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A Novel Radio-guided surgery for complete tumor resection

Radio-guided surgery (RGS) is a technique adopted by the surgeon to perform a complete lesion resection, taking advantage from the uptake from the tumor of specific radiolabelled tracers. Established methods make use of γ emitting tracer and γ radiation detection probe, but the high attenuation lenght of this radiation prevents the use of RGS when there are newarby uptaking organs.
To extend the applicability of RGS, our team of physicists, nuclear physicians, bio-engineers and chemists is developing an innovative technique exploiting β- radiation [1]. It penetrates only a few mm resulting both in a lower required radio-pharmaceutical activity and the possibility to apply the technique also to cases with a large uptake of nearby healthy organs. Low background rate is also correlated with low medical team exposure.
To this aim, We developed and tested several prototypes of intraoperative β- probe, the core made of para-terphenyl scintillator[2]. The readout electronics is portable and customized to match the surgeon needs, with wireless data transfer to the PC.
In the current prototypes the p-terphenil is directly copupled with SensL SiPMs (series C).
Feasibility studies have been performed on DICOM images for meningioma, glioma,and neuroendocrine tumors (NET) [3,4] showing that even when the tumor uptake is too low for therapeutical treatments, like in the case of glioma, the sensitivity of the probe can be sufficient.
Besides these feasibility studies, we have also validated the technique on "ex-vivo"specimen of patients affected by meningioma, confirming the predictive model[5].
The actual diffusion of such technique requires:
- to be able to certify the prototypes for clinical use, performing the risk assessment (or eventual mitigation). This will allow a broader range of clinical tests
- to make the detector more versatile to be sensitivity to more radio-nuclides and to be useable also in laparoscopy
- to identify more tumors of interest and to develop new radio-tracers to be used in this technique. From the physics point of view this also involves studies on the production of beta- emitting radio-isotopes, typically using neutron irradiation.

References:
[1] E. Solfaroli Camillocci et al, "A novel radioguided surgery technique exploiting β– decays", Sci. Rep. 4, 4401 (2014)
[2] Polycrystalline para-terphenyl scintillator adopted in a beta- detecting probe for radio-guided surgery, E Solfaroli Camillocci et al 2015 J. Phys.: Conf. Ser. 620 012009
[3] F. Collamati et al, "Toward Radioguided Surgery with Beta- Decays: Uptake of a Somatostatin Analogue, DOTATOC, in Meningioma and High-Grade Glioma"J. Nucl. Med. 56:3–8 (2015)
[4] F. Collamati et al, "Time evolution of DOTATOC uptake in Neuroendocrine Tumors in view of a possible application of Radio-guided Surgery with beta- Decays"J. Nucl. Med. 56:1501–6 (2015)
[5] E. Solfaroli Camillocci et al, "First Ex-Vivo Validation of a Radioguided Surgery Technique with $\beta-$ Radiation", Submitted to Cancer Research

Summary

Radio-guided surgery(RGS) is a technique that helps the surgeon to perform a complete lesion resection. Currently, RGS uses γ emitting tracers, to mark the cancerous tissue form the healthy organs, and a γ radiation detection probe. To overcome the limitations due to the high penetration of γ radiation, a novel approach based on β- radiation has been patented and developed(Camillocci, Sci Rep.2014;4:4401), allowing to include cases with high uptake of nearby healthy organs, and to benefit of a low medical team exposure.

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