Heart, Vessels and Transplantation 2024; 8: 154-9
DOI: 10.24969/hvt.2024.467

Cardiac microanatomy: understanding fundamental histological features and functional significance in the heart

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Abstract

Cardiovascular diseases are a leading global cause of death. Coronary heart disease stands as the most prevalent, posing a significant global health challenge. The proper functioning of organs hinges on well-defined anatomical structures, making it imperative to comprehend the fundamental histological characteristics of the heart. In this manuscript, we explore microscopic features of acute myocardial infarction, post-myocardial infarction (post-MI), left ventricular hypertrophy, and fatty heart. The research, conducted ethically, utilized microscopic images captured at Uzhhorod National University, Ukraine. Specimen analyses revealed distinct histological changes associated with conditions such as intracellular lipid accumulation, myocardial hypertrophy, and acute myocardial infarction. This exploration serves as a valuable resource for students, researchers, and healthcare professionals seeking a deeper understanding of cardiac microanatomy, offering insights crucial for accurate diagnosis and management in cardiovascular healthcare.

Key words: Humans, cardiovascular diseases, global health, myocardial infarction, heart, vessels, microanatomy

(Heart Vessels Transplant 2024; 8: 154-9 doi: 10.24969/hvt.2024.467)

Introduction

Cardiovascular diseases are a leading cause of death globally. According to the World Health Organization (WHO), an estimated 17.9 million people die each year from cardiovascular diseases, representing 31% of all global deaths (1). In the tapestry of cardiovascular diseases, coronary heart disease (CHD) stands as the most prevalent form. Its insidious nature often lurks beneath the surface, stealthily compromising the heart's vital functions and paving the way for potentially devastating events such as heart attacks. As a leading cause of morbidity and mortality worldwide, CHD poses a significant global health challenge.

The proper functioning of organs relies on a well-defined anatomical structure. It is crucial to comprehend the fundamental histological characteristics of the heart to unravel the complexities associated with both its physiological processes and pathophysiological conditions (2, 3). As we embark on this journey through cardiac microanatomy, we aim to provide a valuable resource for students, researchers, and healthcare professionals seeking a deeper understanding of the heart's histological intricacies.

In this manuscript, we will explore microscopic features of the acute myocardial infarction (AMI), post-myocardial infarction (post-MI), left ventricular hypertrophy, and fatty heart.

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Received: 31.01.2024 **Accepted:** 31.01.2024

Methods

The research was conducted in accordance with Ethical Guidelines and was approved by the Local Bioethical Committee. Microscopic images of histological slides were captured using the Optika B-383PL 40x-1000x Trino microscope and a Delta Optical DLM-Cam Pro 3MP USB 3.0 digital video camera at the Department of Human Anatomy and Histology, within the Pathomorphology Course at Uzhhorod National University, Uzhhorod, Ukraine.

Results

Specimen 1. The first specimen is dedicated to the revealing of the intracellular lipid accumulation in cardiomyocytes, distorting their structure and disrupting myofibrillar architecture (Fig. 1). Additionally, interstitial lipid deposits, inflammation, fibrosis, vacuolation, impaired vascularization, and microvascular changes contribute to the pathology. Typically associated with individuals who have conditions such as obesity, metabolic syndrome, or diabetes.

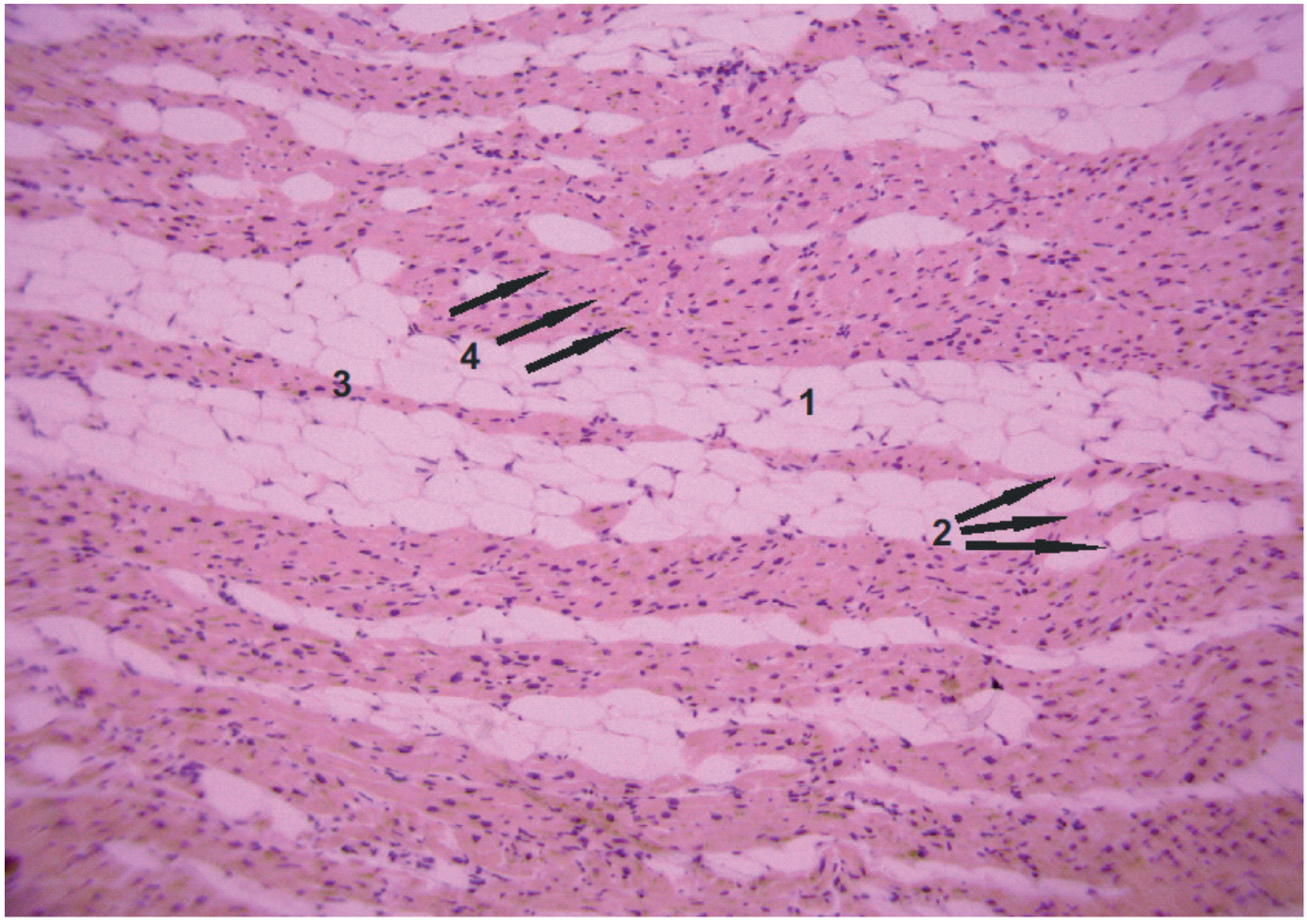

Figure 1. Photomicrograph of heart. H&E, x100

1.1. Determine histological structures in the micrograph of heart according to the given numbers:

a) changed direction of cardiac muscular fibers

b) adipose tissue between cardiomyocytes

c) deposition of lipofuscin pigment in cardiomyocytes

d) thinned and atrophied cardiomyocytes

1.2. What pathology of heart is represented in the histological image according to the determined pathological changes?

a) Myocardial hypertrophy

b) Postinfarction cardiosclerosis

c) Diffuse cardiosclerosis

d) Fatty heart

e) Myocardial steatosis

Specimen 2. The second specimen is characterized by enlarged cardiomyocytes (Fig. 2) with increased nuclear size, heightened myofibril density, and potential fibrosis. This condition is typical for individuals experiencing prolonged cardiac stressors, such as chronic hypertension or valvular heart disease.

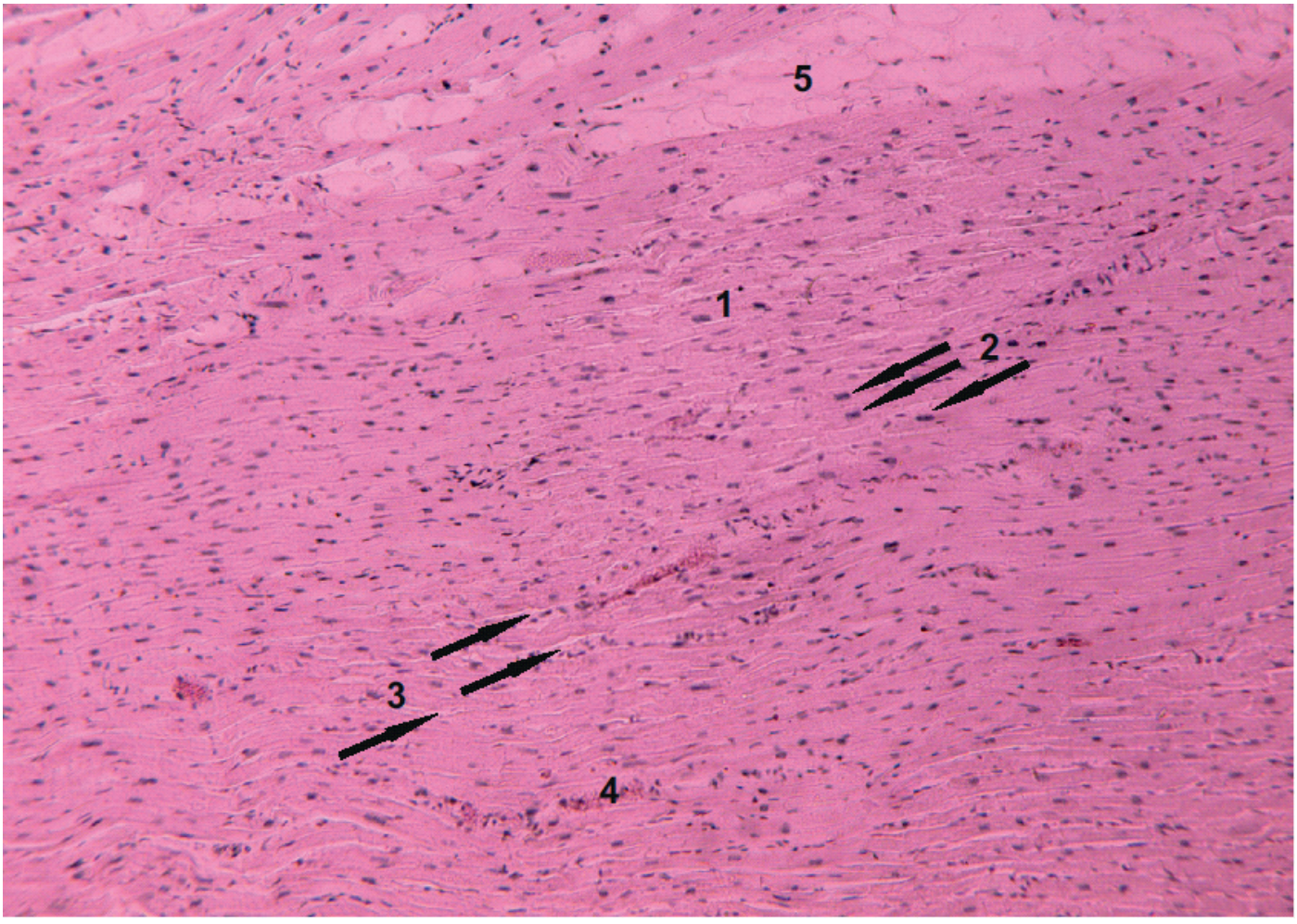

Figure 2. Photomicrograph of heart. H&E, x100

2.1. Determine histological structures in the micrograph of heart according to the given numbers:

a) increased volume of interstitial tissue between cardiomyocytes

b) enlarged cardiomyocytes

c) adipose tissue between cardiomyocytes

d) blood vessels in interstitial tissue of myocardium

e) enlarged hyperchromatic nuclei of cardiomyocytes

2.2. What pathology of heart is represented in the histological image according to the determined pathological changes?

a) Myocardial hypertrophy

b) Myocardial atrophy

c) Diffuse cardiosclerosis

d) Fatty heart

e) Acute myocardial infarction

Specimen 3. Histologically, the presented specimen is characterized by coagulative necrosis, an inflammatory response with neutrophil infiltration (early) and macrophage infiltration (later), loss of myocardial architecture, hemorrhage, and edema.

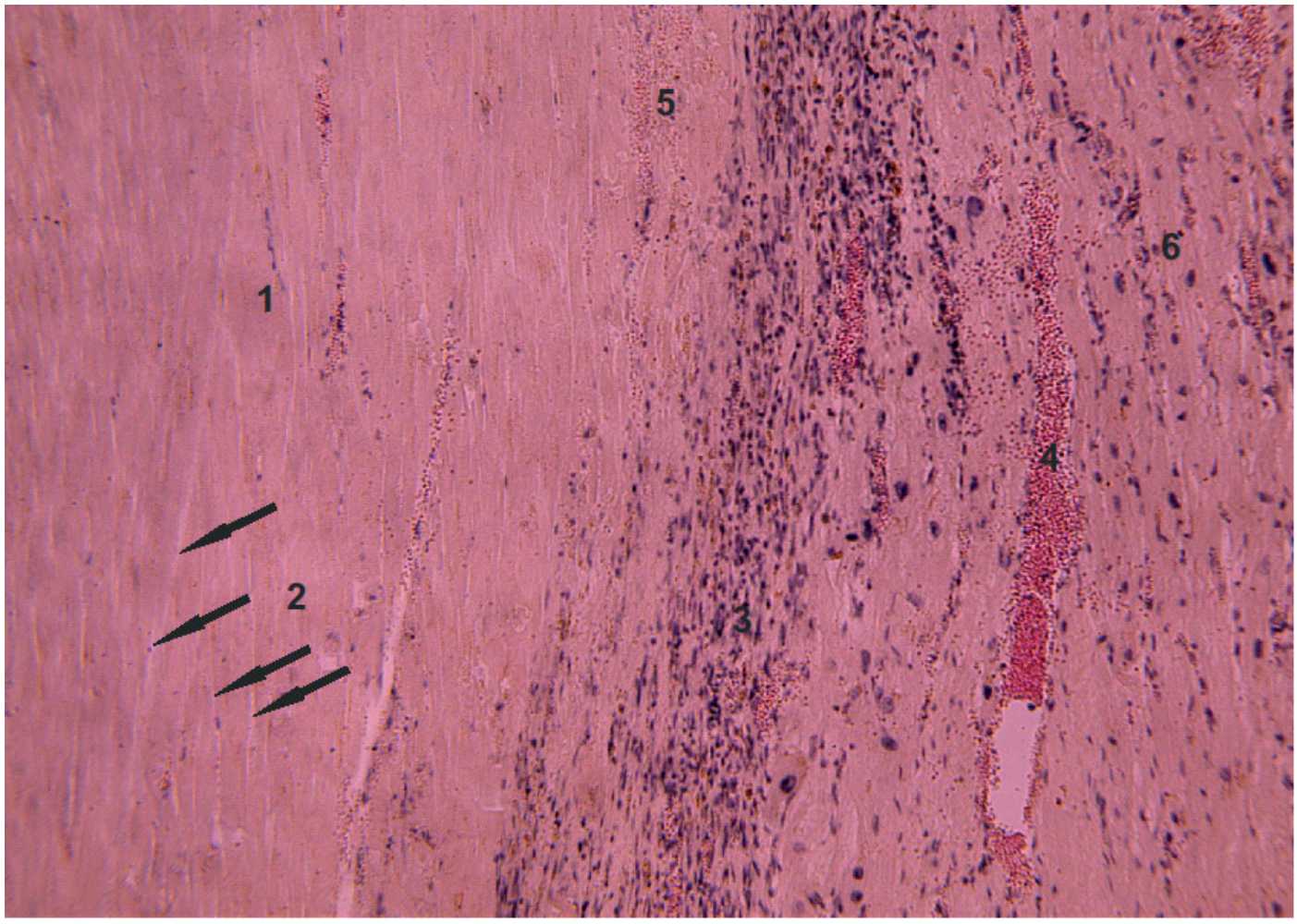

Figure 3. Photomicrograph of heart. H&E, x100

3.1. Identify morphological changes in the image of histological microslide:

a) inflammatory infiltrate in the myocardium

b) hemorrhages in the myocardial tissue

c) enlarged swollen hypereosinophilic cardiomyocytes with features of

kariolysis

d) hyperemia of small blood vessels

e) cardiomyocytes with typical histological structure

f) edema of the interstitial tissue of the myocardium

3.2. What pathological process is represented in the given image according to identified histological changes?

a)Acute myocarditis

b)Chronic myocarditis

c)Acute myocardial infarction

d)Postinfarction cardiosclerosis

e)Diffuse ischemic cardiosclerosis

Specimen 4. The last sample is a result from the previous pathology. In the healing phase, granulation tissue forms, eventually leading to scar formation. These changes are indicative of the ischemic damage and subsequent repair processes in the affected myocardial tissue.

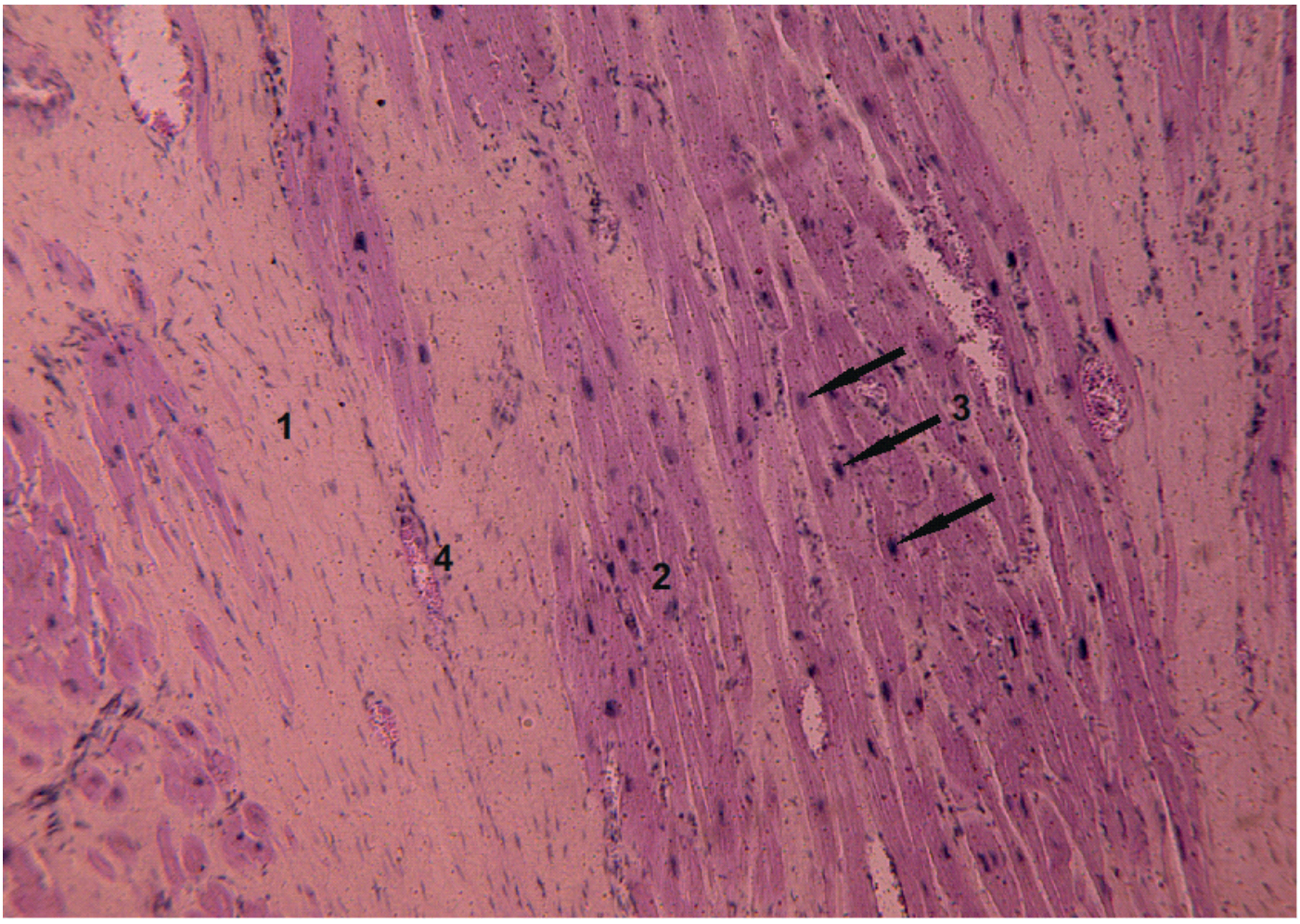

Figure 4. Photomicrograph of heart. H&E, x100

4.1. Determine histological structures in the image of microslide according to the given numbers:

a) enlarged hypertrophied cardiomyocytes

b) enlarged hyperchromatic nuclei of cardiomyocytes

c) well differentiated connective tissue

d) well differentiated vessels in the connective tissue

4.2. What pathology is represented in the histological image according to the determined pathological changes?

a) Acute myocardial infarction

b) Postinfarction cardiosclerosis

c) Diffuse cardiosclerosis

d) Myocardial atrophy

e) Myocardial hypertrophy

Discussion

In this exploration of cardiac microanatomy, we provided a comprehensive resource for students, researchers, and healthcare professionals seeking a deeper understanding of the heart's histological intricacies (4). Histologically, AMI is characterized by coagulative necrosis, inflammatory responses, and subsequent healing, crucial for accurate diagnosis. Post-MI analysis reveals granulation tissue formation and scar development, shedding light on tissue repair dynamics. Examination of left ventricular hypertrophy elucidates cellular adaptations to chronic cardiac stressors, including increased cell size and potential fibrosis. For fatty heart, or cardiac steatosis, histology showcases intracellular lipid accumulation, cellular enlargement, and potential fibrosis, offering insights into the impact of metabolic conditions.

In conclusion, this exploration contributes to the understanding of cardiac histology, serving as a valuable educational tool and providing insights for accurate diagnosis and management in healthcare practice.

Ethics: The research was conducted in accordance with Ethical Guidelines and was approved by the Local Bioethical Committee

Peer-review: Internal

Conflict of interest: None to declare

Authorship: U.P., T.H., I.K., M.P., and L.M.-V. collaboratively contributed to the preparation of the manuscript with equal efforts

Acknowledgement and Funding: None to declare

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