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Scanning electron microscopic study of the fibrous rings of the arterial orifices in embryos of the 7th and 8th weeks

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The arterial fibrous rings were investigated in human embryos aged 7 and 8 weeks under light and scanning electron microscopes. In the present study it was shown that the arrangement of collagen and formation of fibres changes rapidly within one week. In the 7th week there are no collagen fibres and the netlike fibrils extend between processes of fibroblasts. At the end of the 8th week the collagen fibres are formed and they have different arrangements in the particular layers of the fibrous rings. (Folia Morphol 2010; 69, 3: 180–183)

Key words: human embryology, heart, arterial fibrous rings, scanning electron microscope

INTRODUCTION

Early in the development of the heart, the single heart tube consists of the inner and outer tubes, the endocardium, and myocardium, respectively, which are separated by an extracellular matrix secreted by the myocardial cells and termed cardiac jelly. This extracellular matrix promotes the tubular lumen during contraction and acts as a site for the deposition of inductive factors from the myocardial cells which can modify the differentiation of specific endocardial cells [1]. The cardiac extracellular matrix contains: a) structural proteins (collagen and elastin), b) cell adhesive molecules (fibronectin and laminin), and c) proteoglycans [4]. This extracellular matrix of the heart plays an important role in growth and development. The role of the extracellular matrix in heart development includes signalling necessary for cell migration, cell sorting, adhesion, differentiation, angiogenesis, and valve formation [3–5]. During early embryogenesis, collagen is detected in the atrioventricular region, which is associated with the formation of valves.

Alteration of collagen results in changes in the myocardial mechanical properties and ventricular function [8]. Cardiac collagen plays a vital role in the maintenance of myofibrillogenesis [6]. The aim of the present study is to describe the arrangement of collagen fibres in the outflow tract of human embryos aged 7 and 8 weeks.

MATERIAL AND METHODS

Investigations were performed on 7 embryos of developmental stages 19 and 23 (age 46 and 56 post-ovulatory days) from the Collection of the Department of Anatomy in Poznań. All embryos were embedded in toto in paraplast, and serial sections in horizontal and sagittal planes were made (Table 1). Five embryos were intended for histological study. Sections of these embryos were stained with haematoxylin and eosin and with cresyl violet according to Nissl. Sections of two embryos were inspected under scanning electron microscope (SEM). Sections were rinsed in 96% alcohol, and after drying at room temperature (20–25 degrees) all sections

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Table 1. Developmental stage, age, and plane of section of investigated embryos

Catalogue No.	Developmental stage	Age in postovulatory days	Plane of section
B288	19	51	Horizontal
B123	19	46	Horizontal
Bł1	20	49	Sagittal
Z9	21	51	Horizontal
Z3	22	53	Horizontal
Bł9	23	56	Horizontal
B293	23	56	Sagittal

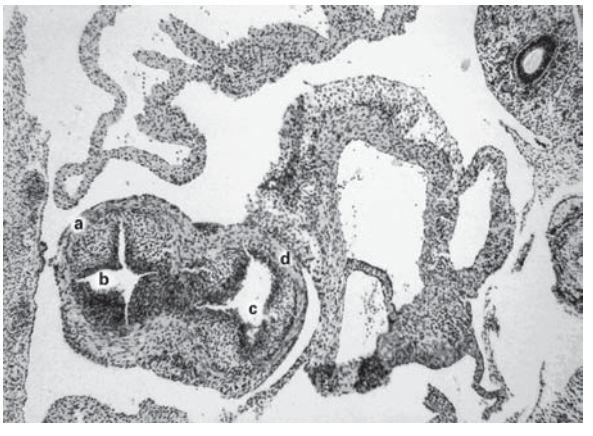

Figure 1. Horizontal section of an embryo at stage 19; H+E; × 40; a — annulus fibrous of the aorta, b — lumen of the aorta, c — lumen of the pulmonary trunk, d — annulus fibrous of the pulmonary trunk.

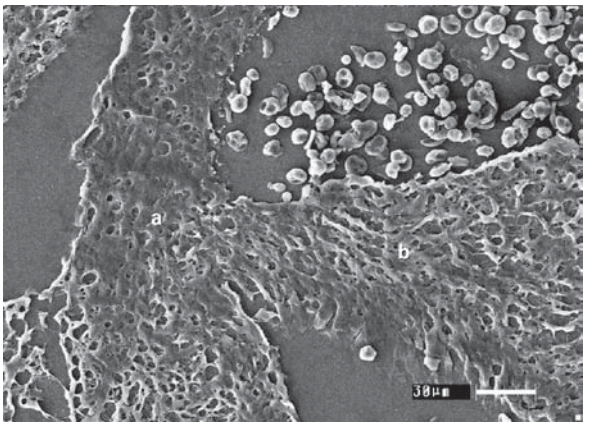

Figure 2. Horizontal section of an embryo at stage 19. Valve of the aorta; SEM; a — annulus fibrous of the aorta, b — cusp of the aorta.

were coated with a 15 μm layer of gold and examined under SEM Zeiss 435 VP at an accelerating voltage of 15 KV.

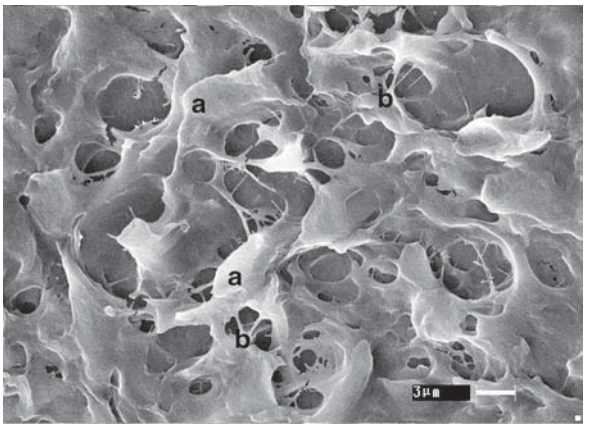

Figure 3. Horizontal section of an embryo at stage 19. Part of annulus fibrous of aorta; SEM; a — fibroblast, b — network of collagen fibrils.

RESULTS

In embryos at stage 19 (46 postovulatory days) the arterial valves develop in the lower part of the conotruncal septum. Cells from this septum contribute to the formation of the valves (Fig. 1). The fibrous rings contain on their periphery concentrically arranged connective tissue fibres. Collagen fibres in the rings are arranged in the form of loose, netlike structures with many fibroblasts (Figs. 2, 3). Collagen fibrils extend between the processes of the fibroblasts (Fig. 4). The collagen fibrils are thin, elongated structures of variable diameter. They pass in various directions and surround the fibroblasts and myocytes. In the last week of embryonic development the fibrous rings are more compact annuli (Fig. 5). Under the SEM these rings consists of three layers. The outer and inner layers have a loose arrangement. The middle layer is formed of densely packed collagen fibres which are built of collagen fibrils (Figs. 6, 7).

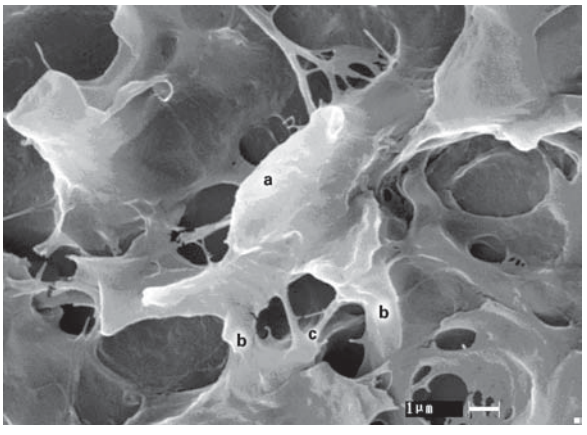

Figure 4. Horizontal section of an embryo at stage 19; Part of valve of the aorta; SEM; a — fibroblast, b — process of the fibroblast, c — collagen fibrils.

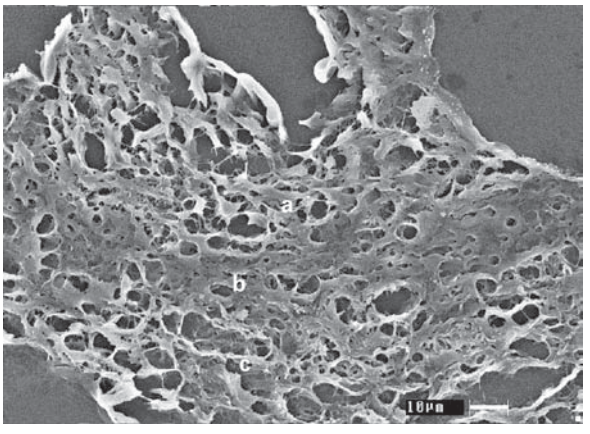

Figure 6. Horizontal section of an embryo at stage 23; Valve of pulmonary trunk; SEM; layers of annulus fibrous; a — inner layer, b — middle layer, c — outer layer.

Figure 5. Sagittal section of an embryo at stage 23; H+E; × 100; a — ductus arteriosus, b — aorta, c — valve of pulmonary trunk, d — left ventricle, e — mitral valve, f — left fibrous trigone.

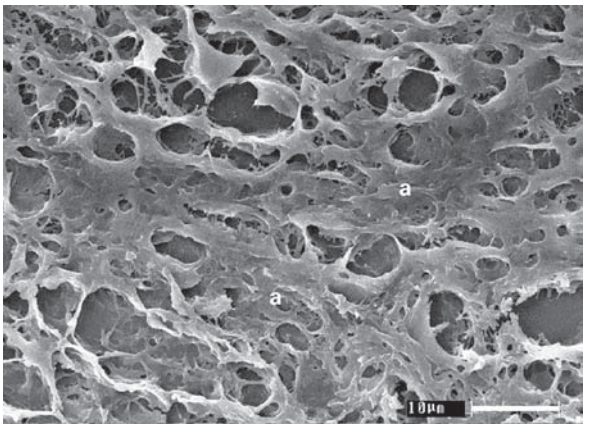

Figure 7. Horizontal section of an embryo at stage 23; Valve of pulmonary trunk; SEM; a — bands of collagen fibres.

DISCUSSION

In the adult myocardium there are at least five collagen isoforms. The most abundant forms of collagen are collagen types I and III, which represent more than 90% of all collagen fibres in the myocardium [2, 8–12]. During development, collagen types I and III are present in the valvular regions.

Collagen fibres of the heart have been divided into epimysial, perimysial and endomysial components [7]. Modifications of the collagenous architecture change during development and in heart disease. The main sources of collagen synthesis are cardiac fibroblasts, which form the largest group among cardiac nonmyocyte cells.

In the present study it was shown that the arrangement of collagen and the formation of fibres changes rapidly within one week. In the 7th week there are no collagen fibres and the netlike fibrils extend between processes of fibroblasts. At the end of the 8th week the collagen fibres are formed and they have different arrangements in the particular layers of the fibrous rings.

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