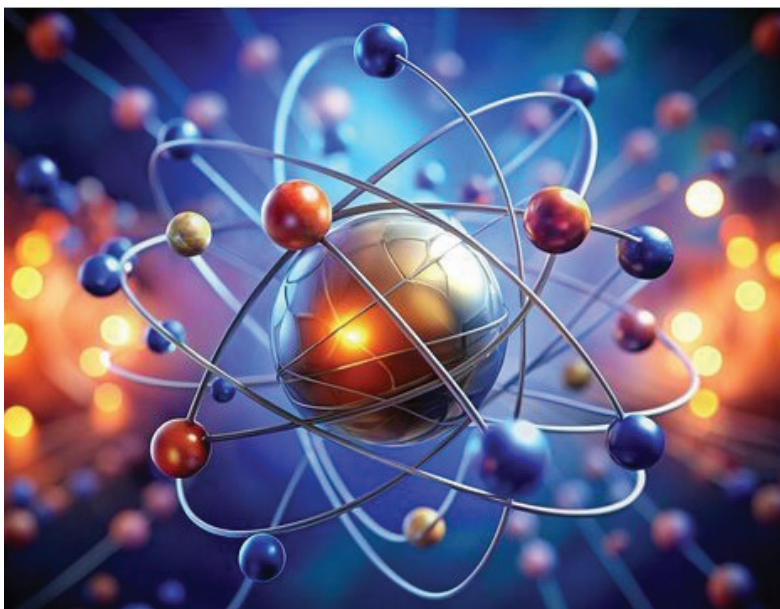

INTERNATIONAL SYMPOSIUM ON NUCLEAR MEDICINE: DIAGNOSIS AND THERAPY

Novi Sad April 5th, 2025



Organizers:

**Faculty of Medicine, University of Novi Sad
Academy of Medical Sciences of the Serbian Medical Society**



ABSTRACT BOOK

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Organizers:
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On behalf of the Organizing and Scientific Committee, it is my great pleasure to welcome you to the International Symposium on Nuclear Medicine in Novi Sad.

The scientific program of the Symposium will present the latest innovations in the field of nuclear medicine. It will combine the two most important fields of nuclear medicine: diagnostics and therapies. Our distinguished invited speakers are the leading experts in these fields and will present their latest state-of-the-art lectures and their own results in these areas.

The aim of this conference is to bring together the nuclear medicine community from different countries. At the same time, the participants of this Symposium will get the opportunity to share their own experiences in nuclear medicine.

This Symposium will evaluate the current status of general nuclear medicine and nuclear medicine theranostics – imaging and therapy - and identify future challenges and directions in this field of medicine.

*Prof. Jasna Mihailović
President, Organizing Committee*

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F-18 FDG-PET/CT IN THYROID INCIDENTALOMAS

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A thyroid incidentaloma (TI) is defined as an unexpected, asymptomatic, newly identified thyroid tumor that is found while performing imaging studies (CT, MRI, PET/CT), not related to the thyroid. F-18 FDG-PET/CT is expanding imaging tool used for diagnosis staging and treatment response in various malignancies and leads to identification of increasing numbers of patients with an incidentaloma in the thyroid gland. There is a female predominance, especially above 50 years of age. Literature reports in various studies TI that range from 0.02- 8.9%. Rates of malignancy also vary widely between 13 - 59% of TI. Because of the relatively high malignancy risk, related to the uptake of F-18 FDG in thyroid nodules, ultrasound assessment is mandatory and furthermore fine needle aspiration (FNA) of FDG-avid thyroid nodules is usually performed regardless of their sonographic features. SUVmax is a semiquantitative parameter that reflects metabolic activity. No cut-off value has been proposed so far to distinguish benign from malignant lesions and controversy still exists. Patients with nodular uptake on F-18 FDG-PET/CT need to be further examined. Larger prospective studies are needed.

Keywords: Thyroid Incidentaloma, F-18 FDG-PET/CT, Thyroid Ultrasound

Invited Lecture

INFILTRATION OF INFERIOR LARYNGEAL NERVE IN ADVANCED THYROID CANCER: EVALUATION AND MANAGEMENT

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Inferior laryngeal nerve invasion is the most common infiltration site in locally advanced T4 tumors, with a prevalence of up to 70% of patients. It is most frequently seen in older age, larger tumor size, presence of lymph node metastases, aggressive histologic type, and BRAF V600E mutated tumors. Decision-making on nerve management includes several stages: 1. preoperative evaluation: imaging, laryngoscopy for vocal cord function; 2. intra-operative assessment: nerve identification, the point of suspected infiltration, characteristics of suspected invasion, nerve function assessment using intraoperative neuro-monitoring, resection margin assessment with intraoperative histopathology; 3. disease characteristics: tumor histological type, M stage, the probability of disease recurrence, availability of neo-adjuvant and adjuvant therapies and overall oncological benefit of nerve resection or preservation; whether there is an infiltration by primary tumor or by lymph nodes; whether there is invasion by the primary tumor or from the local recurrence; the residual disease after surgery; 4. patients' factors and preferences: age, comorbidities, vocation, patient's preferences and expectations; 5. surgical expertise: trained and qualified surgical team, high volume surgeons, specialized centers. The ESES consensus statement on advanced thyroid cancer from 2024 gives the most comprehensive overview of definitions and management of challenging advanced cases in clinical practice, giving explicit expert opinions on nerve preservation vs. resection and how to properly evaluate every case and provide the best care for the patients.

Keywords: Advanced Thyroid Cancer, Inferior Laryngeal Nerve, Infiltration

Invited Lecture

I-131 WHOLE BODY IMAGING IN DIFFERENTIATED THYROID CARCINOMA: TO DO OR NOT TO DO, THAT IS THE QUESTION?

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Preoperative I-131 imaging in patients with differentiated thyroid cancer includes postoperative, diagnostic (i.e., pre-treatment) whole-body imaging (DxWBS) and post-therapeutic whole-body imaging (PT WBS). Although the role of PT WBS is well established, the benefit of planar DxWBS is still a matter of debate. DxWBS is aimed to provide information about the volume of postoperative thyroid remnants. However, it cannot detect occult cervical metastases due to low sensitivity. Moreover, cervical foci detected on planar DxWBS may be misinterpreted as nodal disease, thus leading to a false N upstaging. SPECT/CT imaging improves the planar diagnostic scan interpretation by accurate localization of cervical nodal foci. PT WBS evaluates the extent of radioiodine-avid disease and determines the initial staging of DTC patients. It shows higher sensitivity in comparison to DxWBS and is considered a gold standard imaging modality. Post-treatment WBS may disclose the presence of unsuspected metastatic lesions in 10–26% of high-risk patients and in ~2% of cases of low-risk and intermediate-risk DTC patients. In addition, PT WBS is able to detect radioiodine non-avid tumors. Post-treatment SPECT/CT imaging increases the diagnostic accuracy of planar WBS and provides precise anatomic localization and characterization of detected lesions. Since PT SPECT/CT can detect significantly more neoplastic lesions than planar PT-WB imaging, it consequently changes patients' classification and alters the treatment management in 16% or 25% of cases. Post-treatment I-131 imaging has to be performed in all DTC patients following I-131 therapy. Since SPECT/CT improves the accuracy of PT WBS, it is recommended that it is performed whenever possible.

Keywords: Differentiated Thyroid Carcinoma; Whole-Body Imaging; I-131

Invited Lecture

NUCLEAR MEDICINE THERAPEUTIC APPROACH TO REFRACTORY DIFFERENTIATED THYROID CANCER

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Differentiated thyroid cancer (DTC) is generally considered to have a favorable prognosis, with a high cure rate following initial treatment. However, a subset of patients presents with refractory disease, characterized by resistance to conventional therapies such as surgery and radioactive iodine (RAI) therapy. Managing these refractory cases remains a clinical challenge, calling for alternative therapeutic strategies. Nuclear medicine offers promising therapeutic approaches, mainly through targeted radiopharmaceuticals such as I-131 and novel beta- and alpha-emitting isotopes. Radioactive iodine (RAI) remains a cornerstone in treating DTC; however, the emergence of RAI resistance has prompted the development of newer radiotherapeutic agents. Recent advances in peptide receptor radionuclide therapy (PRRT) and radiolabeled monoclonal antibodies have shown significant promise in targeting metastatic and residual disease in DTC patients with limited therapeutic options. This work will provide an overview of the mechanisms behind refractory differentiated thyroid cancer, highlight current nuclear medicine-based therapeutic options, and discuss emerging therapies, including the role of combination strategies. The clinical outcomes of several treatments will also be reviewed, focusing on improving patient prognosis and quality of life. By incorporating innovative nuclear medicine approaches, we aim to offer a potential pathway to manage patients with advanced, refractory DTC who may otherwise face poor outcomes.

Keywords: Refractory Differentiated Thyroid Cancer, Radioactive Iodine Resistance (RAI-R), Treatment of RAI-R disease

Invited Lecture

MEDULLARY THYROID CARCINOMA- OUR EXPERIENCE IN DIAGNOSIS AND THERAPY

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Medullary thyroid carcinoma is a rare neuroendocrine neoplasm originating from the parafollicular C cells producing calcitonin. It accounts for 4-10% of all thyroid cancers. The exact cause of medullary thyroid carcinoma is not always clear; it can occur sporadically (75-80%) or as part of the multiple endocrine neoplasia (MEN) syndrome. Medullary thyroid carcinoma most commonly presents as a solitary nodule in the thyroid. At the time of diagnosis, approximately half of the patients have enlarged cervical lymph nodes, while a small number of patients have distant metastases. On ultrasound, medullary carcinoma typically appears as a hypoechoic nodule with pronounced vascularity and irregular contours, occasionally containing calcifications. In most cases, it is located in the upper thyroid poles. The biological behavior of medullary carcinomas can be favorable, showing slow progression and long-term survival, but it can also present as rapidly progressing tumors, with survival measured in months. Preoperative diagnosis of medullary carcinoma is crucial, primarily for the proper preoperative preparation of the patient, especially to exclude pheochromocytoma in MEN syndrome. This study aims to analyze our experience in the diagnosis and therapy of medullary carcinoma and to identify issues in the context of current international recommendations. From January 2020 to December 2024, 483 patients underwent thyroid surgery at the University Clinical Centre in Tuzla, Bosnia and Herzegovina. In 154 patients, a diagnosis of thyroid cancer was confirmed, of which 17 patients had medullary carcinoma. After the surgical procedure, four patients required continued therapy, which was determined and initiated based on the levels of calcitonin and the presence of distant metastases.

Keywords: Medullary Carcinoma, Thyroid, Therapy

Invited Lecture

EXPERIENCE WITH F-18 DOPA PET/CT IN MEDULLARY THYROID CARCINOMA: A STUDY FROM A SINGLE CENTRE

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Medullary thyroid carcinoma (MTC) is a neuroendocrine tumor that originates from C cells in the thyroid. Mutations in the RET proto-oncogene primarily drive it and account for approximately 1% to 5% of deaths are related to thyroid carcinoma. The primary tumor marker used to diagnose MTC is the level of calcitonin, followed by carcinoembryonic antigen (CEA), which is expressed only by MTC in the thyroid. Radiopharmaceuticals visualize MTC through various physiological mechanisms. For instance, F-18 DOPA utilizes L-amino acid transporters, which are molecules incorporated into the C-cell membrane. The Centre for Nuclear Medicine with PET at the University Clinical Centre of Serbia began evaluating cases of MTC in late September 2024. The patients underwent scans following the latest recommendations from the European Association of Nuclear Medicine (EANM) and the Society of Nuclear Medicine and Molecular Imaging (SNMMI). A whole-body scan is typically performed 30 to 45 minutes after administering 4 MBq/kg of FDOPA. If there are suspicions of lesions in the head and neck, the patients are scanned 10 to 15 minutes after the injection. The patients are selected in close collaboration with the referring endocrinologists, and they all have significantly elevated postoperative calcitonin levels. In most cases, MTC lesions were identified that were not detected by other radiopharmaceuticals, such as FDG, pentavalent DMSA, MIBG, and tectrotyd.

Keywords: Thyroid, Calcitonin, F-18 DOPA PET/CT

Invited Lecture

GUIDING PARATHYROID SURGERY WITH F-18 FLUOROCHOLINE (FCH) PET/CT

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In 2012, our team in Paris, concomitantly with a team in Ljubljana, started a deliberate use of FCH PET/CT to localize hyperfunctioning parathyroid glands (HPTG), initially as second-line functional imaging in case of non-conclusive ^{99m}Tc -sestaMIBI scintigraphy and/or SPECT, and then since 2017, as first line. In primary hyperparathyroidism (pHPT), the surgical resection of the HPTG(s) is the only radical treatment, best if guided by positive preoperative imaging allowing minimally-invasive parathyroidectomy (MIPTX). The analysis of the series from Hôpital Tenon until January 2022 confirmed the influence of FCH-PET/CT on the decision of PTX and its acceptance by the patient: PTX rate was $192/264=73\%$ if FCH-PET/CT was positive versus $29/83=35\%$ if FCH-PET/CT was negative ($p<0.0001$). Hocevar et al. concluded from their retrospective analysis of a series of 151 patients with pHPT that patients with a single parathyroid adenoma on FCH-PET/CT can safely undergo focused PTX without intraoperative testing of PTH serum levels, in the prospective comparative study of Quaket al. On 57 pHPT patients, the primary endpoint was guiding the surgical procedure appropriately, i.e., toward positive MIPTX resulting in normocalcemia 1 month after surgery. This endpoint was fulfilled in 23/27 patients (85%) who benefited from first-line FCH-PET/CT vs. 14/25 patients (56%, $p=0.03$) in the case of first-line MIBI SPECT/CT. A meta-analysis included 22 studies in 1129 pHPT patients who underwent surgery after FCH-PET/CT; the pooled cure rate was 93% (58%-100%). In renal HPT, the multiglandular disease is expected. The initial PTX, if planned, consists of sparing one or a half HFPTG to avoid hypoparathyroidism. Preoperative imaging aims to ensure if 3, 4, 5, or even more HPTGs are present and if any are ectopic. In our series, the multiglandular disease was accurately detected in this context in 88% of the patients with FCH-PET/CT vs. 45% with ultrasonography ($p<0.004$) and 27% with MIBI ($p<0.001$).

Keywords: F-18 Fluorocholine PET/CT, Primary Hyperparathyroidism, Parathyroidectomy

Invited Lecture

NUCLEAR MEDICINE IMAGING FOR EVALUATION OF AXILLARY LYMPH NODE STATUS IN BREAST CANCER AFTER NEOADJUVANT TREATMENT: SENTINEL LN BIOPSY & BEYOND

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In recent years, targeted axillary dissection (TAD) has become the standard of minimally invasive surgery after neoadjuvant chemotherapy (NACT) in patients with lymph node-positive breast cancer. Unfortunately, this procedure is not widely available. Our institution study evaluates an alternative approach called targeted sentinel lymph node biopsy. I will present a new approach for SLN biopsy in patients with node-positive breast cancer after NACT. Forty-seven breast cancer patients aged above 40 years with biopsy-proven, clinically T1–3, N+, and M0 disease were eligible for this study and underwent SPECT/CT examination 10–15 minutes after injecting 740–1000 MBq of Tc-99m-labeled methoxy-isobutyl-isonitrile (Tc-99m-MIBI). SPECT/CT revealed the precise localization of metastatic lymph nodes in the axillary region in all cases. All patients received NACT according to the guidelines. After NACT, all patients underwent SPECT/CT imaging of sentinel lymph nodes (SLNs). Examination was performed 120 minutes after tumor-site injection 0.2–0.4 ml of 99m-Tc - radiocolloids (100–300 MBq) with tiny particle size < 50–80 nm (Tc-99m-Sentiscan, MedicorPharma Ural, Russia). All regional LNs with uptake of radiocolloids were regarded as sentinel LNs. The identification rate, numbers, and topography of SLNs were calculated and analyzed on these SPECT/CT images. After the fusion of both SPECT/CT images, we evaluate the frequency of match/mismatch in localization of primary metastatic (on SPECT/CT Tc-99m-MIBI) and sentinel (SPECT-CT 99m-Tc-radiocolloids after NACT) lymph nodes. SLNs after NACT were visualized in 42 patients (89%). The mean number of detected SLNs was 1.9 ± 0.3 . The differences in the topography of primary metastatic (on SPECT/CT Tc-99m-MIBI) and SLNs (on SPECT/CT Tc-99m-radiocolloids after NACT) were mentioned in 8 patients (19%). In the remaining 34 patients (81%), we determined identical localization of SLNs and metastatic

LNs before NACT. The proposed approach for targeted SLN biopsy can be successfully performed in 81% of breast cancer node-positive patients who underwent NACT.

Keywords:Breast Cancer,SPECT/CT, Sentinel Lymph Nodes

Invited Lecture

METASTATIC BREAST CANCER-CONVENTIONAL IMAGING

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At presentation, 4–10% of breast cancers (BC) are metastatic. Accurate staging of BC is obligatory for treatment planning and optimizing patient outcomes. Several imaging modalities may be used for the staging of women with advanced disease. Imaging provides information concerning metastatic disease's presence, extent, and distribution. Staging and repeated evaluation of patients with metastatic BC are central to the accurate assessment of metastatic breast cancer extent initially and during treatment, providing information for further clinical management. Although bone scintigraphy and multiplanar-CT are the most frequently used tests, others, including PET, MRI, and hybrid scans, are also used, with no specific recommendations of which test has to be preferentially used. The ESMO's guidelines recommend performing US, CT, or MRI imaging in chest and abdominal imaging and a bone scan for patients with clinically positive axillary nodes, large tumors (T3-4), or BC with aggressive biology. If such imaging modalities are inconclusive, dual imaging methods combining functional and anatomical information, such as F-18 FDG-PET/CT, are suggested. No single imaging technique is without limitation. Advances in the diagnostic and therapeutic fields have been made, particularly with new targeted therapies. Oncological imaging has evolved exponentially with the development of functional and anatomical imaging techniques. Consistent, reproducible, and validated methods of assessing response to therapy are critical in effectively managing patients with this pathology.

Keywords: Metastatic Breast Cancer, Conventional, Imaging

Invited Lecture

BREAST CANCER STAGING WITH PET/CT

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Accurate initial staging of breast cancer is important for the selection of optimal therapy. Specifically, detecting the distant metastases at initial diagnosis is crucial for the prognosis and treatment. Guidelines considering these issues, as well as assessment of treatment response and assessment of recurrence, are constantly changing, both in Europe and in America. The newest guidelines on the role of FDG-PET/CT in breast cancer, published in 2024 by Groheaux et al., have a focus on differences and agreements on these topics from several European (EANM/SNMMI and ESMO – European Society for Medical Oncology) and American Societies (NCCN – American National Comprehensive Cancer Network). The comparison shows that EANM/SNMMI recommends FDG-PET/CT for stage IIB and higher in baseline staging, while ESMO finds FDG-PET/CT useful when conventional imaging is inconclusive in high-risk patients. However, American Societies consider that systemic staging can be performed in stage I breast cancer of more than 1 cm. EANM/SNMMI finds FDG-PET/CT helpful in assessing early metabolic response after primary systemic treatment, with a possibility to exclude metabolically active lymph nodes or metastases before surgery. However, NCCN and ESMO consider FDG-PET/CT not indicated in this setting. EANM/SNMMI and ESMO agree on the role of FDG-PET/CT in assessing bone metastases in metastatic disease. For response assessment, NCCN recommends CT using RECIST or the WHO criteria. In recurrence assessment, FDG-PET/CT has a higher sensitivity in detecting locoregional and distant metastases than conventional imaging. ESMO recommends imaging with FDG-PET/CT, either as “preferably imaging modality” if there is suspicion of metastatic disease or as a minimum imaging workup in known metastatic disease. In the assessment of recurrence, EANM/SNMMI and NCCN agree on FDG-PET/CT as applicable when conventional imaging is equivocal or helpful in “certain circumstances”, retrospectively. In conclusion, FDG-PET/CT is widely used in patients with breast cancer, with a proven impact on its clinical management. Overall, EANM/SNMMI guidelines more often recommend the use of FDG-PET/CT in patients with breast cancer. ESMO has specific indications when FDG-PET/CT can replace conventional imaging. While NCCN recommendations are less specific, with often-used statements that FDG-PET/CT can be used in “certain circumstances”.

Keywords: FDG-PET/CT Imaging, Breast Cancer, Staging

Invited Lecture

PET/CT IMAGING IN METASTATIC/RECURRENT BREAST CANCER

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Positron emission tomography (PET-CT) has become an indispensable imaging tool in the treatment of metastatic and recurrent breast cancer; it offers greater diagnostic precision than conventional imaging methods. F-18 FDG (fluorodeoxyglucose) PET-CT plays an important role in detecting metastatic spread, assessing response to therapy, and identifying disease recurrence at an early stage. As it can detect metabolic activity, it is valuable in distinguishing post-treatment changes from active disease. However, its effectiveness may be limited in tumors with low glycolytic activity, as is present in some forms of breast cancer. The introduction of novel PET tracers, such as F-18 FES (fluoroestradiol) and Ga-68 FAPI (fibroblast activation protein inhibitor), can further improve the detection of specific breast cancer subtypes, particularly hormone receptor-positive tumors and those with high stromal involvement. Beyond detection, PET/CT provides important prognostic information through metabolic parameters like maximum standardized uptake value (SUV_{max}), metabolic tumor volume (MTV), and total lesion glycolysis (TLG), which help predict patient outcomes and guide clinical decision-making. PET/CT can help guide a more patient-specific approach to treatment and long-term disease monitoring by enabling more precise disease characterization. With ongoing advancement in molecular imaging, the role of PET/CT imaging of breast cancer will continue to expand.

Keywords: Breast Cancer, PET/CT Imaging, F-18 Fluorodeoxyglucose

Invited Lecture

THERANOSTICS: ERASMUS MC: PAST, PRESENT AND FUTURE

Eric Verburg

Erasmus MC, University Medical Center of Rotterdam, Rotterdam, Netherlands

Erasmus MC in Rotterdam is world-renowned as the birthplace of somatostatin receptor targeted imaging. From the first tries with I-131 octreotide via the eventual diagnostic product In-111-octreotide, later known as Octreoscan, the experiments and experiences gained eventually led to the development of the therapeutics Y-90-DOTATOC and Lu-177-DOTATATE. The combination of diagnostic and therapeutic radio metalized compounds was the original example of what these days is called "theranostics," thus also enabling later improvements of the concept with Ga-68-based PET-tracers and new tracers targeting the prostate-specific membrane antigen or the fibroblast activating protein. In the presentation, the history of the theranostics and possible future directions will be discussed based on the experiences and practical examples gained in the Erasmus MC, which can lay a claim to being the original "theranostic center".

Keywords: Theranostics, In-111-Octreotide, Lu-177-DOTATATE

Invited Lecture

CURRENT AND FUTURE LANDSCAPE OF THERANOSTICS

Lisa Bodei

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Radiotheranostics are an innovative class of cancer medications that provide the capability for simultaneous imaging and treatment. Thus, theranostics can be used to visually assess the biodistribution of the radiopharmaceutical and for the selection of patients to receive the therapeutic drug. This concept can be best explained as "treating what you see and seeing what you treat". Theranostics significantly contribute to lowering the risks of failure in drug development by providing the means to visualize and quantify the presence and engagement of targets. Therefore, theranostics play a crucial role in reducing the risks of failure in drug development by enabling the visualization and quantification of both the presence and engagement of the target. The clinical successes seen in areas like neuroendocrine tumors and prostate cancer demonstrate the potential of theranostics. However, challenges continue to exist in the effective deployment of new agents and in exploring their future potential and emerging opportunities. A significant challenge in this area is the limited duration of treatment response. Various innovative strategies have been proposed to improve the efficacy and tolerability of radiotheranostics, with the use of alpha emitters demonstrating notable potential in overcoming the natural radioresistance of cancer cells. A critical factor in this process is the personalization of treatments, which is based on precise dosimetric calculations for both the tumor and non-targeted organs, as well as an evaluation of the tissue's sensitivity to radiation.

Keywords: Theranostics, Cancer, Treatment

Invited Lecture

PSMA PET/CT IMAGING FOR THE SELECTION OF PATIENTS FOR ACTIVE SURVEILLANCE

Levent Kabasakal

Istanbul University-Cerrahpasa, Medical Faculty, Department of Nuclear Medicine

PSMA-PET/CT has gained prominence for prostate cancer staging and restaging. Recently, its potential for diagnosing, particularly distinguishing between aggressive and indolent forms of prostate cancer, is being considered. PSMA expression, which correlates with cancer grade and severity, can be visualized via this imaging technique. Elevated PSMA levels on PET/CT scans have been associated with higher-grade groups of prostate cancer. The introduction of the PRIMARY score marks progress in initial prostate cancer diagnosis. This score considers the pattern of the prostate gland, PSMA presence in the peripheral zone, and PSMA uptake intensity, aiming to refine diagnostic accuracy. Reproducibility studies indicate that the PRIMARY score is consistent with MR imaging and may predict clinically significant cancers effectively. This raises the possibility of using PSMA-PET/CT as an alternative to repeat biopsies in diagnosing clinically significant cancer. Furthermore, PSMA-PET/CT could serve as a non-invasive diagnostic tool for significant prostate cancer and for monitoring patients under active surveillance. However, since the PRIMARY score's data encompasses all cancer grades, its diagnostic performance and reproducibility are potentially inflated. Its efficacy in patients with ISUP 1 diagnosed via biopsy remains unclear, suggesting a need for further refinement of the PRIMARY score. Consequently, the application of PSMA PET/CT might expand beyond its conventional use in staging and restaging.

Keywords: Prostate Cancer, PSMA PET/CT, Active Surveillance

Invited Lecture

TARGETED RADIONUCLIDE THERAPY – MRRC EXPERIENCE

V.V. Krylov, T.Yu. Kochetova, A.Yu. Shurinov, E.V. Borodavina, M.A. Sigov, E.A.Sidorenko, M.Ja.Smolyarchuk, S.I.Ivanov, A.D.Kaprin

Institute of Nuclear Medicine A. Tsyb Medical Radiological Research Center (MRRC) – branch of the National Medical Research Radiological Center of the Ministry of Health of the Russian Federation, Obninsk, Russian Federation

The first radionuclide therapy department (RNT) in Russia (in the USSR) was opened in 1982 at the MRRC (Obninsk). It is Russia's largest radionuclide therapy center, where more than 5 thousand patients were treated in 2024. In 2025, the Institute of Nuclear Medicine was established here. It includes the following departments: radionuclide diagnostics, radionuclide therapy, nuclear pharmacy, and a preclinical research laboratory. We use targeted radiopharmaceuticals (I-131 for thyroid cancer and thyrotoxicosis, Lu-177/Ac-225 PSMA, Lu-177/Ac-225 DOTATATE) and osteotropic (Sm-153 EDMP, Ra-223 chloride, Sr-89 chloride, Re-188 HEDP, Re-188zoledronic acid). All of these radiopharmaceuticals are produced in Russia. We also use radiopharmaceuticals for local administration (Re-188 5-10 μm microspheres intra-articularly, Re-188 5-10 μm microspheres for liver radioembolization). Radioiodine therapy has been used since 1982. In 2024, 2315 patients with thyroid cancer and 1615 patients with thyrotoxicosis were treated. Sm-153 EDTMP has been used since 1997. In 2024, 250 patients were treated. Ra-223 chloride has been used since 2014. In 2024, 350 patients were treated. Lu-177 PSMA has been used since 2021. In 2024, 340 patients were treated. We use personalized dosing in the range of 5 to 10 GBq. Ac-225 PSMA and Lu-177/Ac-225 PSMA tandem were launched in 2023. In 2024, 225 patients were treated. We also use personalized dosing of Ac-225 PSMA in the 6 to 12 MBq range. Lu-177 DOTATATE was launched in 2024.

Keywords: Radioiodine Therapy, Radioligand PSMA Therapy, Peptide Receptor Therapy

Invited Lecture

RADIONUCLIDE CUTANEOUS TUMOR THERAPY

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Nuclear Medicine IRCCS Azienda Ospedaliero-Universitaria, Bologna, Italy

Basal-cell carcinoma (BCC) and squamous cell carcinoma (SCC) are the most common histotypes of non-melanoma Skin Cancers (NMSC). In most cases, Mohs surgery is the treatment of choice, but in case of “difficult to treat” lesions with surgery, other techniques are possible like External Beam RT, Photodynamic Therapy, Laser, Imiquimod etc; one new option is the application of high dose brachytherapy using a non-sealed Re-188 resin directly on the surface of the lesion. The therapy is easily applicable in all lesions, regardless of the location, geometry, or surface area, with the only limitation of a thickness lower than 2.5/3.0mm, which is the maximum penetration of the Beta - rays emitted by Re-188. The therapy is painless and very well accepted by patients. The application time is relatively short (usually around 70-90 minutes). The aim of the talk is to report the efficacy in terms of local control, early side effects, and long-term cosmetic results. According to the limited literature data and our experience, the relapse rate is around 6-8% after a mean follow-up of 24 mo. Early severe adverse events are rare and easily manageable. Long-term cosmetic results are excellent or good in most of the cases. In conclusion, the use of Re-188 resin in NMSC could be recommended in all those cases where lesions could result in difficulty with surgery treatment or in patients with co-morbidities that might contra-indicate surgical intervention.

Keywords: Non Melanoma Skin Cancer, Brachytherapy, Re-188 resin.

CORRELATION OF PET/CT METABOLIC PARAMETERS AND KI67
PROLIFERATION MARKER IN THE ASSESSMENT OF TUMOR
AGGRESSIVENESS IN NSCLC PATIENTS

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Introduction: PET/CT imaging is routinely performed in the initial staging of malignant tumors. The expression of Ki67 is strongly related to tumor growth and aggressiveness. This study aims to investigate the correlation between PET/CT metabolic parameters (SUVmax, TLG, and MTV) and the Ki67 proliferation index in the assessment of tumor aggressiveness in non-small-cell lung cancer (NSCLC) patients. **Methods:** This retrospective study included 112 patients with prior history of NSCLC. All patients underwent PET/CT exam and immunohistochemical determination of the Ki67 proliferation marker. Statistical analyses include univariate and multivariate analyses. **Results:** The tumor size correlates well with SUVmax: tumors sized ≤ 4.15 cm and tumors sized > 4.15 cm have average SUVmax of 12.25 ± 5.97 and 17.01 ± 7.08 , respectively ($p=0.03$). However, the average SUV max has no significant difference between different histological types of NSCLC: adenocarcinoma, squamous cell cancer, and not otherwise specified (NOS) lung carcinoma (14.24 ± 6.65 , 14.88 ± 7.49 , and 9.62 ± 6.87 , respectively). The SUVmax values were significantly higher in patients with a Ki67 proliferation index $> 30\%$ ($p=0.001$). The SUVmax, MTV, and TLG parameters do not influence the probability of disease-specific survival (DSS) ($p=0.312$, $p=0.81$, and $p=0.09$, respectively). **Conclusion:** The SUVmax

values correlate with the Ki67 proliferation index in the assessment of the tumor aggressiveness. Probability of DSS after 1,3,5,7 and 9.3 years after the time of the diagnosis was $93.8\% \pm 2.3\%$, $67.9\% \pm 4.4\%$, $50.3\% \pm 4.8\%$, $31.8\% \pm 4.5\%$, and $17.6\% \pm 3.4\%$ months, respectively.

Keywords: PET/CT Metabolic Parameters, NSCLC, Ki67 Proliferation Index

COMPARISON BETWEEN ULTRASOUND FEATURES, NODULE FIRMNESS, AND FINE-NEEDLE ASPIRATION CYTOLOGY FINDINGS OF THYROID NODULES

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Introduction: Timely ultrasound detection of thyroid nodules requiring further fine-needle aspiration cytology (FNAC) evaluation is essential for the early diagnosis and treatment of thyroid cancers. Understanding the nodules' key morphological features that indicate a higher risk of malignancy is critical for clinicians performing FNAC in everyday practice. **Aim:** This study aimed to determine whether there are differences in the ultrasound morphological characteristics of thyroid nodules, as well as in the subjective assessment of nodule firmness by the nuclear medicine specialist performing the FNAC, about the FNAC results expressed according to the six categories of the Bethesda classification. **Material and Methods:** This retrospective study analyzed the ultrasound morphological characteristics (including parenchymal echogenicity, nodule echogenicity, cystic degeneration, microcalcifications, margins, and nodule size), subjective assessments of nodule firmness during puncture, and FNAC results of 566 thyroid nodules, all punctured and evaluated by the same nuclear medicine specialist over two years at the Oncology Institute of Vojvodina. The cytopathological results of FNAC were categorized according to the Bethesda system, dividing the subjects into six groups for comparative analysis. **Results:** Among the 566 punctured nodules, 137 (24.2%) were classified as Bethesda I, 311 (55.0%) as Bethesda II, 61 (10.8%) as Bethesda III, 14 (2.5%) as Bethesda IV, 29 (5.1%) as Bethesda V, and 14 (2.5%) as Bethesda VI. Irregular margins, microcalcifications, and the subjective assessment of increased nodule firmness during FNAB differed significantly among the Bethesda classification subgroups ($p < 0.01$ for all features). Increased nodule stiffness and microcalcifications were statistically significantly more prevalent in all Bethesda

categories suspected of malignancy (III-VI). At the same time, irregular margins were statistically significantly more common only in Bethesda categories V and VI. Conclusion: Microcalcifications and irregular margins on ultrasonography should alert clinicians to a higher risk of malignancy, influencing the decision to perform FNAC. Incorporating elastography into routine nodule evaluation could be beneficial for the early detection of malignant characteristics, as it provides a non-invasive assessment of nodule stiffness associated with malignancy risk.

Keywords: Thyroid Nodules, FNAC, Bethesda Classification

Case report

CLEAR CELL RENAL CARCINOMAMETASTASIS TO THE THYROID GLAND ANDMETACHRONOUS PAPILLARY THYROID CANCER - A CASE REPORT

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Background: Metastases to the thyroid gland are uncommon in clinical practice and account for 2-3% of thyroid malignancies. Metastatic clear cell renal carcinoma (CCRC) to the thyroid gland occurs rarely, usually many years after the initial diagnosis. Papillary thyroid cancer accounts for 85% of differentiated thyroid cancer. **Case presentation:** We present the case of a 61-year-old male with a prior history of histologically confirmed CCRC after the right nephrectomy in 2011, stage II (pT2NxMx). After the surgery, the patient underwent active surveillance only. Ten years after the primary surgery, in October 2021, the patient underwent pancreas resection for suspicious metastases detected on MRI. Histopathologically, the metastatic CCRC, G2, was confirmed. Although abdominal CT was negative during the postoperative follow-up, head and neck CT revealed several nodules in the right thyroid lobe and isthmus. One year later, the ultrasound (US) exam detected an enlarged heterogeneous mass in the right thyroid lobe and isthmus consisting of several confluent nodules with cystic degeneration. Subsequent fine-needle aspiration of the right thyroid nodule was done with a cytological report of Bethesda II (colloid-rich follicular nodule). Neck CT, which was performed soon after, showed the right thyroid lobe increased in size and tracheal compression. Therefore, the patient underwent a right thyroid lobectomy in December 2023. The metastatic CCRC was histologically confirmed with additional immunohistochemical (IHC) studies. IHC staining of the right thyroid lobe for CD10 showed positivity of tumor cells and RCC and negative results for CK7, CK20, vimentin, and thyroglobulin. In

July 2024, an ultrasound revealed two hypoechogenic nodules, a 25mm-sized nodule in the isthmus and a 5mm-sized nodule in the left thyroid lobe. The completion thyroidectomy was performed in August 2024, with a histological diagnosis of papillary thyroid cancer staged pT1a (5 mm tumor-sized). After the surgery, the patient was put on LT4 therapy and placed under regular surveillance. At the last follow-up in January 2025, FNA of the suspicious cervical lymph nodes level II was performed, but cytology reported no malignant cells. The patient was referred to a Urological Tumor Board meeting to discuss further patient management. Conclusion: Renal cancer with thyroid metastases in combination with primary thyroid cancer is rare. Total thyroidectomy must be performed in all patients, including regular and careful postoperative monitoring.

Keywords: Clear Cell Renal Carcinoma, Thyroid Gland, Papillary Thyroid Cancer

Case Report

FOCAL F-18 FDG-PET/CT THYROID UPTAKE - A CASE REPORT

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Introduction: The prevalence of thyroid nodules in the general population is reported to be between 8 and 65%. More thyroid nodules have been detected with advances in imaging methods in the last decade. Various studies show that focal FDG thyroid uptake ranges from 0.2%-10.1% and approximately one-third are associated with malignancy. This incidentaloma requires further investigation and management, such as ultrasound, biochemical analysis, fine needle aspiration biopsy (FNAB), and surgery if needed. There are equivocal findings on the role of SUVmax in differentiation malignancy in this incidentaloma. **Case report:** We present a case of 62 years old female diagnosed with breast cancer, and referred to F-18 FDG-PET/CT for follow-up. She underwent a bilateral mastectomy and also had a left thyroid lobectomy 8 years ago because of an adenoma. F-18 FDG-PET CT revealed intense focal FDG uptake in the right thyroid lobe with SUVmax=33.0, and further investigation was recommended. Ultrasound of the thyroid gland showed a vascularized 17mm hypoechogenic nodule in the right thyroid lobe. Subsequently, according to Bethesda, FNAB resulted in the 4th classification group being suspicious of follicular neoplasm. The patient was referred to a thoracic surgeon, a right lobectomy was done, and pathology findings were consistent with follicular adenoma. **Conclusion:** F-18 FDG-PET/CT thyroid incidentalomas are common and require further investigations. SUV max value, in this case, was indicative of malignancy; FNAB findings could not have excluded that, but surgery confirmed a benign lesion.

Keywords: F-18 FDG-PET/CT, Thyroid Incidentaloma, FNAB

Case Reports

FLUORODEOXYGLUCOSE POSITRON EMISSION TOMOGRAPHY WITH COMPUTED TOMOGRAPHY IN THE EVALUATION OF UNCOMMON LOCATIONS OF NON-HODGKIN'S LYMPHOMA: TWO CASE REPORTS

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Background: Non-Hodgkin lymphoma (NHL) is a malignant proliferation of lymphatic cells of the immune system, characterized by involvement of lymph nodes as well as spread to extranodal sites. Follicular lymphoma (FL) is the most common subtype of indolent NHL, while diffuse large B-cell lymphoma (DLBCL) is the most common subtype of aggressive NHL. The aim of the presented cases is to underline the role of F-18 fluorodeoxyglucose positron emission tomography with computed tomography (FDG PET/CT) in determining disease staging and monitoring therapy response in two patients with unusual locations of NHL. **Case reports:** We present two cases of atypical presentations of the two most common subtypes of NHL—FL in the eyeball and DLBCL in the calcaneus. Both patients underwent initial FDG PET/CT to determine the initial disease stage, followed by follow-up FDG PET/CT after the application of the appropriate therapeutic modality, in order to assess the response to therapy. **Conclusion:** The presented uncommon locations of the FL and DLBCL pose diagnostic challenges. FDG PET/CT imaging provides important information for managing such cases, both in the precise localization and extent of disease spread, as well as in the timely assessment of the response to the applied therapy.

Keywords: Follicular Lymphoma, DLBCL, Rare Locations

Case Report

FDG PET/CT IN THE DETECTION OF EXTRAPULMONARY MALIGNANCY IN A PATIENT WITH A LUNG LESION OF AN UNKNOWN ETIOLOGY: A CASE REPORT

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Background: F-18 fluorodeoxyglucose positron-emission tomography/computed tomography (FDG-PET/CT) is widely used in the evaluation of lung lesions of an unknown etiology, with high sensitivity and a relatively high specificity for a differentiation of a malignant lesion from a benign. Furthermore, due to its' routine protocol, which includes the acquisition from the skull base to the proximal third of the femur, the utility of this method in detecting an extrapulmonary lesion as an underlying cause of secondary lung changes is also high. **Case report:** A 74-year-old male patient with a positive medical history of chronic obstructive pulmonary disease (COPD) was referred for FDG-PET/CT for further assessment of nodular and reticular lung lesions. Increased FDG uptake was detected not only in some of the lung lesions but also in a soft tissue mass in a distal part of the sigmoid colon. A colonoscopy was performed, and pathophysiology revealed adenocarcinoma. Since a non-mutated wild-type RAS gene was confirmed, panitumumab and chemotherapy were combined. **Conclusion:** When performing FDG-PET/CT in patients with lung lesions of an unknown etiology, a careful analysis of extrapulmonary locations should be conducted to search for an underlying cause.

Keywords: F-18 FDG-PET/CT, Imaging, Lung Neoplasms

Case Report

COMPLEX REGIONAL PAIN SYNDROME OF THE FOOT: A CASE REPORT

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Introduction: Persistent foot pain is a significant problem affecting patients' quality of life. Complex regional pain syndrome is a rare form of neuroinflammatory and dysautonomic disorder that is not a common differential diagnosis in patients with pain of unknown cause. **Case presentation:** The male, 59yo, consulted an orthopedic surgeon because of pain and swelling in their right foot that started suddenly and has been going on for 5 months. Because of these problems, the patient had difficulty walking. The patient denies any previous injuries. A rheumatologist ruled out rheumatic disease. MR findings showed minor edema of the cuboid bone. CT showed decreased foot bone density due to the inability to walk. Color Doppler of the blood vessels was described as usual, and electromyoneurography was used. Without diagnosis, the patient was referred for bone scintigraphy. Bone scan showed significantly increased vascularization of the right foot, increased perfusion of soft tissues, and increased osteoblastic activity in the projection of the calcaneus and, more intensively, in the projection of the tarsal bones. These findings can be a classic scintigraphic image of a complex regional pain syndrome. After the diagnosis, the patient was

given corticosteroid therapy by the orthopedic surgeon, which significantly improved his condition, and he was referred for further physical therapy. Conclusion: In addition to numerous new diagnostic methods and advances in nuclear medicine, classical bone scan still has a significant place in the diagnostic algorithm of skeletal system diseases.

Keywords: Pain Syndrome, Bone Scan, Tarsal Bone

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