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PRODUCING IODINE-131 FROM TELLURIUM-130 NEUTRON ACTIVATION: STUDY OF FEASIBILITY IN THE ARGONAUTA RESEARCH REACTOR AT IEN

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A B S T R A C T

Introduction/Justification: Modern oncology faces challenges when treating elderly patients, who often have limited responses to conventional chemotherapy. To address this, theranostics combines diagnostic and therapeutic properties of radioisotopes in the same molecule, enabling personalized medicine. Iodine-131 (I-131) is a pioneering theranostic radionuclide widely used in Nuclear Medicine, for thyroid cancer due to its high affinity for thyroid tissue and beta and gamma radiation emission. In Brazil, the production and supply of I-131 are managed by the Nuclear and Energy Research Institute (IPEN) in São Paulo. However, delivering short-lived radioisotopes to remote regions presents challenges that may cause delays, affecting clinical and research applications. This highlights the need for alternative production methods to ensure timely availability of crucial radionuclides. This study explores the feasibility of producing I-131 through neutron activation of tellurium-130 at the Argonauta Research Reactor at the Nuclear Engineering Institute (IEN) in Rio de Janeiro. The Argonauta reactor, in operation since 1965, has been used for R&D in nuclear technology and the training of human resources for Brazil's Nuclear Program. Its team has optimized I-131 synthesis from tellurium-130 via neutron activation. The reactor's Nuclear Instrumentation and

Radiochemistry laboratories are equipped for radiochemical processing, purification, and gamma spectrometry. Developing a validated I-131 production method at IEN would benefit local research and reduce dependence on external suppliers. **Report:** In the methodology, high-purity tellurium dioxide (TeO₂) was irradiated for one hour at a neutron flux of 10⁹ n/cm².s. After irradiation, I-131 was isolated using a radiochemical separation process. The irradiated oxide was dissolved in sodium hydroxide solution (4 mol/L), followed by hydrochloric acid (1 mol/L) addition to adjust the pH to 5-6. The separation method ensured I-131 retention in the aqueous phase. Gamma spectrometry confirmed radionuclide half-life, radionuclidic purity, and activity levels. The results demonstrated successful I-131 production with radionuclide purity over 95% within four hours post-irradiation. The highest activity was observed approximately 10 hours after neutron activation. Decay curve analysis confirmed the expected half-life of 8.025 days, consistent with literature values. The study also highlighted the efficiency of the radiochemical separation method in minimizing contamination from tellurium-131. **Conclusion:** These findings indicate that the proposed method is a viable alternative for local I-131 production, particularly for research purposes. While the activity levels achieved are suitable for experimental applications, further optimizations, such as increasing neutron flux, extending irradiation time, or improving chemical processing efficiency, may be required to meet higher activity demands in nuclear medicine. Future work will focus on refining the process to scale up production while maintaining the stringent purity and safety standards needed for medical applications. The successful implementation of this technique could provide a reliable and accessible source of I-131 within Brazil, benefiting the scientific community.

Keywords: Argonauta reactor, Iodine 131, Neutron activation, Tellurium.

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PSMA PET/CT FOR DETECTING BRAIN METASTASIS IN ESOPHAGEAL CANCER: A CASE REPORT

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A B S T R A C T

Introduction/Justification: PET/CT with prostate-specific membrane antigen (PSMA) has been investigated in various scenarios beyond prostate cancer, with PSMA expression reported in multiple solid tumor tissues, including their neovascular endothelium.[1] We present the case of a patient with esophageal cancer who developed brain metastasis, emphasizing the critical role of 18 F-PSMA PET/CT imaging in detecting metastatic lesions and its potential impact on guiding treatment strategies. **Report:** G. H. B., a 71-year-old Brazilian male with a history of smoking, alcohol consumption and gastroesophageal reflux disease, was diagnosed with esophagogastric adenocarcinoma in 2024. 18 F-FDG PET/CT staging revealed a localized neoplasm at the esophagogastric junction (6.4 cm, SUV=15.1) and regional paratracheal lymphadenopathy (SUV = 17.2), with no evidence of distant metastasis. The patient initiated neoadjuvant chemotherapy with the FLOT regimen (fluorouracil, leucovorin, oxaliplatin, and docetaxel) and after four cycles, he underwent 18 F-FDG and 18 F-PSMA PET/CT. 18 F-FDG PET/CT revealed disease progression with increased primary lesion metabolic activity, new paratracheal lymphadenopathy and a right temporal lobe lesion consistent with metastasis. In comparison, 18 F-PSMA PET/CT showed higher 18 F-PSMA uptake in the temporal lobe lesion, similar uptake in the distal esophagus, and reduced uptake in the mediastinal lymph nodes. The multidisciplinary team contraindicated esophagectomy, recommending radiotherapy for the central nervous system metastasis over neurosurgery, and palliative systemic treatment. **Conclusion:** To our knowledge, this is the first reported case of brain metastasis from esophageal cancer identified using 18 F-PSMA PET/CT. The increased 18 F-PSMA uptake in the brain lesion, compared to 18 F-FDG PET/CT, may be attributed to PSMA overexpression in the neovascular endothelium of non-prostate cancers.[2] 18 F-PSMA PET/CT represents a novel diagnostic tool for non-prostate cancers, potentially offering higher sensitivity for detecting brain metastases than 18 F-FDG PET/CT. Further clinical trials are warranted to investigate its role in gastrointestinal malignancies.

Keywords: 18 F-PSMA PET/CT, Brain metastasis, Esophageal cancer.

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“ARMADILHA” NA ESTRATÉGIA DA RADIOEMBOLIZAÇÃO HEPÁTICA COM ÍTRIO90 NAS METÁSTASES DE CARCINOMA DE CÓLON. RELATO DE CASO

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R E S U M O

Introdução/Justificativa: O câncer colorretal é a segunda causa de morte relacionada ao câncer no mundo. Aproximadamente metade dos pacientes apresenta metástase hepática ao diagnóstico ou no curso do tratamento. A ressecção cirúrgica com intenção curativa contempla apenas 20% dos casos. A maioria é considerada irresssecável, sendo submetida a tratamento sistêmico. A radioembolização interna seletiva (SIRT) com microesferas de ítrio90 tem desempenhado importante papel na estratégia terapêutica das metástases hepáticas por câncer de cólon com aumento da sobrevida livre de progressão. **Relato:** Este é o caso de um homem de 54 anos, submetido a cirurgia por obstrução intestinal em agosto de 2022, com diagnóstico de adenocarcinoma de cólon direito já com metástases hepáticas. Iniciou quimioterapia sistêmica (QT) e após progressão hepática, iniciou segunda linha de QT no início de 2023. O estudo de PET/CT evidenciava quatro lesões no lobo direito e uma lesão no segmento IVa, sem evidência de doença extra-hepática e pequena área de dilatação biliar associado a diminuto foco de captação no segmento II. A RNM apresentava os mesmos nódulos e referia pequena dilatação biliar no segmento II, sem caracterização de fator obstrutivo. Paciente foi submetido a radioembolização hepática com ítrio90, com excelente concentração nas 5 lesões hepáticas secundárias. Foi administrado ítrio90 seletivamente no segmento IVa (maior lesão, 0,4 Gbq correspondendo pelo Partição a 200Gy no tumor), segmento VI (0,4Gbq com 200Gy nas duas lesões), e de forma não seletiva no tronco que irrigava os segmentos V/VIII e VI/VII (1,0 Gbq). Optou-se por não abordar