11. AORTIC ANEURYSM INFLAMMATORY CELL DETECTION WITH DEEP LEARNING METHODS

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https://www.youtube.com/live/fSpXH-3Xy5w?t=16878s

INTRODUCTION: In digital pathology, neural networks such as the Multilayer Perceptron (MLP) and Residual Neural Network (ResNet) are becoming increasingly prevalent for the analysis of tissue structure. However, their application remains constrained. MLP networks connect layers sequentially, whereas ResNet introduces blocks that span across layers, thereby enabling faster learning and rendering it suitable for complex tasks. In the context of aortic aneurysm progression, the number and location of acute and chronic inflammatory cells are of critical importance, as these cells and the enzymes they release have the potential to weaken the vascular wall and promote aneurysm growth. This highlights the necessity for a more detailed study of vascular inflammation through digital image analysis, given that the current pathology literature offers limited insights into this area**. OBJECTIVE:** Our objective was to determine the number of inflammatory cells in the aortic wall using MLP and ResNet50 methods and to compare these results with data obtained from traditional immunohistochemical methods. **MATERIALS AND METHODS:** We selected a total of 13 digitalized hematoxylin-eosin stained histological sections of aortic aneurysm surgical samples from the archives of the Department of Pathology and Experimental Cancer Research at Semmelweis University from the years 2023-2024. Automated nucleus recognition was performed on 10 slides using the Biological Image Analysis program (BIAS, Single-Cell Technologies Ltd., Szeged, Hungary), and a training image database containing 10,781 elements was created. The cells were classified into 5 categories. In the remaining 3 cases, the proportions of neutrophil and plasma cells were calculated relative to the number of identified nuclei using MLP and ResNet methods. Immunohistochemical labeling was performed using the CD138 antibody for plasma cells and Myeloperoxidase labeling for neutrophil granulocytes. The number of labeled cells was determined using the 3DHistech (Budapest, Hungary) Quantcenter Nuclearquant module. Finally, the cell type ratios determined by Quantcenter were compared with those determined by MLP and ResNet50. The ANOVA method was used for statistical analysis. **RESULTS**: The average proportion of plasma cells was 17.17% (n=3, SD= ± 11.56%) according to the MLP method, 13.54% (n=3, SD= ± 9.54%) according to the ResNet method, and 8.09% (n=3, SD= ± 5.08%) according to immunohistochemistry. There was no significant difference between the methods.The average proportion of neutrophils was 7.97% (n=3, SD= ± 1.64%) according to the MLP method, 6.53% (n=3, SD= ± 1.7%) according to the ResNet method, and 5.02% (n=3, SD= ± 2.02%) according to immunohistochemistry. There was no significant difference between the methods. **CONCLUSIONS:** In the histological sections of aortic aneurysms we examined, the cell recognition method performed using MLP and ResNet50 produced similar results to the IH method in identifying neutrophils and plasma cells. Based on these findings, digital image analysis may be suitable for the accurate recognition of cells with characteristic structures visible in HE-stained sections.

Key Words: Aortic Aneurysm, Image Analysis, Vascular Wall Inflammation, Cell Recognition, Deep Learning.