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A histological study of human ductus arteriosus during the last embryonic week

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It was found that the ductus arteriosus is a muscular channel and resembles the muscular artery in structure. The diameter of the ductus is equal throughout its length. At the orifice of the ductus to the aorta the cells of its wall blend with those of the aorta. The primordia of the tunica media of the aorta and the pulmonary trunk consist of regularly arranged, circular layers which are more evident than the layers forming the wall of the dutcus arteriosus.

key words: human embryonic heart, ductus arteriosus, great vessels

INTRODUCTION

The ductus arteriosus develops as a continuation of the pulmonary trunk from the distal part of the 6th left aortic arch and it terminates in the dorsal aorta. It has been found in the mouse that the expression of Hox b5 in the neural crest along the 6th aortic arch may elucidate the differentiation of the ductus [9].

The anatomical structure of the ductus arteriosus has been studied mainly in the second half of the foetal period and in neonates [1, 2, 4, 5, 11]. These morphological studies were performed in human and animals in order to describe changes in the wall of the ductus in the process of its obliteration [1, 2, 6, 8, 14].

Some histological and ultrastructural investigations have been performed in the human foetal period [3, 12, 13].

The aim of the present study is to investigate the histological structure of the human ductus arteriosus during the last week of the embryonic period and to compare this structure with that of the aorta and the pulmonary trunk.

MATERIAL AND METHODS

The study was performed in 10 human embryos from the Collection of the Department of Anatomy in Poznań. The age of the embryos was established according to 23 developmental stages and expressed in postovulatory days. All embryos of developmental stages 21 to 23 (51–56 days of age) were embedded in toto in paraplast and serially sectioned in frontal, horizontal, and sagittal planes. Sections 5 mm in thickness were stained with haematoxylin and eosin, with cresyl violet according to Nissl's method, and impregnated with silver salts. Graphic reconstructions were made for some of the embryos.

RESULTS

The ductus arteriosus, being a continuation of the pulmonary trunk, extends between the point where the pulmonary artery is given off and the dorsal aorta (Fig. 1). It is a wide, short channel and the structure of its wall resembles that of the aorta and pulmonary trunk. The diameter of the ductus arteriosus is equal in its whole length. The ductal wall consists of endothelium and several circular layers of cells forming the primordium of the tunica media (Fig. 2). The endothelial cells are oval, darkly stained and have the same appearance as those of the great arteries (Figs. 3–5). The layers of the tunica media are not clearly demarcated and consist of oval cells embedded in extracellular matrix (Fig. 4). The future tunica media of the aorta and pulmonary trunk is

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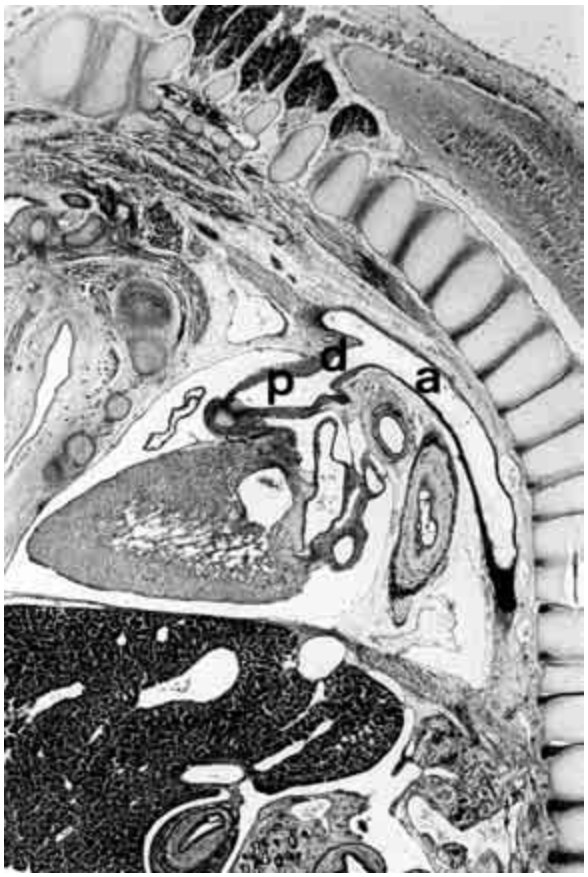

Figure 1. Sagittal section of a human embryo at stage 21. Impregnation with Bodian's protargol, × 16; a — aorta, d — ductus arteriosus, p — pulmonary trunk.

Figure 2. Transverse section of human embryo at stage 23. H+E, × 80; a — aorta, d — ductus arteriosus, e — oesophagus, p — pulmonary trunk, t — bifurcation of trachea.

a little thicker and their concentric lamellae are more closely arranged more regular compared with those of the ductus arteriosus (Fig. 3, 5). At the orifice of the ductus into the aorta the cells forming the tunica media blend with the tunica media of the aorta (Fig. 2).

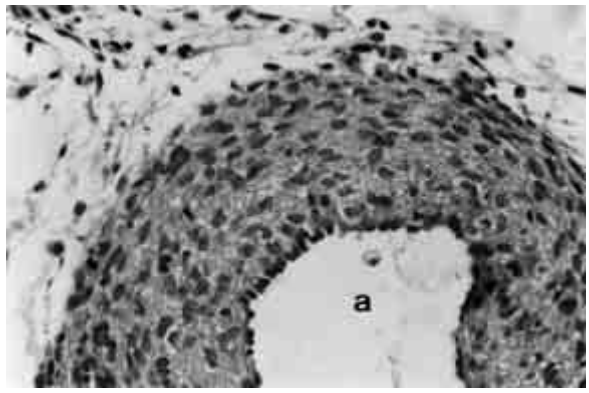

Figure 3. Transverse section of human embryo at stage 23. H+E, × 400; a — aorta.

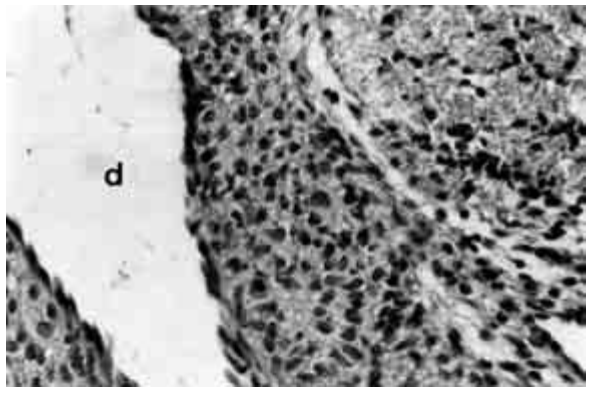

Figure 4. Transverse section of human embryo at stage 23. H+E, × 400; d — ductus arteriosus.

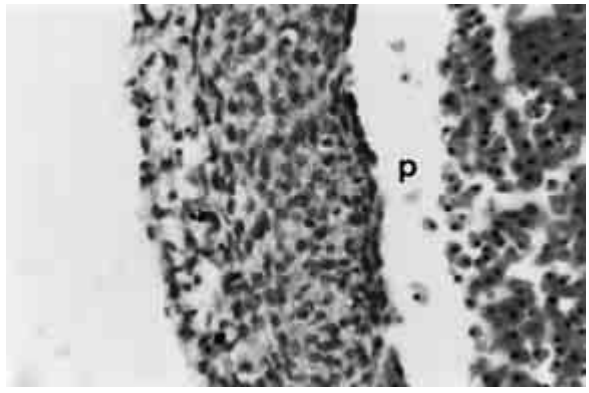

Figure 5. Transverse section of the wall of pulmonary trunk at stage 21. H+E, × 400; p — pulmonary trunk.

DISCUSSION

During foetal life oxygenated blood from the placenta returns via the umbilical vein to the inferior vena cava, passing through either the ductus venosus or the hepatic microcirculation. Most right ven-

tricular blood bypasses the lungs through the ductus arteriosus to the aorta, allowing each ventricle to contribute to the systemic blood flow [7]. Thus the ductus arteriosus is the exercising channel of the right ventricle, as it makes it possible for that ventricle to carry its full share of work.

Gittenberger-de Groot et al. [4, 5] investigated the ductus arteriosus in human foetuses and preterm infants ranging in age from 16 to 37 weeks. They distinguished 4 morphological maturation stages. At Stage I (4 to 5 month-old foetuses) the internal elastic lamina may be single or locally duplicated. The intima consists of a very thin layer of endothelial cells.

In the present study it was shown that the intimal layer is thick and it is composed of darkly stained cells which have the same appearance as those of large vessels.

Rabinovitch et al. [10] demonstrated that vascular cells harvested from the foetal lamb ductus arteriosus, aorta and the pulmonary artery maintained similar phenotypic properties during early passage in culture.

From our study it may be concluded that the ductus arteriosus in early human intra-uterine development has a structure similar to that of the large arteries. However, it is evident that even in this early period of development, slight structural differences in the ductal wall may be observed.

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