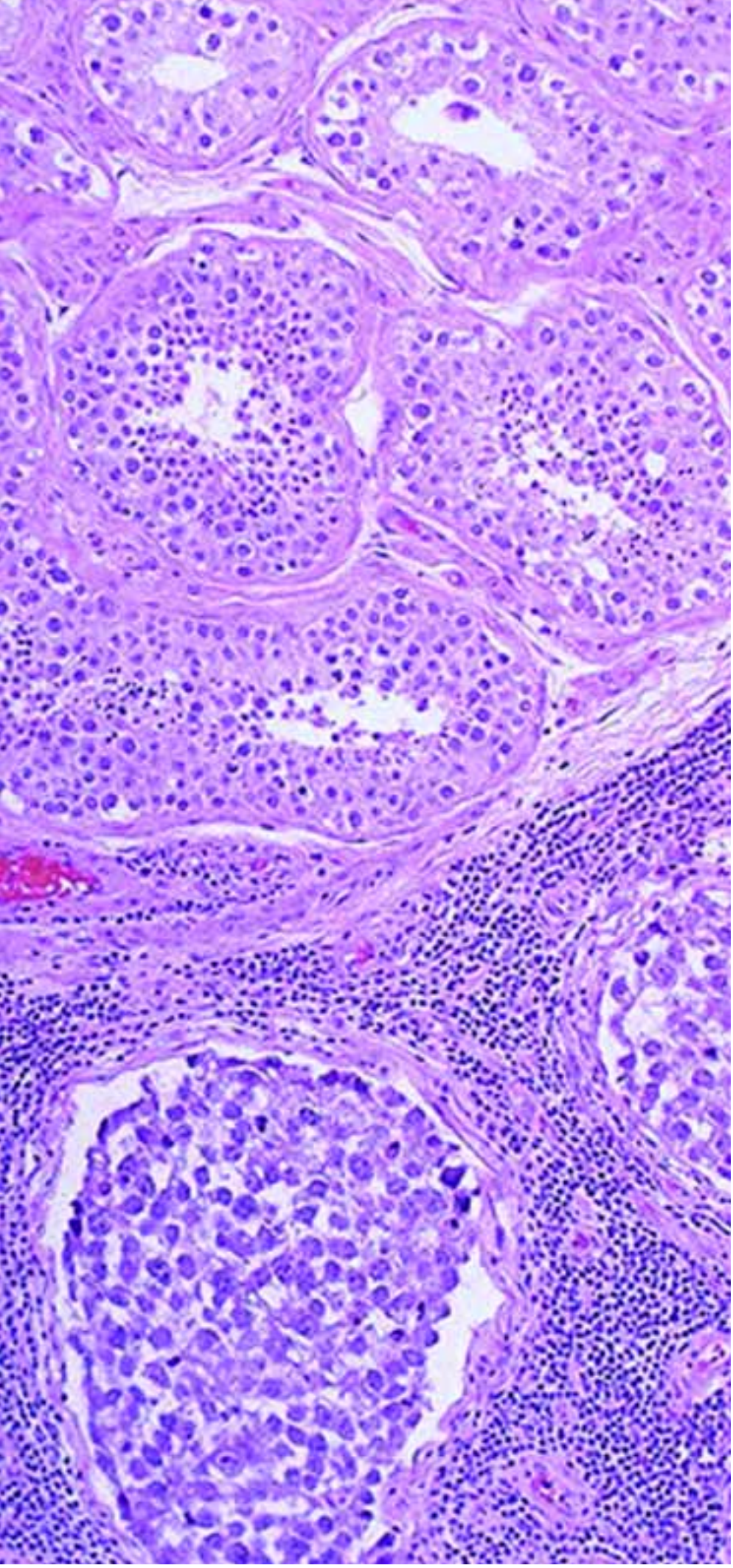


Cancer Facts

An introductory guide to cancer and radiotherapy

ELEKTA

Contents

What is Cancer?

Cancer is a group of many related diseases. All forms of cancer involve out-of-control growth and spread of abnormal cells.

Normal body cells grow, divide, and die in an orderly fashion. During the early years of a person's life, normal cells divide more rapidly until the person becomes an adult. After that, normal cells of most tissues divide only to replace worn-out or dying cells and to repair injuries.

Cancer cells, however, continue to grow and divide, and can spread to other parts of the body. These cells accumulate and form tumors (lumps) that may compress, invade, and destroy normal tissue. If cells break away from such a tumor, they can travel through the bloodstream or the lymph system to other areas of the body. There, they may settle and form 'colony' tumors. In their new location, the cancer cells continue growing. The spread of a tumor to a new site is called metastasis.

When cancer spreads, though, it is still named after the part of the body where it started. For example, if prostate cancer spreads to the bones, it is still prostate cancer, and if breast cancer spreads to the lungs it is still called breast cancer.

Leukemia, a form of cancer, does not usually form a tumor. Instead, these cancer cells involve the blood and blood-forming organs (bone marrow, lymphatic system, and spleen), and circulate through other tissues where they can accumulate.

It is important to realise that not all tumors are cancerous. Benign (non-cancerous) tumors do not metastasise and, with few exceptions, are not life-threatening.

Cancer is classified by the part of the body in which it began, and by its appearance under a microscope. Different types of cancer vary in their rates of growth, patterns of spread, and responses to different types of treatment. That's why people with cancer need treatment that is aimed at their specific form of the disease.

How is Cancer Treated?

The three modalities in current use for the treatment of cancer are surgery, radiotherapy and chemotherapy. Enough is known about the therapeutic management of cancer to be able to decide in advance, in each case, which of the three modalities to choose as the main line of treatment, either in isolation or in association with one or both of the other two modalities.

Radiotherapy

After surgery, radiotherapy is the most effective treatment in the management and cure of cancer. It plays a significantly greater role than chemotherapy. Approximately 70% of patients who come to radiotherapy departments receive treatment with curative intent, either by radiotherapy alone or in conjunction with surgery and chemotherapy. Of these, approximately 50% are cured. Those treated with palliative intent will have had their quality of life improved by their radiotherapy.

As a result of new imaging and computer technology, the outcomes for radiotherapy have steadily improved over the last 20 years. Further developments offer the prospect of up to 10% improvement in cure rates for patients having radical treatment[1].

Surgery

Generally, surgery on its own can only be regarded as the treatment choice if the solitary tumor is relatively small, mobile, readily accessible and with no evidence of spread to local lymph nodes or elsewhere, so that removal of every cancer cell is assured.

Chemotherapy

Chemotherapy is the simultaneous administration of multiple drugs, which results in the summation of their destructive power on the tumor, but no similar increase in the side effects. This has made chemotherapy the treatment of choice in some leukemias, certain types of Hodgkin's and Non-Hodgkin's Disease, as well as following removal of testicular tumor (remarkable for its sensitivity to damage by chemotherapy).

[1]*Einhorn, J., Frôdin, J.E. et al. (1997) Radiotherapy for Cancer, Vol. 1, Acta Oncologica, 36, suppl. 6.*

How Does Radiotherapy Work?

Radiotherapy, the treatment of cancer with radiation, is a very important element of curative treatment for cancer, and is also important for maintaining and/or improving patients' quality of life. It is anticipated that it will retain a key role in cancer treatment for the next 10-20 years and will continue to make a significant contribution to improved treatment and palliative outcomes.

Radiotherapy owes its pre-eminent position in the treatment of cancer to its ability to deliver, with precision, a lethal radiation dose to each cancer cell situated within a chosen area of the body.

The main aim of treatment is to give a sufficient radiation dose to the tumor to cause destruction without producing unacceptable damage to surrounding normal tissue. The higher the differential between the dose to the tumor and that received by the normal tissue, the better the chance of a cure.

This high differential hinges on the precision with which the size and position of the tumor can be ascertained and, equally importantly, on the accuracy with which the required dose of radiation can be delivered to the chosen site.

Radiation can be delivered in a variety of ways, depending on the nature of the cancer. The most commonly used method is called external beam therapy, which directs high energy X-ray radiation at the tumor. Although the radiation affects both cancer and normal cells, because of the nature of the cancer cells it has a greater effect on them. Treatment aimed at cure will give the highest possible dose of radiation, within safe limits, to attempt to kill all the cancer cells. Sometimes smaller doses are used, where the aim is to reduce the size of a tumor and/or relieve symptoms.

Radiotherapy treatment is given using either a machine called a linear accelerator or, for some skin tumors, a superficial X-ray unit. To receive the radiotherapy, the patient lies on a couch under the machine, and is asked to remain still during the actual treatment.

Every course of radiotherapy treatment is designed to suit the particular needs of the person receiving it, so prior to treatment the patient will make a preliminary visit to the hospital for the course of treatment planned.

A typical treatment will last six weeks, with the patient visiting the hospital every day.

How a Linear Accelerator Works

A linear accelerator produces a beam of either electrons or very high energy X-rays. The radiation beam can be shaped and directed to match the tumor shape.

The beam of radiation is directed on to the patient within an accuracy of 2mm. This is achieved by a combination of:

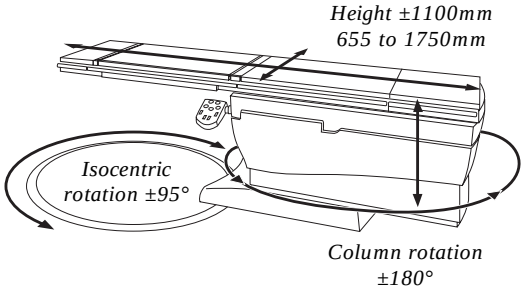
- control and shaping of the X-ray beam
- accurate patient positioning with respect to the X-ray beam.

Shaping of the beam can be achieved in three ways:

- use of the primary and secondary collimators. These are large tungsten blocks which can shape the X-ray beam into the appropriate square shape
- custom blocks – these are cast blocks which are specifically for an individual patient to shield sensitive tissue or structures and can be made to the exact shape
- Multileaf Collimator (MLC) – these are fine leaves (usually 1cm wide) that are computer-controlled to match the shape of the tumor. Use of MLC is now common practice in many countries.

Multileaf Collimator

The patient is positioned on a treatment table that can be moved in three linear planes as well as up to two rotational planes.



Range of Table Movements

The linear accelerator can rotate about the patient allowing the beam to be delivered from several different positions. This results in a higher exposure to the tumor tissue compared to surrounding healthy tissue.

Patient set-up on a Linear Accelerator

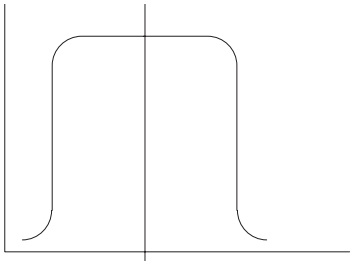
Intensity Modulated Radiotherapy (IMRT)

Benefits

The main aim of treatment is to give a sufficient radiation dose to the tumor to destroy it without producing unacceptable damage to the surrounding normal tissue or critical structures. The higher the differential between the dose to the tumor and that received by the normal tissue, the better the chance of a cure.

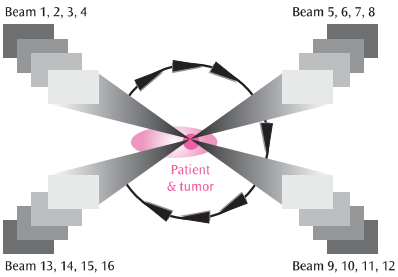
Intensity Modulated Radiotherapy (IMRT) is the latest technique available to the radiation oncologist which enables better shaping of the radiation beam to match the tumor shape.

Traditionally radiotherapy was given by delivering two to three beams of radiation from varying positions around the patient to achieve the differential described above. Each beam delivered a square shaped field of radiation which had a flat dose profile across the field, ie. at all points along this profile of the field the destructive power was the same.



Flat beam profile

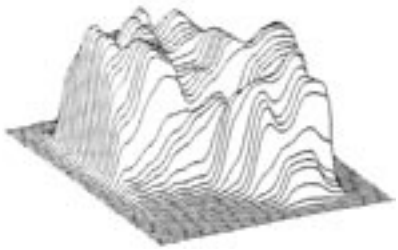
IMRT is based on the principle of merging together a large number of beams from a great many angles. These small beams, termed segments, can in turn be individually shaped using a multileaf collimator.



Delivery of an IMRT treatment

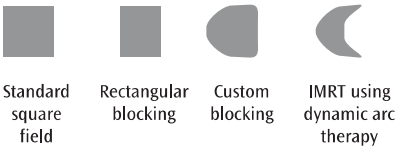
These combined segments enable the dose profile to vary across the field. When many of these segments are combined complex shapes can be formed which;

i) match the shape of the tumor,
ii) avoid critical structures,
iii) minimise dose to normal tissue and
iv) allow a higher dose to be delivered to the tumor.



Dose profile from IMRT

By achieving this shape matching (conformity) the best differential between dose to tumor and normal tissue is achieved.



Delivery shapes which can be achieved through different techniques

Additional Reading & Resources

Walter and Millers Textbook of Radiotherapy 5th Ed.; C.K. Bomford, I.H. Kunkler and S.B. Sherriff; Churchill Livingstone 1993; ISBN 0 443 02873 7

A Primer on the Theory and Operation of Linear Accelerators in Radiation Therapy 2nd Ed.; C.J. Karzmark, Robert J Morton; Medical Physics Publishing; 1998; ISBN 0 944838 66 9

Linear Accelerators For Radiation Therapy 2nd Ed.; D. Greene and P.C. Williams; Institute of Physics Publishing; 1997; ISBN 0 7503 0476 6

Websites

Cancer BACUP
http://www.cancerbacup.org.uk/

Cancer Research Campaign
http://www.crc.org.uk/

Imperial Cancer Research Fund
http://www.icnet.uk/

TeleSCAN, European Internet service for Cancer research, treatment and education
http://telescan.nki.nl/

American Cancer Society
http://www.cancer.org/docroot/home/index.asp

Oncolink
http://cancer.med.upenn.edu/

Cancer Mortality database
http://www-depdb.iarc.fr/who/menu.htm

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