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Advances in Artificial Intelligence (AI) Along With the Growing Digitization of Pathology

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Description

Breast cancer is the most common cancer and second leading cause of cancer-related death worldwide. The mainstay of breast cancer workup is histopathological diagnosis - which guides therapy and prognosis. However, emerging knowledge about the complex nature of cancer and the availability of tailored therapies has exposed opportunities for improvements in diagnostic precision. In parallel, advances in Artificial Intelligence (AI) along with the growing digitization of pathology slides for the primary diagnosis are a promising approach to meet the demand for more accurate detection, classification and prediction of behaviour of breast tumours. In this article, we cover the current and prospective uses of AI in digital pathology for breast cancer, review the basics of digital pathology and AI, and outline outstanding challenges in the field. Modern approaches to the treatment of breast cancer require careful diagnostic stratification of patients and prediction of survival for tailored therapy. This stratification is primarily based on manual interpretation of pathology slides a time-consuming process with significant interobserver variability .The trend towards digitization in pathology opens the door to computer-based image analysis solutions which have the potential to provide a more objective and quantitative slide reviews. Over the last several decades, due to algorithmic advances, more accessible computing power, and the curation of large datasets, machine learning techniques have come to define the state-of-the-art in many computer vision tasks - including many healthcare applications.

Improving the Efficiency of the Diagnostic Workflow

Concurrently, digital pathology has emerged as a method for imaging and handling high magnification images of pathology slides - initially for research purposes but increasingly as a clinical tool. Recently, these two fields have intersected as computer scientists and pathologists have come together to apply the latest Artificial Intelligence (AI) techniques to the problem of analysing pathology slides for diagnostic, prognostic, predictive and other clinically relevant purposes in addition to other applications such as improving the efficiency of the diagnostic workflow. Many problems in breast cancer pathology involve assessing morphological features of the tissue. However, this is often not straightforward and significant research has gone into improving reliability and reducing variability of the assessment .The reliability and variability problem has the potential to be solved efficiently with computational methods. Once trained, the algorithms always give consistent results when the same input data is provided. In this article, we explore AI applications in breast pathology. We start with an overview of digital pathology, a necessary prerequisite for the application of AI techniques. Then, we do a deep dive into the applications of machine learning to digital pathology for breast cancer, including both diagnostic and prognostic applications. Finally, we address outstanding challenges in the field and promising future directions.

Applications of AI in the Field Of Breast Pathology

Digital pathology is the process of transforming histopathology slides into digital images using whole-slide scanners and subsequent analysis of these digitized images. In 1966, Prewitt and Mendelsohn first proposed a method to scan images from a microscopic field of a blood smear and use these scanned images to discern the presence of different cell types. In the mid 1990's, advances in microscopic imaging and software systems for storing, serving, and viewing large images led to the development of Whole-Slide Imaging (WSI) techniques. These techniques allow an entire slide to be digitized and examined at a resolution comparable to light microscopy. Further developments in the following decades have brought digital pathology from a niche research topic to the edge of mainstream adoption in clinical practice. The widespread use of WSI technology for primary diagnosis of breast pathology will enable the adoption of AI-based tools. The applications of AI in the field of breast pathology is increasing and it is expected that will not only complement the work of breast pathologists, reduce their workload and improve their diagnostic accuracy but also provide information beyond that can be gain by eyeball assessment of morphological features with the potential to replace some of the expensive multigene assays to predict the outcome of breast cancer.