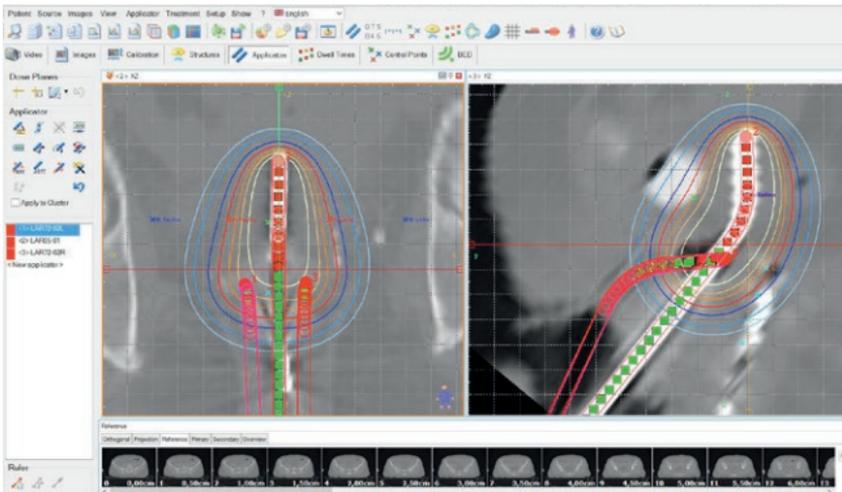


Figure 2: Example of a dose distribution to the cervix in different perspectives with a three channel applicator as calculated in a treatment planning system

When the patient is in the radiation treatment room, a computer driven apparatus, called a remote afterloading device, pushes the radioactive source, which is attached to a wire, through the transfer tubes and the applicators to the treatment site. The radioactive source, either Cobalt-60 or Iridium-192, can be moved in millimeter increments and remain in a certain position (dwell position) for a predetermined amount of time.

When the desired treatment dose has been achieved, the remote afterloading device automatically withdraws the radioactive source so there is no residual radiation or radioactivity<sup>1</sup>.

# About HDR Brachytherapy

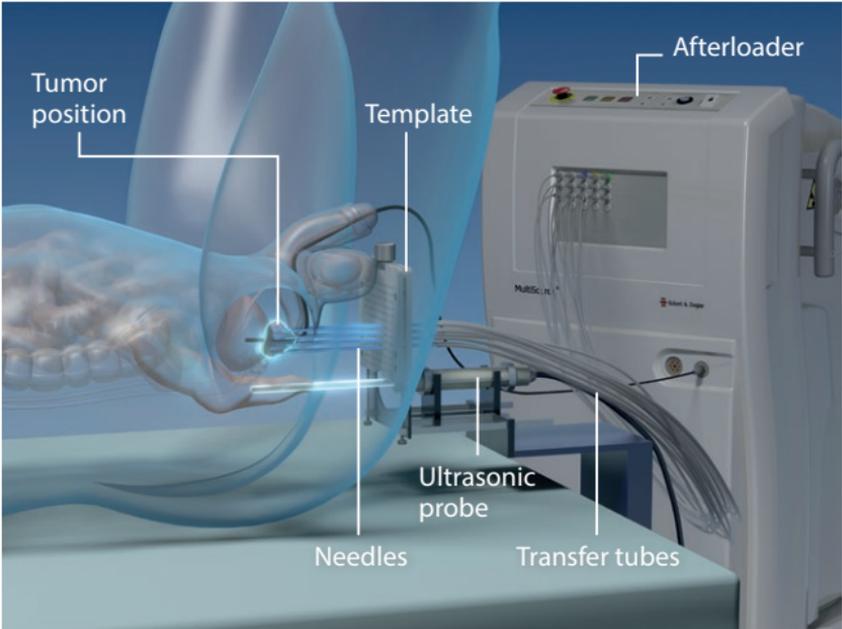


Figure 3: Schematic of HDR treatment delivery to the prostate

Most HDR brachytherapy treatments are done with one weekly treatment for a period of up to four weeks or with one or two treatments per day for up to five days. These common indications may differ in some cases. The radiation delivery only lasts a few minutes while the procedure (also called session) including patient setup, applicator positioning, treatment planning and treatment delivery itself, last up to a few hours.

## References:

- 1) [www.aapm.org](http://www.aapm.org) (The American Association for Physicists in Medicine)

# Area of Application for HDR Brachytherapy

Compared to permanent seed implantation, which is used to treat prostate cancer, the high dose rate afterloading therapy is used on a broader level. It can be used for the treatment of cancer in the following organs:

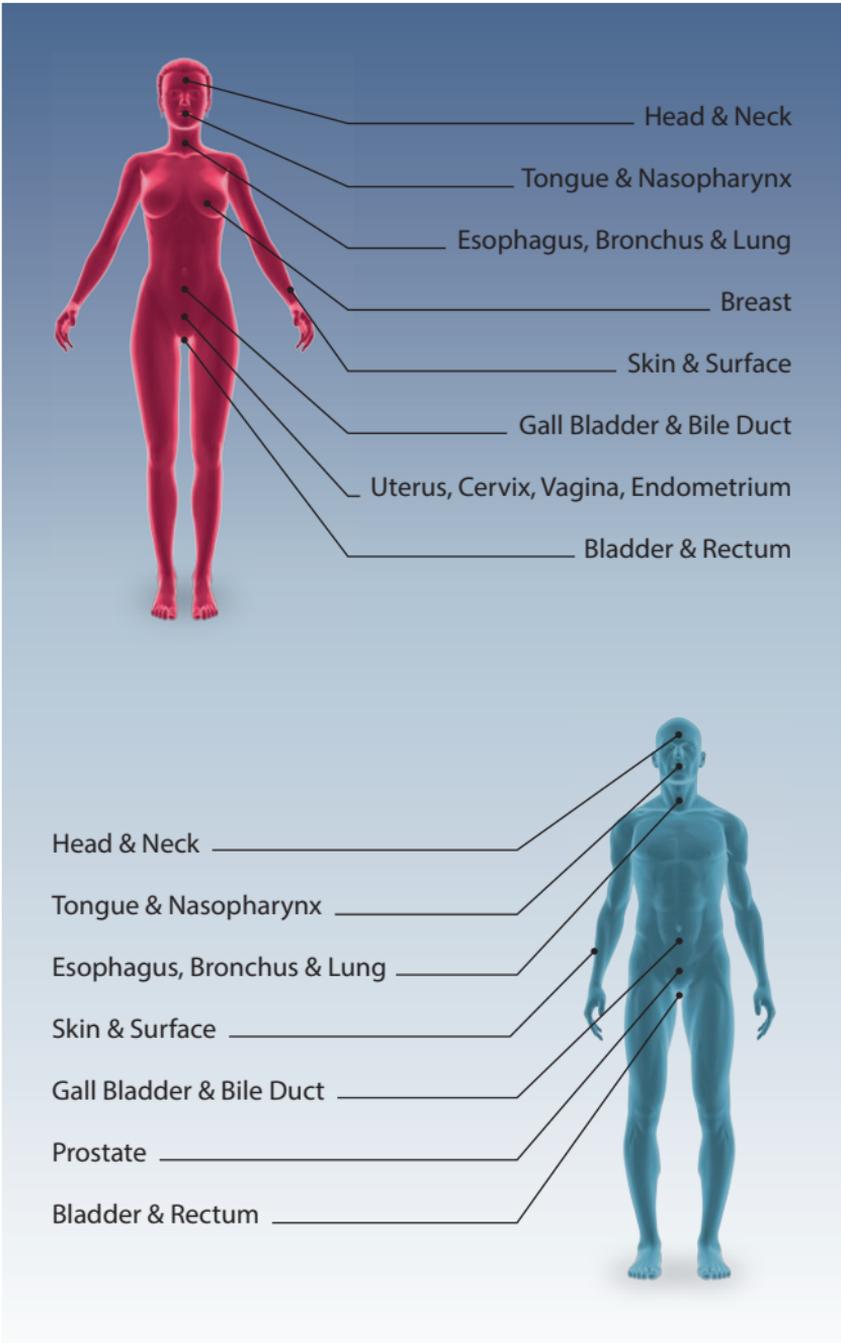


Figure 4: Body sites that can be treated with HDR brachytherapy

# HDR Brachytherapy for Prostate Cancer

The prostate is a small walnut shaped well defined gland located below the bladder and next to the rectum. It is a part of the male reproductive system. Prostate cancer occurs when cells in the prostate grow out of control. These multiplying cells may form a tumor within the gland or may spread to other parts of the body (metastasize). Prostate cancer usually takes years to develop before being large enough to detect<sup>2</sup>.

Prostate cancer is the most commonly diagnosed cancer in men over the age of 65, but it can also be found in younger men. It is estimated that one out of every six men will be diagnosed with prostate cancer during his lifetime.

Over the past two decades, the incidence of prostate cancer has increased rapidly and is now the most frequent cancer amongst men in Western Europe<sup>3,4</sup>. It is unclear why this is the case, but it could be due to improved screening for the disease, which is an advantage when it comes to early intervention, choice of treatment and the long term survival rate<sup>5</sup>.

Prostate cancer is usually detected through a Prostate Specific Antigen (PSA) blood test and/or a routine Digital Rectal Exam (DRE). Once cancer is suspected, your doctor will decide on further tests. The first step is often a biopsy performed by an urologist, under anesthesia.

The tissue samples from the biopsy are examined under the microscope to determine the Gleason Score (range two to ten). The Gleason Grading system of the prostate tissue is used to help evaluate the prognosis of men with prostate cancer. Together with other tests and parameters, such as the staging (size) of the tumor (graded from T1 to T4), the overall risk is evaluated which helps guide the therapy as well as any follow-up treatment.

	Low-Risk	Medium-Risk	High-Risk
PSA Level	< 10 ng/ml	10 – 20 ng/ml	10 – 20 ng/ml
Gleason Score	2 – 6	7	8 – 10
Tumor Stage	T1a, b, c – T2a	T2b	T2c – T3a

Table 1: The most common parameters for evaluation of prostate cancer<sup>6</sup>

Once all necessary tests have been done, your doctor will discuss the possible treatment options with you. In general, the earlier the cancer is detected, the more choices you will have. Also, treatments and medical procedures keep getting better and you should discuss the advantages as well as disadvantages of all the treatment options available to you, with your doctor.

For prostate cancer that is diagnosed before it has spread outside the prostate gland, and the tumor stage is T1 or T2 HDR brachytherapy is becoming more and more the treatment of choice. It may be given as the only treatment (called HDR monotherapy) or it may be used in combination with external radiation therapy. HDR brachytherapy has been found to be highly effective to virtually all stages of localized prostate cancer<sup>7</sup>.

The HDR brachytherapy procedure is performed under anesthesia in a specialized radiation suite. Depending on the size of the tumor, a series of long needles are placed into the prostate using a template.

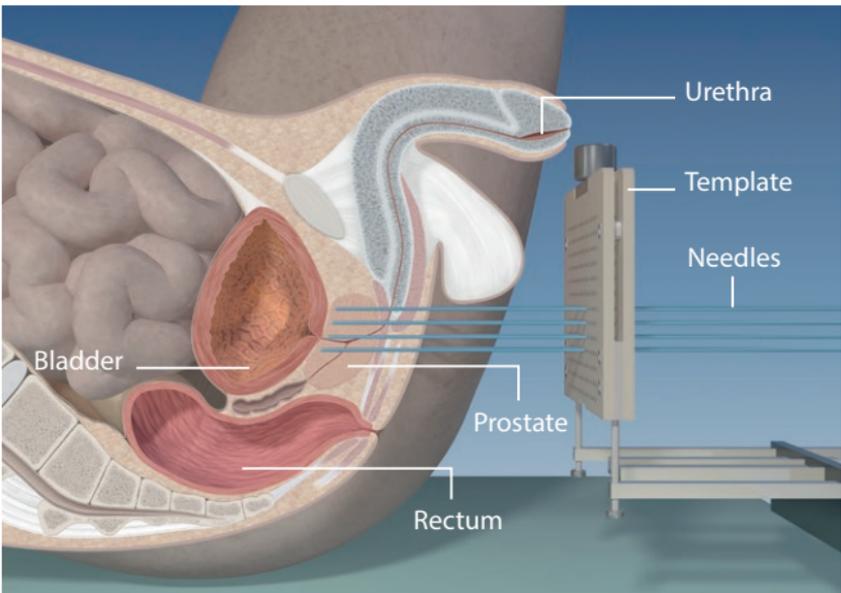


Figure 5: Schematic placement of needles for prostate HDR brachytherapy<sup>6</sup>

# HDR Brachytherapy for Prostate Cancer

The exact placements of the needles have been calculated using advanced specialized software. During the procedure, the physician may use a trans-rectal ultrasound probe to ensure accurate needle placement. Upon completion of each HDR treatment sessions, the needles are removed.

The most important advantages of HDR brachytherapy for prostate cancer are:

- Short duration of the treatment (only one to two procedures).
- Exact knowledge of radiation dose distribution before treatment is given.
- High accuracy and precision of tumor-specific radiation dose delivery.
- Optimal radiation dose uniformity across the tumor (absence of low dose regions/ "cold" spots).
- Preservation of the structure and function of other (adjacent) organs.
- Few side effects, both short-term and long-term, due to targeted therapy.

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Following the HDR brachytherapy procedure, you will be staying in a recovery room until the anesthesia wears off and you feel stable on your feet. Since HDR brachytherapy is usually done as an outpatient procedure, you will not need to stay in the hospital overnight.

Once at home, you should avoid any strenuous physical activity for a few days and follow the specific instructions that your doctor gives you when you are released from the hospital. Most patients resume their normal activities within four or five days.

With regards to possible side effects, you can expect some soreness and swelling in the treatment area, sometimes accompanied by bruising directly following the procedure. You may also experience some side effects in the first couple of days after the procedure caused by the instruments used during the procedure. These include slight bleeding or burning beneath the scrotum or blood in the urine.

These side effects are normal and should only last for a couple of days. Your doctor can prescribe pain medication if necessary. However, you should contact your doctor immediately if you have any severe pain, discomfort or bleeding after the first few days.

With regards to long-term side effects, a few patients are at risk of becoming incontinent or impotent. Patients over the age of 70 are more likely to be affected in this manner. However, based on years of experience, the rates of any long-term side effects seem to be much lower with HDR brachytherapy than with other procedures for the treatment of prostate cancer<sup>8</sup>.

For follow-up examinations and tests, your doctor will inform you how often you need to be seen after the HDR brachytherapy procedure. You need to be checked for treatment progress, treatment side effects and to make sure that the cancer has not recurred. The schedule will often be more frequent during the first four to five years following the initial treatment.

# HDR Brachytherapy for Prostate Cancer

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- 4) Bray F, Lortet-Tieulent J, Ferlay J, Forman D, Auvinen A. "Prostate cancer incidence and mortality trends in 37 European countries: an overview." *Eur J Cancer*. Nov; 46 (17), 2010.
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- 6) [www.prostate-cancer.org](http://www.prostate-cancer.org) (California Endocurie Therapy Cancer Center)
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- 8) [www.americanbrachytherapy.org](http://www.americanbrachytherapy.org) (The American Brachytherapy Society)

# HDR Brachytherapy for Breast Cancer

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Breast cancer is the most common cancer in women, worldwide (men can also get the disease). Western Europe has the highest incident rate of breast cancer<sup>9</sup> and the incident of the disease has risen steadily over the past 20 – 30 years. The highest incident of breast cancer is found in women 50 – 70 years old<sup>10</sup>. However, due to better and more efficient screening programs as well as improvements in breasts cancer treatment, the survival rate keeps increasing<sup>11</sup>.

Breast cancer starts in the tissues of the breast. There are two main types of breast cancer<sup>12</sup>:

- Ductal carcinoma starts in the tubes (ducts) that move milk from the breast to the nipple. Most breast cancers are of this type.
- Lobular carcinoma starts in the parts of the breast, called lobules, which produce milk.

In rare cases, breast cancer can start in other areas of the breast. It can be invasive or noninvasive. Invasive means it has spread from the milk duct or lobule to other tissues in the breast. Noninvasive means it has not yet invaded other breast tissue. Noninvasive breast cancer is also called “in situ”.

Ductal carcinoma in situ (DCIS), or intra-ductal carcinoma, is breast cancer in the lining of the milk ducts that has not yet invaded nearby tissues. It may progress to invasive cancer if untreated.

Lobular carcinoma in situ (LCIS) is a marker for an increased risk of invasive cancer in the same or both breasts.

Once a woman has been diagnosed with breast cancer, a series of tests will be done to ensure that the stage and classification of the cancer is accurate. Today, breast cancer can be treated in several ways, which will depend on the type and how far it has spread.

# HDR Brachytherapy for Breast Cancer

The most common treatments include surgery, chemotherapy and radiation. The best treatment option for a patient should be discussed with an oncologist, a doctor who specializes in the treatment of cancer. Also, in order to make sure that the cancer has been completely removed, it is common that people with breast cancer get a combination of treatments. Therefore, doctors from different specialties often work together in treating the disease<sup>13</sup>.

The most common treatment for breast cancer is surgery either with partial removal of the breast tissue where the tumor is located (lumpectomy) or complete removal of the breast (mastectomy). The surgery is often combined with radiation treatment.

One of the most promising and efficient radiation treatment options for breast cancer, today, is HDR brachytherapy. In general, there are three types of breast cancer patients who qualify for HDR brachytherapy<sup>14</sup>:

- Those who have early stage breast cancer.
- Those who have locally advanced breast disease, but no metastasis.
- Those who have recurrent breast cancer to the chest wall (these patients may not be candidates for surgery or choose not to have surgery).

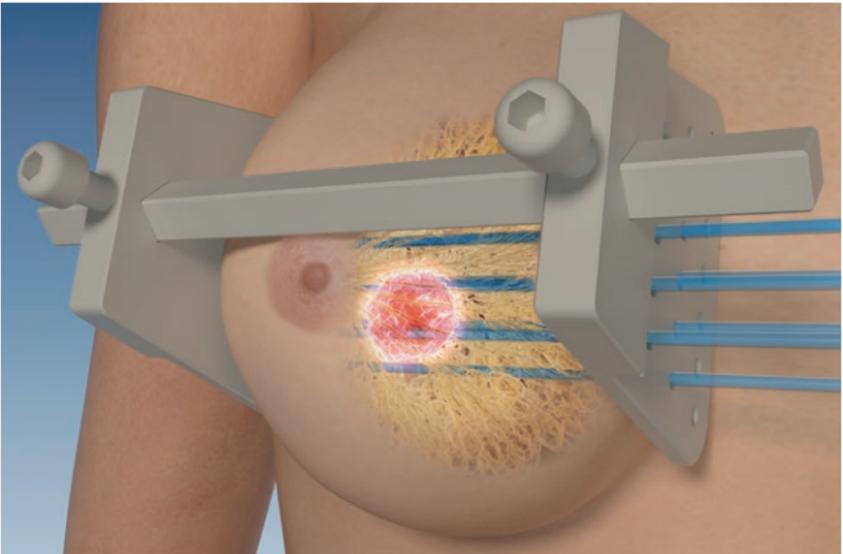
HDR brachytherapy was developed to reduce risk of recurrence while shortening the amount of time it takes to complete the radiation treatment.

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Planning for multi-catheter interstitial radiation therapy involves meeting with your radiation oncologist and possibly having additional imaging test, such as ultrasound (US), computed tomography (CT) or magnetic resonance imaging (MRI) done to plan exactly where the radiation will be delivered.

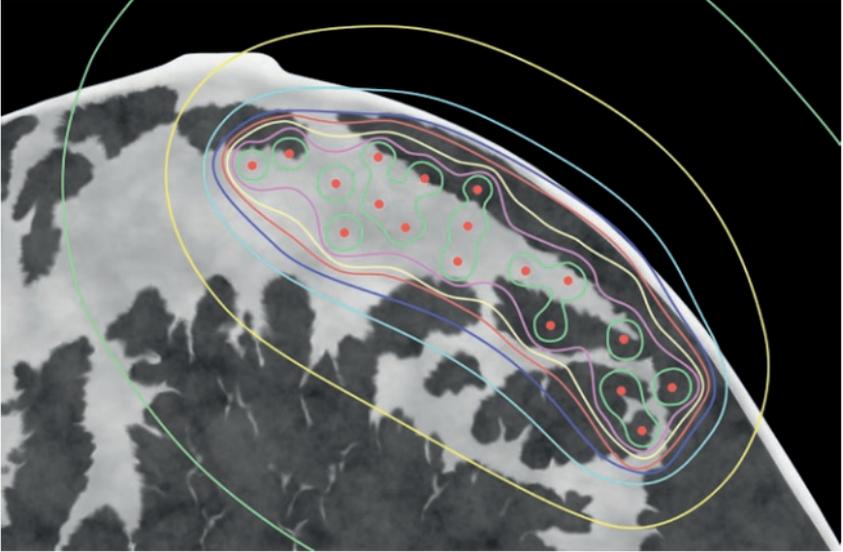
After the planning is completed, a series of catheters or needles are placed temporarily through the breast at the place of surgery. To ensure a homogeneous dose distribution and an optimal placement of catheters or needles a template with a defined pattern of holes is used (see Figure 6).

Each catheter or needle is connected to the afterloader that moves the radioactive source through each of them. Computer controlled, the afterloader performs the given treatment plan to achieve the predetermined dose and optimal protection for the skin (Figure 7).



*Figure 6: Placement of catheters in the breast for interstitial HDR using a special template<sup>15</sup>*

# HDR Brachytherapy for Breast Cancer



*Figure 7: CT image showing the position and intensity of the dose distribution in the breast<sup>13</sup>*

With a few well-placed catheters, HDR brachytherapy can provide a targeted treatment. If high dose radiotherapy is used, it typically requires one to two treatments per day for about one week. Each treatment session will last about one hour. However, during the treatment, the radioactive source is inside your breast for only a few minutes. Once the course of the treatment is completed, the catheters are removed<sup>15</sup>.

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As compared to external beam radiation therapy (EBRT), the most important advantages of HDR brachytherapy are:

- Overall treatment time is one week versus six to seven weeks for EBRT.
- Yields excellent cosmetic results.
- It delivers a precise, highly concentrated dose of radiation directly to the tumor bed, for a short time.
- Reduces radiation dose and possible damage to adjacent organs such as the opposite breast and the lungs.
- Very low risk of cancer recurrence.

There are few side effects associated with HDR breast brachytherapy. Some patients will experience minor bruising, redness and mild discomfort. All of these side effects are common in minor breast surgery and radiation treatment and usually last two to four weeks.

However, should any of these symptoms worsen, contact your doctor immediately. Scarring from the catheter insertion sites decrease and fade over time<sup>14</sup>.

As for follow-up visits, you will see your primary doctor and the radiation oncologist a couple of weeks after your treatment. After that, your doctor will decide on a long-term follow-up schedule. During some of these visits, various scans of your treated breast will be taken and compared with scans from the initial diagnosis and before your therapy started<sup>16</sup>.

# HDR Brachytherapy for Breast Cancer

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# HDR Brachytherapy for Gynecological Cancer

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Endometrial and cervical cancers remain very prevalent in our society. Endometrial cancer refers to several types of malignancies that develop in the cells that form the inner lining of the uterus (endometrium), and is one of the most common cancers of the female reproductive system<sup>17</sup>. This cancer occurs most frequently in women aged 60 years or older and is on a slow rise, worldwide, due to the increase in the aging population<sup>18</sup>. In Western Europe, about 70 % of endometrial cancers are diagnosed at an early stage, and as a result the majority of patients are cancer free following the treatment.

Cervical cancer is most commonly found in women age 30 – 50 years<sup>19</sup>. Over the past decades, the incidence of cervical cancer has decreased greatly in countries where routine gynecological examinations, PAP tests and vaccines are readily available<sup>20</sup>. Still, cervical cancer remains the number one cause of female cancer mortality worldwide<sup>21</sup>.

Developing countries have much higher rates of cervical cancer and, worldwide, there are three times as many cases of cervical cancer as endometrial cancers diagnosed each year<sup>22</sup>. Cancer can also be found in other parts of the female reproductive system, such as the ovaries, vagina and vulva. However, these are more rare types.

As for all cancers, the long-term prognosis depends on the stage of the cancer. With treatment, almost all patients will survive the earliest stages of invasive cervical cancer<sup>23</sup>.

# HDR Brachytherapy for Gynecological Cancer

There are many treatment choices for gynecological cancers, so you should discuss all available options with your doctor. For both endometrial and cervical cancers, the use of HDR brachytherapy has been shown to be very effective<sup>24</sup>.

Necessarily, there is a variety of gynecological HDR applicators existing. Different designs allow to adopt to the patient's anatomy as well as the characteristics of the tumor.

The high activity radioactive source is positioned in close proximity to the tumor (intracavitary brachytherapy) or within the tumor itself (interstitial brachytherapy), allowing each treatment session to be completed in one to two hours. An important benefit of HDR brachytherapy is that the position of the radiation can be precisely calculated and adjusted, allowing customized dose distributions based on the individual patient's tumor and anatomy<sup>25</sup>.

For endometrial and cervical cancer, HDR brachytherapy is delivered using special intra-vaginal applicators for introduction of the radioactive source (see Figure 8). Once the treatment is done, the applicator is removed and the patient can continue her day. Patients with cervical cancer will require a few short treatments given over a couple of days.

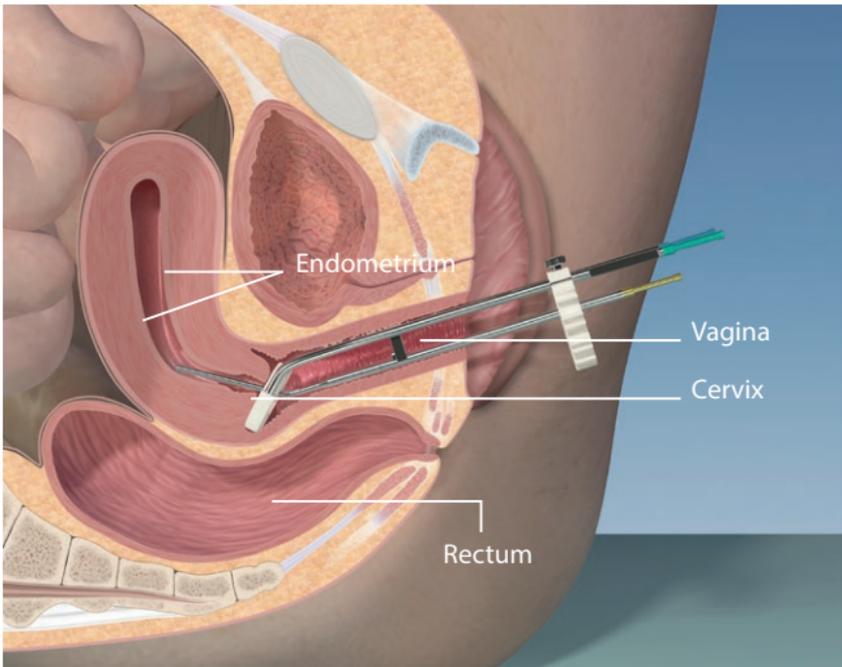


Figure 8: Intra-vaginal applicator for HDR brachytherapy

For vaginal cancer, a cylinder similar to a plastic tampon with a central channel is used. After placement of the cylinder, it is connected to the HDR afterloader where the radioactive source is stored until the time of treatment. After the treatment is complete, the vaginal cylinder is disconnected and removed from the patient. The treatment takes about an hour and most patients will require only a few treatment sessions. After the treatment is complete, the patient can continue with her day as this type of treatment is extremely well tolerated<sup>24</sup>.

# HDR Brachytherapy for Gynecological Cancer

The benefits of HDR brachytherapy in the treatment of gynecological cancers are:

- High dose precisely targeted to the tumor with minimal exposure to adjacent tissues and organs. The risk of radiation to the rectum and bladder is minimized by the precision delivery of the radiation dose.
- Treatment can be delivered on an outpatient basis within a few days.
- Short treatment and recovery times provide convenience for patients.
- Few side effects and complications as compared to other radiation procedures.

As for follow-up examinations, you will see your primary doctor and the radiation oncologist a couple of weeks after your treatment. After that, your doctor will decide on a long-term follow-up schedule.

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