Chapter 14
Artificial Intelligence for the Identification of Endometrial Malignancies:
Application of the Learning Vector Quantizer

Abraham Pouliakis

National and Kapodistrian University of Athens, Greece

Niki Margari

National and Kapodistrian University of Athens, Greece

Effrosyni Karakitsou

University of Barcelona, Spain

Evangelia Alamanou

Tzaneio Hospital, Greece

Nikolaos Koureas

St. Savas Hospital, Greece

George Chrelias

National and Kapodistrian University of Athens, Greece

Vasileios Sioulas

National and Kapodistrian University of Athens, Greece

Asimakis Pappas

MHTERA Maternity Hospital, Greece

Charalambos Chrelias

National and Kapodistrian University of Athens, Greece

Emmanouil G Terzakis

St. Savas Hospital, Greece

Vasileia Damaskou

National and Kapodistrian University of Athens, Greece

Ioannis G Panayiotides

National and Kapodistrian University of Athens, Greece

Petros Karakitsos

National and Kapodistrian University of Athens, Greece

ABSTRACT

Aim of this article is to investigate the potential of Artificial Intelligence (AI) in the discrimination between benign and malignant endometrial nuclei and lesions. For this purpose, 416 histologically confirmed liquid-based cytological smears were collected and morphometric characteristics of cell nuclei were measured via image analysis. Then, 50% of the cases were used to train an AI system, specifically a learning vector quantization (LVQ) neural network. As a result, cell nuclei were classified as benign or malignant. Data from the remaining 50% of the cases were used to evaluate the AI system performance. By nucleic classification, an algorithm for the classification of individual patients was constructed, and performance indices on patient classification were calculated. The sensitivity for the classification of nuclei was 77.95%, and the specificity was 73.93%. For the classification of individual patients, the sensitivity was 90.70% and the specificity 82.79%. These results indicate that an AI system can have an important role in endometrial lesions classification.

INTRODUCTION

The endometrium is a human system with inherent complexity because it undergoes cyclic regeneration under estrogen effects during each menstrual cycle. These effects, as well as sex steroids, oncogene products, growth factors and various peptides (Murphy, Murphy, & Friesen, 1987; Shyamala & Ferenczy, 1981) may cause premalignant and malignant transformation of the endometrium. Early diagnosis is crucial because it is associated with patient management and therapy. However, and despite that in the last decades the incidence of endometrial cancer has increased (Jemal et al., 2006), there is still not a global and well-established screening method for the early detection of endometrial cancer. Moreover, there is no automated procedure.

Artificial Intelligence (AI) techniques are not new in medicine (Adams, Bello, & Dumancas, 2015; Darcy, Louie, & Roberts, 2016; Foran, Chen, & Yang, 2011; Grabe et al., 2010; Karakitsos et al., 1996; Luo et al., 2015; Seffens, Evans, Minority Health, & Taylor, 2015; Su, Xu, He, & Song, 2016). During the last decades, numerous applications have been reported; these involve the use of classical statistical models (Karakitsos et al., 2004), as well as more advanced techniques, such as neural networks. In the field of oncology related medical disciplines there are numerous efforts (Cruz & Wishart, 2006; Hassan, Ruusuvuori, Latonen, & Huttunen, 2015; Karakitsos et al., 1997; Kourou, Exarchos, Exarchos, Kara- mouzis, & Fotiadis, 2015; Pouliakis et al., 2016; Simões et al., 2014). However, the literature related to endometrial cytological material evaluation by AI and especially publications reporting the comparison of machine learning performance are rather poor.

In this article, a methodology aiming to classify endometrial lesions based on cell nuclei morphometry data will be presented. Initially, the morphometrical features and their biological relation will be described and then the construction of machine learning systems classifying individual nuclei will be outlined. Furthermore, according to the nuclei classification results, a second stage classifier aiming to categorize individual cases will be constructed. The validation of the results will be based on the histological result, which will be considered our gold standard. The applied Machine Learning Algorithm (MLA) was the Learning Vector Quantizer (LVQ) ANN and was selected because it has the capability to provide solutions by creating clusters. The applied classifier was compared with the performance of the cytological outcome.

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