Cancer and Its Treatment

Sai Prakash Vempadpau
NRI College of Pharmacy

Abstract: Cancer is a heterogeneous and genetically programmed disease that leads to uncontrolled growth of tissue proliferation and potential metastasis. Cancer is a devastating disease, and statistics tell us that cancer affects several individuals every year. Cancer biology in therapeutic aspects has evolved and researchers have created an array of therapies as a result. Management of neoplasm has included surgery, chemotherapy, and radiation, which are the most predominant forms of treatment and are aimed at local and systemic disease. Tumor resection is aimed at tumor tissue removal, chemotherapy and radiation are used for all fast-dividing tissue including cancer cells. In recent years, a paradigm shift in the managementof cancer has taken place with the introduction of modern therapies with greater specificity and customization. For example, in immunotherapy cancer is treated by making immune cellsdetect and target cancer cells while targeted therapy focuses on the genetic changes that cause the cancer. Hormones are an important component in the treatment of some cancers, especially breast cancer and prostate cancer. Stem cell transplants are also a possibility for people with blood cancers to replace the diseased bone marrow. Tumor molecular and genetic patterns are embedded within precision medicine to offer manifold possibilities for treatmentsthat can be tailor-designed.

Keywords: Cancer, Immunotherapy, Radiation therapy, Targeted therapy.

INTRODUCTION

Cancer is a disease in which the cells become uncontrollably fatal. They are caused in anypart of the body, especially organs. It is said that the cells of the cancer are uncontrollablebecause, unlike the normal cells, they do not stop growing even after reaching the limit eventhough they receive signals from the growth suppressors. They multiply endlessly withouthaving a boundary they also invade other tissue and distant organs that is termed as stage IVcancer. Cancer is categorized into 5 stages based on the severity of proliferation rate of cells.

STAGE 0: where the cancer lies in the tissue and a small glimpse of cell abnormalproliferation is seen.

STAGE I: The cancer is small and seen in one area.

STAGE II and III: The cancer has grown big and may have spread to other tissues or lymph nodes nearby.

STAGE IV: The cancer has spread to the distant part of the body. This stage is said to be the last stage of cancer because it is advanced to the other organs of the body. (so it is called metastatic cancer).

The cells in cancer divide uncontrollably to form a mass called a "tumor". The tumors are categorized into two categories according to their characteristics.

TYPE 1: Benign tumor: The cancer cells remain seated at one place rather than invading other tissues. These are generally removed by surgery.

TYPE 2: Malignant tumor: This type of cancer is the one that invades other tissues including distant organs.

There are over 100 types of cancers that can occur in any part of the human body, however, they remain major which categorize into 5 types based on the location from which they emerge.

TYPE 1: CARCINOMAS: Cancer that originates in epithelial tissues of the body may be inside or outside (Ex: Lung, Breast, Colon cancers.)

TYPE 2: SARCOMAS: Cancer that emerge from the connective tissues. (Ex: Bone, Muscle).

TYPE 3: LEUKEMIAS: Cancer of blood and bone marrow

TYPE 4: LYMPHOMAS: Cancer of the Lymphatic system (has a relationship to theimmune system).

TYPE 5: MELANOMAS: Cancer develops from melanocytes, which are the cellsresponsible for skin pigment.

Cancer develops due to genetic mutations at the DNA level. It also results from radiation suchas X-rays, gamma rays, alpha particles, beta particles, and neutrons.

Treatment for Cancer:

There are a lot of treatments for cancer but in this paper, there are some important and mostadvanced

types of cancer treatments.

1) IMMUNOTHERAPY
2) TARGETED THERAPY
3) RADIATION THERAPY

IMMUNOTHERAPY

The human body's immune system works a protective function by fighting and resisting any foreign attack from pathogenic substances and bacteria as well as viruses not self. The immune system can also recognize and eliminate any abnormal cells that began in our bodies such as cancer cells within the framework of the process of 'surveillance' (t-cells distinguish a normal from a diseased cell via compticating peptides of a cell).If the peptides are from exogenous proteins, T-cells are stimulated and so they will eliminate the affected cells,thinking those cells are foreign. The mutation of normal genes leads to loss of control of normal cellular division to cause a tumor. Considering cancerous cells as foreign to the body has its benefits because as such the immune system can actively destroy these cancerous cells completely but in the situation where the tumor infiltrates most body systems then – normal cells will start to get destroyed or their ability to kill is decreased due to the presence of PD-1 CTLA-4 which are molecules expressed by cancer cells that inhibit T-cell activity against these tumors. Other mechanisms employed by cancer cells could be the secretion of suppressive proteins and cytokines that make T cells work ineffectively and their differentiation into excessive Regulatory T-cells that actively suppress other T-cells' functionsbut that of inaction.

Immunotherapy works in two ways:

1) By upgrading the Immune system and making it stronger
2) By using the drugs that help to suppress the immune environment of the cancerous cells

Upgrading the Immune system and making it stronger: This enhancement process involves giving a vaccine as the vaccine consists of 'neoantigens'(The foreign proteins that are foundin cancer cells) this vaccine acts on the lymph nodes to produce enhanced T-cells which now can inhibit the cancer to grow further by killing them. This process marks the first enhancing method The second enhancing method involves the extraction of the T-cells and growingthem in a laboratory to modify them to recognize the cancer and act on it so, these T-cells are now called as 'Modified T-cells'. These modified T-cells now injected in to the human bodyas they are stronger they act on the cancer cells by killing them. The third enhancing method involves 'Stimulating Factors' Example: Cytokines and other factors are injected so they act on T-cells to significantly multiply to grow stronger.So, these are some upgrading techniquesused to fight the tumor.Using drugs that help to suppress the immune environment of the cancerous cells: Drugs like Pembrolizumab, Nivolumab target the programmed death 1 orPD-1 receptors on the cancer cells inhibit their action of sending signals to the T-cells thattransform the T-cell into a regulatory T-cell, And drugs like Ipilimumab target the 'Cytotoxic T lymphocyte Antigen 4' or CTLA-4 by blocking its downregulating immune responses byenhancing the T-cell activation and proliferation.

SIDE EFFECTS OF IMMUNOTHERAPY:

- Flu-like symptoms.
- Hormone gland problems.
- Heart palpitations.
- Skin problems.
- Organ Inflammation.

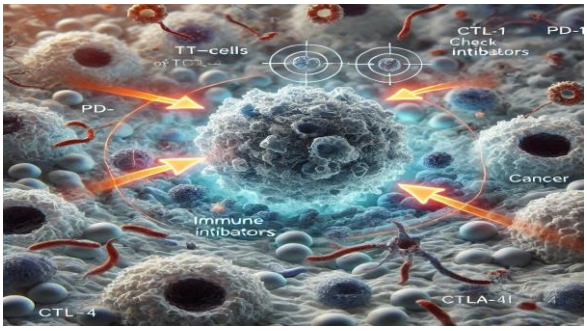

Fig 1: IMMUNOTHERAPY

TARGETED THERAPY

Targeted therapy is the novel therapeutics for the cancer. This approach consists of the use of drugs which effect some specific proteins or genes that are located outside or inside the cancer cell. Unlike conventional chemotherapy which kills all rapidly dividing cells such as cancer and many normal cells as well, targeted therapies are made to be more specific in their approach against the iterative cancer cells (meaning that there is less damage to normal cells). Hence, it has fewer side effects than conventional chemotherapy.Some drugs have beenlabeled as Small molecule inhibitors (Ex: Tyrosine kinase inhibitors) that are able to cross the cell membrane and act on

specific targets by blocking the action of critical enzymes or signaling pathways required for the proliferation of the cancer cells.Then there are Monoclonal Antibodies(mAbs) which are the proteins found in the laboratories that attach themselves to the outer surface of cancer cells as they do not cross the cell membrane. For example HER2 inhibitors such as Herceptin, they collar the cancer cell from its receptors and prevent the spread of the cancer cells. Also, Proteasome inhibitors are drugs that prevent proteasome action resulting in the breakdown of damaged proteins, thus creating a situation whereby the proteins that facilitate cell death or Apoptosis are built up within cancer cells. Angiogenesis inhibitors, for example, are used to target.

SIDE EFFECTS OF TARGETED THERAPY:

- Skin problems.
- Hair loss.
- Mouth sores.
- Organ damage.
- Allergic reactions.

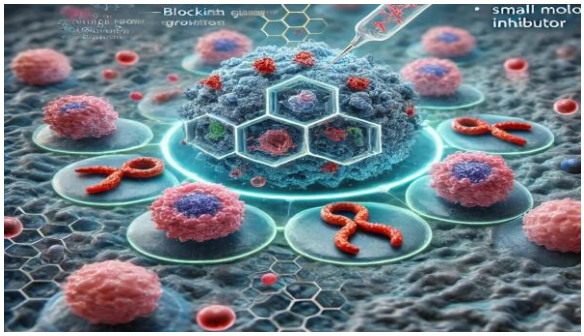

Fig 2: TARGETED THERAPY

RADIATION THERAPY

Radiation therapy is a method authorized for cancer treatment during which a highly energetic beam of particles or waves is applied to target and to either destroy or damage the cancer cells. It can be performed independently or alongside other modalities that include surgical treatment, chemotherapy or immunophenotype. Radiation therapy's major purpose is to guarantee that radiation using a radiation beam has been delivered to the tumor only and as little as possible to healthy tissues around the tumor. High energy such as X rays, Gamma rays or protons are directed to cancer and the nucleus which has its genetic constituent DNA. Through this experience, one strand of DNA helix may break in process and this is termed as single-strand breaks, or two strands of the same DNA molecule break and this is termed as double-strand breaks. Arresting damage to cancerous cells that injury will make less severe. Their DNA repair machinery and lead to either apoptosis (programmed cell death) or mitotic catastrophe (mortality during stages of division of cells). Ionizing radiation activates free radicals upon contact with water shrills in cell membranes or molecules in the cell, and cells give out hydroxyl radicals as the major type of free automobile in the body. Because these ions are highly energetic and stand an average association damage of the DNA and proteins as well as cell membranes indirectly. The overwhelming generation of free radicals and species of oxygen referred to as reactive oxygen species (ROS) also advance oxidative stress. Oxidative stress is key in promoting the cellular death of cancer cells so that they cannot proceed with replication.

Types of radiation therapy:

1) External Beam Radiation Therapy(EBRT): Produce high energy X-rays or protons in theform of beams that target the tumor site,

2) Brachytherapy: Direct delivery of high dose of radiation at the tumor site. Mainly used for Prostrate, Cervical, and Breast cancers.

3) Proton Beam Therapy: The charged particles are directly on the tumor generally used forspecific depths. This therapy is used on tumors that are in critical structures like the brain and the spinal cord.

NOTE: This proton beam therapy uses protons instead of Photons(light particles).

4) Stereotactic Radiosurgery (SRS) and Stereotactic Body Radiation Therapy (SBRT): Highly focused radiation treatments, often used for small tumors, such as brain metastases or lung tumors, delivering a high dose of radiation in just one or a few treatments.

SIDE EFFECTS OF RADIATION THERAPY:

- Fatigue.
- Skin reactions.
- Nausea and Vomiting.
- Fibrosis.
- Secondary cancer.
- Cardiovascular damage.

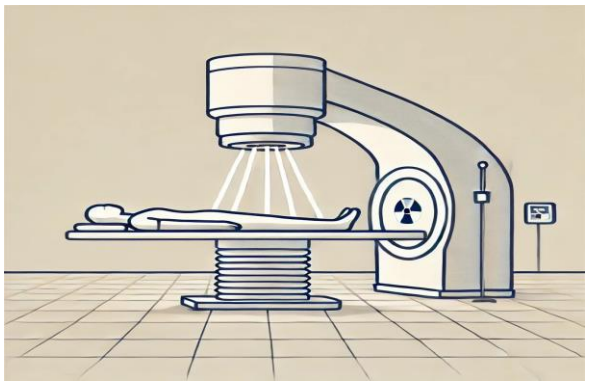

Fig3: RADIATION THERAPY

CONCLUSION

In conclusion, One of the most deadly illnesses is cancer, which can have numerous causes, including genetics, alcoholism, smoking, radiation, and other factors. As previously said, there are contemporary ways to treat cancer. These techniques aid cancer patients in their treatment. In order to cure cancer, it must first be identified. There are numerous methods for doing this, such as liquid biopsy, which is an effective and non-invasive method that checks for the presence of circulating tumor DNA (ctDNA) in bodily fluids. The modern healthcare sector has witnessed a great deal of innovation, and since artificial intelligence is becoming increasingly accurate at making decisions, which will ultimately result in the provision of the greatest care, the future is also in the best hands.

REFERENCES

[1] Society for Immunotherapy of Cancer https://youtu.be/UbFjiWOBErA?si=fqWZGjElVb3_ejHZ https://www.sitcancer.org/home

[2] National Cancer Institute (NCI) – This site offers comprehensive resources on targeted cancer therapies, including the molecular basis of drug action and pharmacological profiles of various cancer drugs. https://www.cancer.gov/

[3] https://www.cancer.gov/about-cancer/treatment/types/targeted-therapies

[4] American Cancer Society – Provides educational material on cancer treatments, including pharmacology and examples of specific targeted therapies like tyrosine kinase inhibitors and monoclonal antibodies. https://www.cancer.org/cancer/cancer-basics/targeted-therapy.html

[5] British Journal of Cancer – Academic journal articles often detail specific targeted therapies and their pharmacological effects. For example, this journal frequently publishes studies on novel cancer treatments and their mechanisms. https://www.nature.com/bjc

[6] Targeted therapy in oncology (searchable on Nature). Mayo Clinic – Discusses the practical aspects of targeted therapy, including pharmacologyand clinical application. https://www.mayoclinic.org/tests-procedures/targeted-therapy/about/pac-20385261

[7] Detailed prescribing information for individual drugs like Imatinib, Trastuzumab, and Bortezomib includes pharmacokinetics, metabolism, and clinical studies. FDA's drug database provides access to this information. https://www.accessdata.fda.gov/drugsatfda_docs/label/

[8] Perez & Brady's Principles and Practice of Radiation Oncology. 7th Edition, 2018. – A comprehensive guide that covers the principles, applications, and clinical aspects of radiation therapy. https://oncology.lwwhealthlibrary.com/book.aspx?bookid=2524

[9] Delaney G, Jacob S, Featherstone C, Barton M. The role of radiotherapy in cancer treatment: estimating optimal utilization from a review of evidence-based clinical guidelines. Cancer. 2005 Sep 15;104(6):1129-37. doi: 10.1002/cncr.21324. Erratum in: Cancer. 2006 Aug1;107(3):660. PMID: 16080176.

[10] Baskar R, Lee KA, Yeo R, Yeoh KW. Cancer and radiation therapy: current advances and future directions. Int J Med Sci. 2012;9(3):193-9. doi: 10.7150/ijms.3635. Epub 2012 Feb 27. PMID: 22408567; PMCID: PMC3298009.