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Renewed interest in porcine and horse heart and pulmonary vein anatomy in an experimental model for atrial fibrillation treatment

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Introduction

Atrial fibrillation is the most common cardiac arrhythmia diagnosed in man. It is frequently initiated by multiple scattered triggering foci located in the myocardial sleeves extending into the pulmonary vein walls. Currently, the efficacy and risks of catheter ablation as an ultimate treatment option for the most obstinate forms of atrial fibrillation are actively debated. As a result, alternative approaches such as the intraluminal implantation of expandable ablation devices are under investigation. However, the search for more efficient and safer ablation techniques is hampered by a lack of in-depth data on the fine anatomical architecture of the pulmonary veins in any experimental animal model considered. In the current investigation, pigs were chosen as animal model. As apart from humans, horses are also prone to develop atrial fibrillation. Therefore the present study was extended towards this species as well.

Objectives

- To evaluate the presence and pattern of the myocardial sleeve in pulmonary veins of horses histologically. (Fig. 3, 4)
- To map the pulmonary vein topography and variability in pigs and horses by anatomical dissection and silicon casts, which provide a better overview. (Fig. 2, 5, 6)
- To measure the stretch tolerance of the pulmonary vein orifices in pigs by a biomechanical stretch test. (Fig. 1, 7, 8, 9)

Fig. 1 To analyse the stretch tolerance of the pulmonary vein of pigs, as a prerequisite for using expandable intraluminal ablation devices, pulmonary vein tissue, taken at the level of ostium II, was stretched to various lengths.

Results

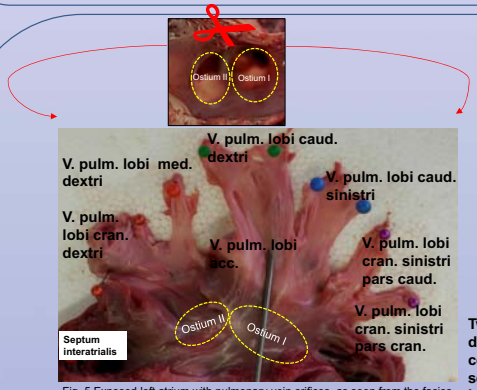


Fig. 5 Exposed left atrium with pulmonary vein orifices, as seen from the facies auricularis of the heart of a pig. The interatrial septum is located in the lower left corner of the image. The v. pulmonalis lobi accessoria is pointed with the probe.

Fig. 6 Exposed left atrium with the pulmonary veins ostia, as seen from the left ventricle of the heart of a horse. The interatrial septum is located at the right side of the image.

Two ostia (I, II) drain the different lung lobes. This constant pattern was seen in all pigs. Ostium II is used for stent placing because of fewer small branches and less variation

More variation in the branching pattern and in the amount of ostia was observed in horses

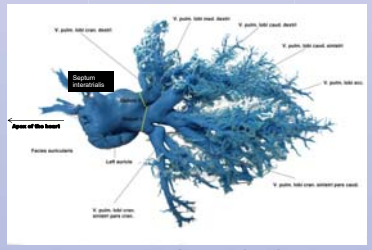


Fig. 2 Silicon cast of the left atrium, as seen from the facies auricularis of the heart, of a pig, with two ostia (I, II) draining the pulmonary veins (right side of the image).

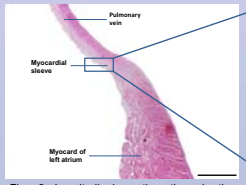


Fig. 3 Longitudinal section through the junction of the pulmonary vein and the left atrium, HE staining, horse. Bar: 1mm

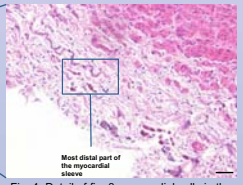


Fig. 4 Detail of fig. 3, myocardial cells in the pulmonary vein, most distal from the left atrium, HE staining, horse. Bar: 50 µm

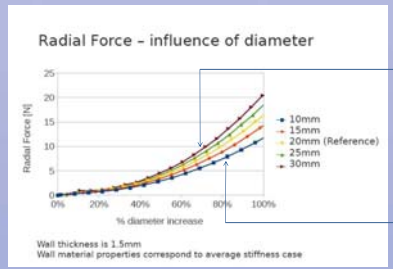
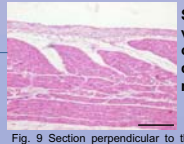


Fig. 7 Determination of the radial force needed to achieve a certain increase in diameter of pulmonary veins. Veins of different diameters were used (10-30mm Ø), FeOps

Stretching up till 170% of the original diameter caused no apparent histological damage in any of the samples

Fig. 8 Section perpendicular to the applied forces (fig. 1), at the level of ostium II, draining the V. pulmonalis lobi cranialis dextri and lobi medialis dextri, top of the image is endocard, underneath lie myocardial fibers, HE staining, pig. Bar: 200 µm



Stretching the pulmonary vein orifices from 180% onwards, myocardial damage could be detected microscopically

Fig. 9 Section perpendicular to the applied forces (fig. 1), at the level of ostium II, top of the image is endocard, underneath lie myocardial fibers, HE staining, pig. Bar: 200 µm

Conclusion

These results provide fundamental data essential for the further development and in vitro and in vivo testing of a new surgical technique in the treatment of atrial fibrillation in humans and horses.

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