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Hearts and Bones – The Heart Skeleton of the Otter (*Lutra lutra*)

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Key words: Otter, *Lutra lutra*, heart skeleton, cartilage, *Os cordis*

Schlüsselwörter: Fischotter, *Lutra lutra*, Knorpel, *Os cordis*

Summary

The heart skeleton of many species contains fibrous connective tissue, cartilage and in larger animals like cattle, sheep, goat and pig even bone. It serves to stabilize the heart during contraction and relaxation, especially to act against deformation of the aorta. We studied 30 otter hearts histologically and found that the cardiac skeleton contained fibrous connective tissue, pieces of fibrous and hyaline cartilage, calcified cartilage and bones with bone marrow cavities containing red or even white bone marrow. Further more, radiographs were made on intact hearts showing the exact position of small ossified pieces in the Atrio-Ventricular (AV) plane. In two cases bony structures could be gained by macerating heart muscle tissue. The development of bony structures in the heart skeleton of the otter was not sex, but age dependent, which seems to be a sign of a high load of mechanical forces in the AV plane. One reason may be the truncated cone-like form of the otter heart.

Zusammenfassung

Das Herzskelett vieler Arten weist straffes Bindegewebe, Knorpel- und bei größeren Tieren, wie Rind, Schaf, Ziege und Schwein, sogar Knochensubstanz auf. Diese Stützelemente stützen es bei Kontraktion und Dilatation und sie wirken insbesondere einer Deformation der Aorta entgegen. Die histologische Untersuchung von 30 Otterherzen (*Lutra lutra*) zeigt eine Zusammensetzung des Herzskeletts aus Bindegewebe, Faser- und hyalinen Knorpel-elementen, verkalkten Knorpel-elementen und Knochen mit rotem oder sogar weissem Knochenmark zusammen. Weiters wurden Röntgenbilder von intakten Herzen angefertigt, die die genaue Position von kleinen Verknöcherungen in der Atrio-Ventricular-Ebene (AV) zeigten. Bei zwei Ottern konnten durch Mazeration des Herzmuskels verknöcherte Elemente freipräpariert werden. Die Ausbildung der knöchernen Strukturen im

Herzmuskel war nicht geschlechts- aber altersabhängig. Letzteres kann als Folge starker mechanischer Belastung in der AV- Ebene interpretiert werden. Ein Grund dafür könnte die Kegelstumpf-Form des Otterherzens sein.

1. Introduction

The heart skeleton of many species contains fibrous connective tissue, cartilage and in larger animals like cattle, sheep, goat and pig even bone (NICHEL et al. 1984). It serves to stabilize the heart during contraction and relaxation, especially to act against deformation of the aorta. Pieces of cartilage were found in single otter hearts (ZOGALL 1992). In the only other examination of mustelid hearts (*Meles meles* L. and *Zorilla striata* Shaw.) known from the literature, no cardiac cartilage was found by palpation (SIMIC 1938). Therefore, we studied the fibrous skeleton of the otter heart in order to establish cartilage or bone as a regular constituent.

2. Materials and Methods

Otter hearts were provided by S. Hauer, Institute of Zoology, Martin Luther University, Halle/Saale (Germany), A.B. Madsen, Department of Landscape Ecology, Roende (Denmark), A. Gutleb, Institute of Medical Chemistry, University of Veterinary Medicine Vienna, Austria, Alpenzoo Innsbruck, Austria, and WWF Austria. We studied 30 otter hearts, three from juvenile (up to one year), nine from subadult (>1 to ≤ 2 years) and 13 from adult (> 2 years) animals. The age of 5 animals could not be determined. Radiographs were taken before the organ was dissected transversely. For histologic examination, hearts were fixed in 4% buffered formalin, embedded in paraffin and serially sectioned. In two cases bony structures were gained by macerating heart muscle tissue.

3. Results

Radiographs made from intact hearts showed the exact position of a varying number of small ossified pieces (arrows) in the atrioventricular plane. Such pieces of bones were found mainly in the area between the aorta and the left and right atrium respectively (see marked area in the schematic drawing). Histologically, we found that the cardiac skeleton contained fibrous connective tissue, and continuous stages of fibrous and hyaline cartilage development (beginning cartilage formation Fig. D 1, pieces of hyaline cartilage Fig. 2), calcified cartilage and bones with bone marrow cavities containing red (Fig. 3) or even white bone marrow (Fig. 4). All micrographs show histological sections stained with Safranin O.

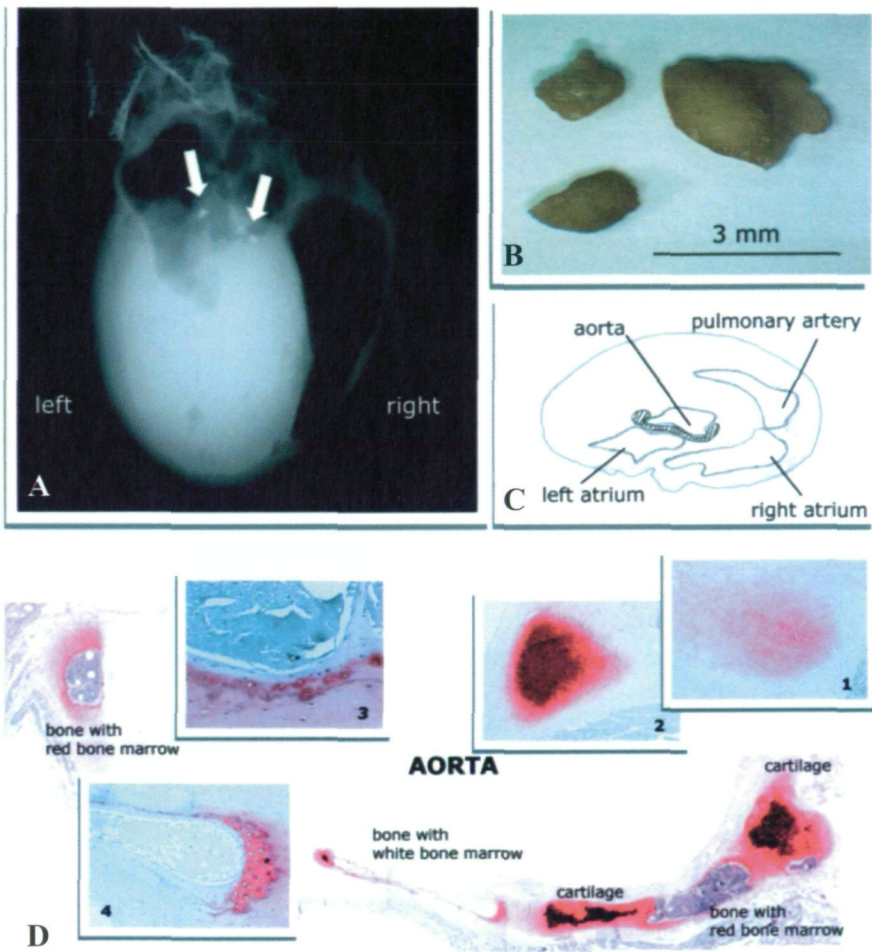


Figure legend

A: Radiograph of an adult otter heart, laterolateral direction, 3 pieces of bones are readily visible (arrows)

B: Macerated bones of an otter heart (adult, 13 years)

C: Schematic drawing of a section through the atrioventricular plane of an otter heart. Pieces of cartilage and bone varying in number and size were found exclusively within the marked area

D: Reconstruction of the fibrous skeleton in an adult otter heart showing cartilage and bony fragments. Inserted pictures:

1) beginning cartilage formation, 2) hyaline cartilage, 3) bone with red and 4) bone with white bone marrow. Safranin O staining

4. Discussion

Our findings represent the first description of bones in the heart skeleton of a relatively small animal. The development of these structures in the otter was not sex, but age dependent, indicating that not the size of the heart but the given mechanical stress is of prime importance. One reason for the high stress load in the AV-plane may be the truncated cone-like form of the otter heart. Pieces of bones found in the otter heart differed in number and size and did therefore not correspond to the *os cordis* described in large domestic animals.

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