

SUMMARY OF THE DOCTORAL THESIS

Methods of processing radio-imaging examinations with contrast and their applications in the medical conduct of patients

Ph.D. Student: **Mărginean Lucian**

Ph.D. Supervisor: **Prof. univ. dr. Suciu Bogdan Andrei**

Prof. univ. Dr. Jovin Tudor

Introduction: Radiology, including examination modalities such as X-rays, computerized tomography (CT), magnetic resonance imaging (MRI), and ultrasound, has revolutionized diagnosis and clinical management. The integration of contrast agents enhances tissue visibility, enabling the detection of previously indiscernible pathologies, thereby facilitating informed therapeutic decisions.

Image processing techniques play a crucial role in radiology, with advancements driven by computing power and artificial intelligence. These techniques encompass image reconstruction, filtering, segmentation, and fusion, leading to improved image quality and quantitative analysis. These methods have a wide range of clinical applications, from disease screening to surgical planning and therapeutic monitoring.

General Objectives: In this doctoral work, we aimed to investigate new image processing methods and their implementation in current medical practice.

General Methodology: The general research methodology involved patient selection for inclusion in studies, analysis and extraction of paraclinical data from patient records, as well as statistical analysis of the obtained data.

Study 1: In the first observational retrospective study, we investigated patients with neoplastic brain pathology (glioma and cerebral metastases) and explored the predictive role of texture analysis in diagnosing these patients. We included 36 patients whose CT images underwent texture analysis. We examined the relationship between textural parameters and the histological diagnosis of these patients, ultimately calculating various prediction classes for identified textural parameters.

Study 1 Conclusions: The peripheral zone of brain tumors underwent radiomic analysis, which proved to be efficient in distinguishing between gliomas and solitary cerebral metastases. Textural parameters may indicate microscopic heterogeneity resulting from tumor infiltration into the surrounding edema of primary malignancies. However, it is essential to note that this hypothesis requires further validation through a comprehensive study involving close coordination between CT imaging and pathological analysis.

Study 2: The second study, an observational, analytical, and retrospective study, represented one of the initial attempts to involve advanced machine learning and simulation systems in the planning of endovascular interventions. We presented a case of a patient with subarachnoid hemorrhage due to the rupture of an aneurysm in the ophthalmic segment of the internal carotid artery. In this scenario, we utilized advanced simulation software for the placement of a flow diverter stent using the Sim&Size system.

Study 2 Conclusions: In conclusion, the use of simulation software such as Sim&Size™ presents a promising methodology that enhances procedural strategy in the management of cerebral aneurysms with flow diverters, potentially improving patient outcomes and procedure efficiency. However, it is crucial to recognize and address specific constraints associated with this approach.

Study 3: The third study was designed as a cohort-type, retrospective observational study, encompassing all patients over 18 years old, diagnosed with ischemic stroke and admitted to the Emergency County Hospital in Târgu-Mureș, Romania, between January 2022 and January 2023. All patients included in the study underwent a CT examination, and all were diagnosed with ischemic stroke as the primary diagnosis. Patients with subsequent hemorrhagic changes, those for whom targeted catheterization of the supra-aortic arteries was not feasible, participants with spontaneous blood flow restoration, and those whose initial CT scan did not reveal the "hyperdense artery sign" aspect were excluded.

Study 3 Conclusions: Based on our research results, we observed that the duration of thrombectomy procedures holds prognostic value in determining the final outcome of the procedure, encompassing various procedural modalities. This statement remains applicable to cases where only aspiration thrombectomy was performed, as well as cases involving exclusively mechanical thrombectomy. Additionally, we established that GrayLevelVariance is a prognostic indicator for a positive outcome in thrombectomy, regardless of the specific procedure used. ClusterShade and SizeZoneNonUniformity were recognized as reliable prognostic markers for the final outcome of endovascular interventions, especially in cases involving only aspiration thrombectomy. Lastly, textural features such as Idmn, Idn, and SmallAreaEmphasis are associated with the success of thrombectomy when stent-retrievers and aspiration catheters were used simultaneously.

Study 4: The fourth study in the doctoral thesis was designed as a cohort-type, retrospective observational study and included 84 patients with cystic adnexal lesions who underwent CT examinations. The final diagnosis for all patients was determined through analysis. The textural features of the lesions were extracted using dedicated software and further used to compare benign and malignant lesions, primary tumors, and metastases, malignant and borderline lesions, and benign and borderline lesions. The discriminatory capacity of textural features was evaluated through univariate analysis and receiver operating characteristic characteristics, as well as by using the k-nearest neighbor classifier. Univariate analysis showed statistically significant results when comparing benign and malignant lesions (Difference Variance parameter) and malignant and borderline tumors (Correlation parameter). The highest accuracy (83.33%) was achieved by the classifier in discriminating primary tumors from ovarian metastases.

Study 4 Conclusions: Textural parameters successfully discriminated between various types of ovarian cystic lesions based on their content. However, it is not entirely clear whether these differences result from the physical properties of fluids or their affiliation with a specific histopathologic group. If further validated, radiomics can offer a rapid and non-invasive alternative in diagnosing ovarian cystic tumors.

General Conclusions: New contrast-enhanced imaging methods prove to be feasible for use in current medical practice and demonstrate significant prognostic power in establishing a diagnosis.