

Anatomical, histochemical and immunohistochemical characterization of the outflow tract of ray hearts (Rajiformes; Chondrichthyes)

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Recent work has shown that the cardiac outflow tract of sharks and chimaeras does not consist of a single myocardial component, the conus arteriosus, as classically accepted, but two, namely, the myocardial conus arteriosus and the non-myocardial bulbus arteriosus. However, the anatomical composition of the outflow tract of the batoid hearts remains unknown. The present study was designed to fill this gap. The material examined consisted of hearts of two species of rays, namely, the Mediterranean starry ray (*Raja asterias*) and sandy ray (*Leucoraja circularis*). They were studied using scanning electron microscopy, and histochemical and immunohistochemical techniques. In both species, the outflow tract consists of two components, proximal and distal with regard to the ventricle. The proximal component is the conus arteriosus; it is characterized by the presence of compact myocardium in its wall and several transverse rows of pocket-shaped valves at its luminal side. Each valve consists of a leaflet and its supporting sinus. Histologically, the leaflet has two fibrosas, inner and outer, and a middle coat, the spongiosa. The distal component lacks myocardium. Its wall consists of smooth muscle cells, elastic fibers and collagen. Thus, it shows an arterial-like structure. However, it differs from the aorta because it is covered by the epicardium and crossed by coronary arteries. These findings indicate that the distal component is morphologically equivalent to the bulbus arteriosus of sharks and chimaeras. In contrast to foregoing descriptions, the valves of the first transverse row are distally anchored to the bulbus arteriosus and not to the ventral aorta. Our findings give added support to the notion that presence of a bulbus arteriosus at the arterial pole of the heart is common to all chondrichthyans, and not an apomorphy of actinopterygians as classically thought.

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