Medical breakthrough technologies benefit users and patients

An EU supported IST project that developed a new integrated brachytherapy system is benefiting significantly both users and cancer patients. During the MITTUG project, researchers developed a system that enables the treatment of a significantly increased number of patients, offers higher accuracy and is cost-effective.

The treatment for cancer has typically been surgery. However, a rapidly growing alternative is radiation treatment. Brachytherapy radiation treatment is a technique where radioactive sources of low or high radioactivity are inserted permanently or temporarily in the patient's body. The objective is to irradiate tumours.

There are two principal methods used. One involves implanting radioactive seeds of low activity (LDR) and leaving them in the tumour forever, continuously decreasing the activity of the interstitial metallic 'seeds' as they decay. The second is a short-duration treatment involving a computer-driven, single high activity radioactive source (HDR) using catheters or needles inserted temporarily in the tissue.

The MITTUG (Minimally Invasive Therapy for Tumours 3D Ultrasound Guided) project partners created a dual usage brachytherapy system employing seeds (LDR) or catheters (HDR) and 3D-ultrasound images rather than CT scans. At the same time, they used sonar technology in their design of an advanced ultrasound beam former (the ultrasound instrument part that provides electronic focusing) to increase the quality of ultrasound images. Clinical validations were performed in European and North American hospitals, facilitating technology and know-how transfer on an international level and opening the door for future co-operation.

The result is two commercially available products being distributed by one of the consortium partners, Nucletron in the Netherlands: FIRST (LDR) and SWIFT (HDR). Says Project Manager Nol Nuijten of Nucletron, "The international co-operation has proven very valuable. The development of products close to theclinical environment made it practical for the industry.
The project has also been a basis for a long-term cooperation between some of the partners."

Benefits all around
The MITTUG system provides minimally invasive procedures as an integrated solution for LDR and HDR applications that are revolutionising brachytherapy. The patient benefits from less time spent during treatment and recovery, as well as an increase in therapeutic success rates, both palliative and curative.

Clinical efficiency is maximised by increasing the number of patients treated, reducing the length of hospital stays, the price and availability of imaging devices, and reducing overall treatment costs. Due to its simplicity and low cost, the system is expected to significantly boost the number of potential customers worldwide.

Nuijten says that the reaction from the various users is very positive. After a very short learning process, the systems have proven very efficient and improve the quality of the procedures. Dr Martinez from William Beaumont hospital, one of the most prestigious brachytherapy centres in the US commented, "this concept is going to revolutionise interstitial therapy. It will give physicians the assurance to achieve good implants because they are getting immediate quality feedback."

Addressing the shortcomings
Present treatment conditions are subject to a number of shortcomings. For example, prior to inserting seeds or catheters, a CT (computed axial tomography) scan or xray enables the physician to plan the number and position of radioactive sources necessary. After inserting the seeds or catheters an additional scan is required to reconstruct their final positions. Existing planning systems can calculate the radiation pattern as the result of this geometry, however, they cannot solve the inverse problem of calculating the optimum position of seeds or catheters once the required or desired amount of radiation has been defined.

The static CT scan image is a poor basis for conducting the radiation itself because the position of the patient can be different between when the scan was performed and the treatment, particularly when soft tissue is involved. In addition, a CT scan performed before the seed or catheter insertion does not provide a real-time indication of true position relative to planned position. Nor are CT scans always available in the radio-ncology department of a hospital.

MITTUG project partners established inexpensive, accurate and easy-to-use LDR systems as an alternative to the established HDR procedure for prostrate treatment. New LDR implanting equipment make the seeds' design and implementation simpler, safer and inexpensive. A patient modelling system based primarily on 3D-ultrasounds was developed, which is much cheaper, more widely available and uncomplicated compared to CT.

An inverse planning system was developed that calculates the minimum number and optimal position of seeds or catheters to deliver the desired dose on a specific area. An innovative anatomy-based 3Ddosage optimisation system solves the inverse problem of calculating the best position of seeds or catheters.

A needle navigation system based on templates or magnetic tracker information gives doctors for the first time the possibility of seeing the results of their action in real-time. This also enables them to position the implants accurately in the positions defined by the pre-planning. This increases the effectiveness of the treatment and enables accurate records to be kept. Finally, the system's telemedical features allows for online communication among experts. Unlike previous teleradiology motivated approaches, the MITTUG system facilitates co-operation both during the planning phase and treatment.

Spin-offs to other application areas
The research and development of MITTUG has produced spin-offs that could introduce innovative technologies in several application areas. For example, the advanced ultrasound beam former can be modified to support high quality imaging in areas such as cardiology, obstetrics and gynaecology. The 3D-ultrasound and CT registration can become a stand-alone tool with application possibilities in other medical areas such as cardiology.

The needle navigation system, based either on magnetic trackers or on image tracking using ultrasound or a combination of both, can also be used for guiding biopsy needles, endoscopes and other surgical instruments. The dosage optimisation system can possibly be used with other irradiation methods and the seed sorter allows for the possibility to arrange radioactive sources in a calculated manner.

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