DOI:

Surgical treatment of primary cardiac tumors: 20-year single center experience

Online supplementary material

Morphology of primary cardiac tumors encountered in our cohort

Myxoma

Myxoma is benign and the most common primary cardiac tumor. Although the detailed etiology and pathogenesis remain unclear, they are supposed to emerge from multipotent subendocardial cells [1].

Familial cardiac myxomas (about 10 % of all myxomas) usually involve multiple sites (heart, skin, breast), harboring a mutation of the gene for cyclic AMP-dependent protein kinase (PRKAR1A) [2].

Cardiac myxomas typically arise in the left atrium near the valve of fossa ovalis. The second most common site is the right atrium, where they groom from the interatrial septum. Ventricular myxomas are rare [1].

Grossly, myxomas can reach up to 10 centimeters, but they are usually about 4–6 mm. The appearance of myxomas is variable – they can be pedunculated or less commonly sessile with a smooth (Supplementary Figure S1), lobulated, or papillary surface, frequently with superficial thrombosis. Papillary myxomas (Supplementary Figure S2) are friable and tend to embolize [1].

Microscopically, the diagnosis is based on the identification of so-called myxoma cells (or lepidic cells) which are set in a myoxid background containing acid glycosaminoglycans. Myxoma cells can be dispersed, form adenomatoid structures or encircle blood vessels (Supplementary Figure S3). Immunohistochemically, myxoma cells express calretinin (75%), S100 (60–85%), CD34 (65%), and NSE – neuron-specific enolase (50%). Secondary changes are frequently found including bleeding of variable age (posthaemorrhagic changes comprise the presence of siderophages and Gamna-Gandy bodies) (Supplementary Figure S4), chronic inflammatory infiltrates (Supplementary Figure S5), fibrosis (Supplementary Figure S6), dystrophic calcification, and bony metaplasia (Supplementary Figure S7) [2].

Papillary fibroelastoma

The pathogenesis of papillary fibroelastoma remains unclear. Theories suggest a reactive, hamartomatous, neoplastic, or even congenital origin. They usually arise on aortic or mitral valve, seldom on tricuspid and pulmonary valve [2].

Grossly, papillary fibroelastomas, sized around 10 mm, are composed of numerous slender papillary fronds, and are pedunculated with identifiable stalk. Their appearance differs in air and liquid. In the air, they appear rather solid, drooping, and mucoid, that is why they could be macroscopically mistaken for myxoma. After submerging them in liquid, they "come into bloom" and resemble sea anemone (Supplementary Figure S8) [1].

Microscopically, papillary fibroelastoma consists of avascular collagenous fronds with characteristic tangles of elastic fibers, which can be visualized by applying special stains. The fronds are covered with a layer of endothelial cells (Supplementary Figure S9). Histologically, papillary fibroelastomas are similar to Lambl excrescences but tend to be larger and have complex architecture [2].

Lipoma

Cardiac lipoma is a rare benign mesenchymal tumor composed of lobulated mature adipocytic tissue, arising in the epicardium or beneath the endocardium [3]. In our case, we encountered a small pedunculated epicardial lipoma with secondary regressive changes. A thick fibrous capsule was formed around necrotic adipocytes, probably due to coiling around the stalk (Supplementary Figures S10 and S11).

Sarcoma

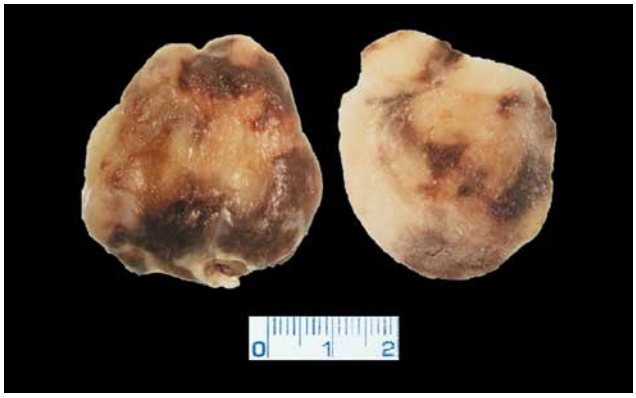
The only representative of cardiac malignancy from our cohort was undifferentiated sarcoma. Primary cardiac sarcoma is a malignant mesenchymal neoplasm with diverse differentiation. The sarcomas tend to occur in atria and are rare. The spectrum includes angiosarcoma, leiomyosarcoma, liposarcoma, synovial sarcoma, and newly recognized intimal sarcoma [2, 4]. Immunohistochemistry and genetic analysis are helpful and routinely use ancillary tests for differential diagnosis of cardiac sarcomas. In cases when the sarcoma is pleiomorphic, it does not show any signs of differentiation even after applying ancillary testing. The sarcoma is then classified as undifferentiated [1, 2].

Grossly, cardiac sarcomas grow in a sessile or pedunculated fashion, tend to be firm with invasive growth into surrounding tissues (Supplementary Figure S12).

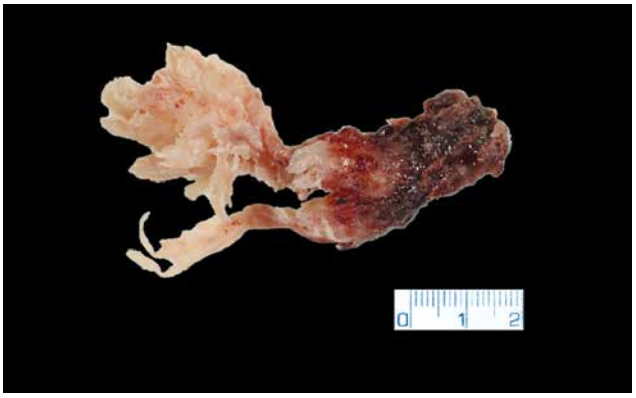
Microscopically, the picture depends on the type of sarcoma. In our case we dealt with pleiomorphic spindled and stellate cells with marked nuclear atypia, the cells were set in the sparse extracellular background (Supplementary Figure S13). The immunohistochemical examination did not show any specific line of differentiation, genetic analysis was not applied.

References

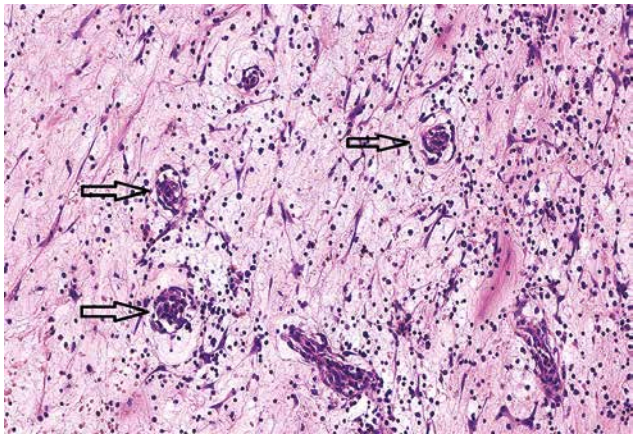
1. Steiner I. Kardiopatologie pro patology i kardiology (1st edition). Galen, Prague 2010; 111-8.
2. Miller DV, Revelo MP. Diagnostic Pathology: Cardiovascular (2nd edition). Elsevier 2018; 147-85.
3. Matejkova A, Fabian O. Differential diagnosis of heart tumours. Cesk Patol 2020; 51: 18-25.
4. Neuville A, Collin F, Bruneval P, Parrens M, Thivolet F, Gomez-Brouchet A, Terrier P, de Montpreville VT, Le Gall F, Hostein I, Lagarde P, Chibon F, Coindre JM. Intimal sarcoma is the most frequent primary cardiac sarcoma. Am J Surg Pathol 2014; 38: 461-9.



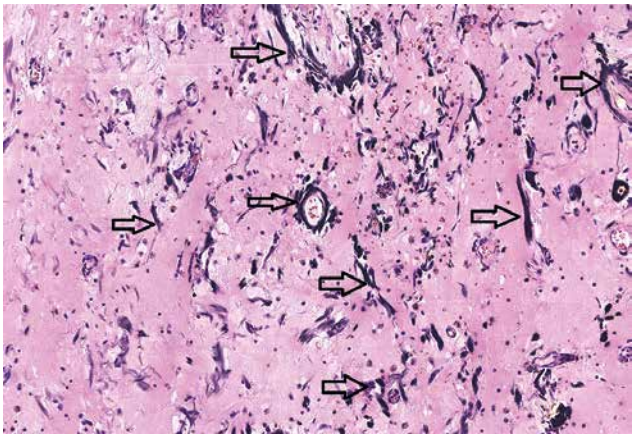
Supplementary Figure S1. Myxoma with a round and smooth surface



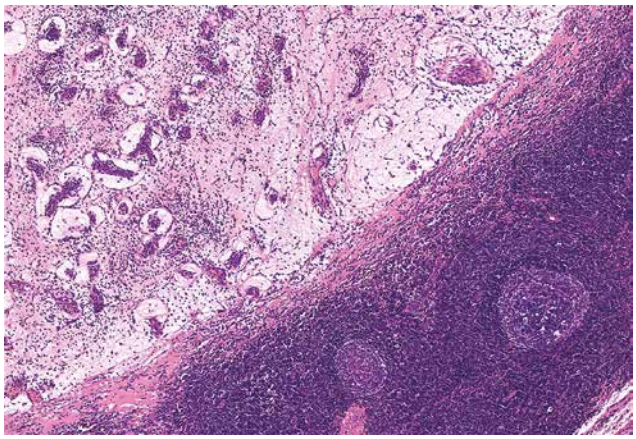
Supplementary Figure S2. Myxoma with a friable papillary surface



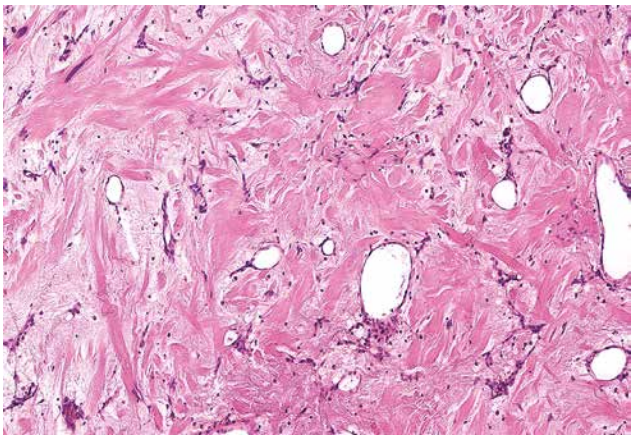
Supplementary Figure S3. Myxoma cells in myxoid background, some of them forming annular formation around vessels (arrows) (HE, 100×)



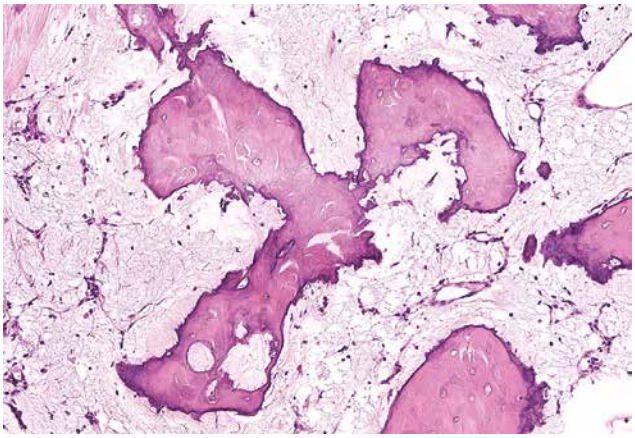
Supplementary Figure S4. Secondary changes in myxomas – posthaemorrhagic (Gamna-Gandy bodies) (HE, 100×)



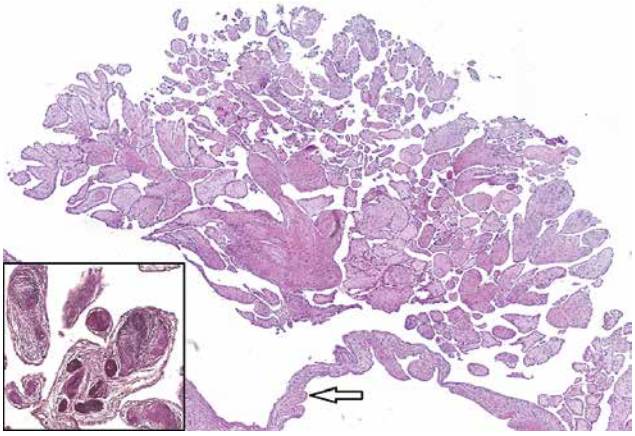
Supplementary Figure S5. Secondary changes in myxomas – chronic inflammatory infiltrate (HE, 50×)



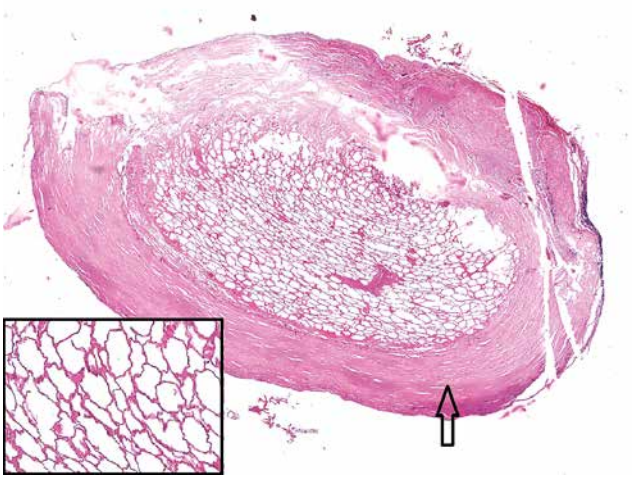
Supplementary Figure S6. Secondary changes in myxomas – fibrosis (HE, 120×)



Supplementary Figure S7. Secondary changes in myxomas – bony metaplasia (HE, 50×)



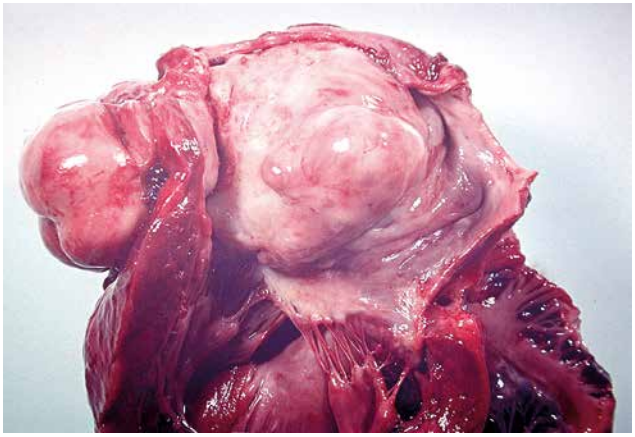
Supplementary Figure S9. Papillary fibroelastoma – branching avascular fronds with a slender stalk (arrow) (HE, 15×). Tangles of elastic fibers (lower left corner) (van Gieson-elastica, 100×)



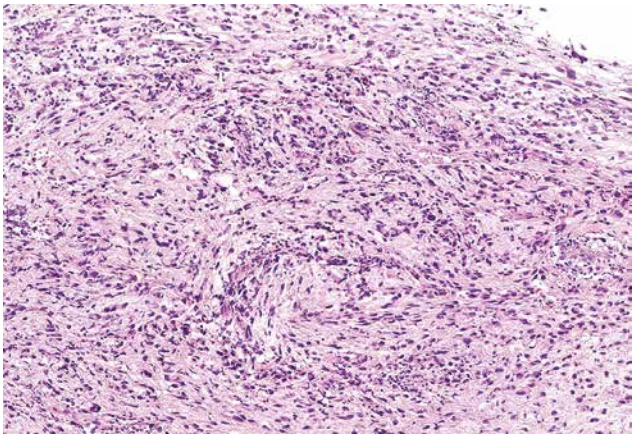
Supplementary Figure S11. Lipoma with regressive changes and a thick fibrous capsule (arrow) (HE, 20×). Detail of necrotic adipocytes (lower left corner) (HE, 200×)

Supplementary Figure S8. Papillary fibroelastoma reminiscent of a sea anemone

Supplementary Figure S10. Lipoma with a stalk



Supplementary Figure S12. Sarcoma – uneven tumorous mass in an atrium (autopsy specimen)



Supplementary Figure S13. Undifferentiated sarcoma (HE, 100×)