Photodynamic therapy vs. Brachytherapy

[1]Söhnchen C., [1]Richter A., [1]Aebisher D. Ph.D., D.Sc., [1]University of Rzeszów, Poland

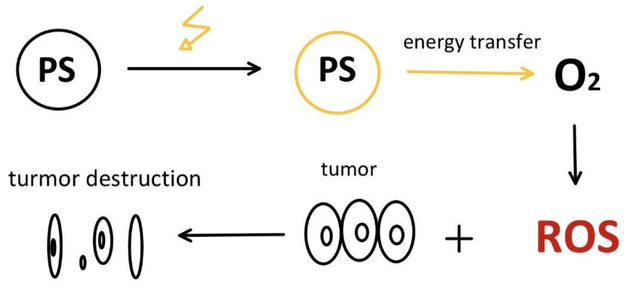
Introduction

Photodynamic therapy and brachytherapy are both relatively new promising therapy forms used in the treatment of cancer. They both first appeared in the turn of the 19th century and are still in common practical use.

Finsen received the Nobel Prize in 1903, in recognition of his contribution to the treatment of cancerous and infectious diseases, especially lupus vulgaris, with concentrated light radiation, whereby he has opened a new avenue for medical science for the application of phototherapy. The origin of brachytherapy is directly related to the discovery of radioactivity by Becquerel in 1896, which led to Marie and Pierre Curie discovering radium in 1898. The first successful radium brachytherapy was the skin irradiation of two patients with basal cell carcinoma in St. Petersburg in 1903.

Photodynamic Therapy

Photodynamic therapy (PDT) is a treatment method that uses specialized photosensitizer agents to eliminate cancer cells through light therapy. The process is also known as photoradiation therapy, phototherapy, or photochemotherapy. Photosensitizers are used in the form of a cream for skin cancer or as an injection through a vein for various different types of cancers. The mechanism of activation of photosensitizers works through absorption of electromagnetic radiation. Activated photosensitizers cause adjacent molecules to produce singlet oxygen (ROS-reactive oxygen species) which act cytotoxic on cancer cells inducing apotosis (cell death).



Graph 1 illustration of the mechanism of PDT

Tabele 1 Oragnaic photosensitizer for use of PDT with electromagnetic wavelengths

Photosensitizer	Wavelength
Curcumin	350 - 450 nm
Aloe-emodin	370 - 500 nm
Chlorophyllin	600 - 670 nm
Hypericin	524 - 593 nm
Tolypophin	676 nm

Brachytherapy

Brachytherapy is a form of radiotherapy where sealed radiation sources are placed inside or next to the area requiring treatment. Treatment includes anal positioning of an ultrasound device for target-oriented placement of radiation sources. Placement of radiation sources can be temporarly using a catheter or permanently using injection. Injected radioactive material, usually in the form of iridium-192 high dose rate (HDR), should have a short half life to minimize long time exposure of high dose radiation to healthy tissues. Radiation is damaging cells using the mechanism of ionization. When a radiation source decays radioactive energy is transmitted via x-rays (gamma rays, beta particles and alpha particles) which lose energy as they pass through cells and interact with molecules. The transferred energy is high enough to disrupt chemical bonds directly or indirectly by the creation of radicals. The major effect in cells are DNA breaks (single stranded or double stranded breaks) which result in impairment of cell function leading to cell death.

Comparison

Brachytherapy and Photodynamic therapy are commonly practiced for treating cancer. Each therapy has individual advantages and disadvantages (in Table 2), with taking into account previous surgical procedures and common mistakes. These should be considered before making any professional recommendation to patients.

Brachytherapy and Photodynamic therapy are both effective in treating many types of cancers in localized sites as radiation is delivered with a high degree of precision to targeted cells, however, to choose the most efficient therapy for treating the cancer, three considerations have to be made; location, type of cancer and patients well-being. PDT for example is often used in treating skin cancer and other types of cancers where the UV light is able to access the tissue, whereas brachytherapy can be placed anywhere in the body, usually in the urethra or bladder, through surgical incision.

Table 2 Advantage and Disadvantages of Brachytherapy and Photodynamic therapy (PDT)

Types of Therapy	Advantages	Disadvantages
Brachytherapy	- requires only 1 treatment session - for various localized cancer treatments - high precision(reduces risk of damaging healthy tissue) - Cost efficient - Small radiation volume	- requires Anaesthesia - longer hospital stay - Severe side effects (include: erectile dysfunction, urinary complications) - Uncommon side effects; rectal ulcers, rectal bleeding and bowel urgency - delayed side effects - needs a shielded room
Photodynamic therapy (PDT)	- No long-term side effects - less invasive - Outpatient, short time - target precisely - can be repeated frequently on same location - little to no scars - low costs	- Can only be used where light can reach - cannot be when cancer metastasize - Drugs side effects are light sensitivity - cannot be used with specific blood type - Side effects: Skin damage, swelling and pain, Immune system chnages

Conclusion

Brachytherapy and photodynamic therapy are highly promising therapy forms in the treatment of various cancers. However to reach full exploitation of their potential further research needs to be conducted. Numerous photosensitizers of natural origin have shown outstanding results in efficient cancer treatment. This should be an encouraging factor for research expansion testing different photosensitizers on distinct cancer types, therefore enabling a more systematic approach in the process of drug selection for optimal PDT treatment. In Brachytherapy, analytical studies which filter information need to be done since contemporary systematic reviews will prevent the decline of application of this promising technique in clinical settings.

Acknowledgements

We would like thank University of Rzeszow for the opportunity of our work publishment as well as Prof. Dr. med. David Aebisher for his support.