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"Sudden cardiac death"

Post-mortem heart examination

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1. INTRODUCTION

This document was established by the members of working group of the Swiss Society of Legal Medicine in order to harmonise their respective protocols for performing post-mortem adult's heart examinations. Minimal standards for heart dissection, sampling and histological examination are outlined. This document is complimentary to the documents "Swiss Principles and Rules for Medico- Legal Autopsy" and "Guidelines for Preserving Autopsy Material for Forensic-Toxicological Analyses". It is based on the paper "Guidelines for autopsy investigation of sudden cardiac death" (Basso et al.).

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2. DEFINITIONS

Active Implantable Medical Devices (AIMD)	Any active medical device which is totally or partially introduced, through a surgical or medical procedure, into the human body through a surgical access or through a natural orifice, and which remains implanted after the procedure, e.g. cardiac pacemakers and defibrillators.
AV node, bundle of His and bifurcation into left and right bundle branch	Parts of the cardiac conduction system.
Cardiomyopathies	A heterogeneous group of myocardial diseases associated with mechanical and/or electrical dysfunction that usually (but not invariably) exhibit inappropriate ventricular hypertrophy or dilatation. There are multiple underlying causes, many of which are genetically determined. Cardiomyopathies are either confined to the heart or are part of a generalized systemic disorder, often leading to cardiovascular death or other progressive heart failure-related disabilities.
Coronary bypass	A surgical procedure performed to relieve angina. Arteries or veins are grafted to the coronary arteries in order to bypass atherosclerotic narrowing and improve coronary blood supply.
CT (computed tomography)	A medical imaging technique that uses X-rays.
MRI (magnetic resonance imaging)	A medical imaging technique that uses nuclear magnetic resonance.
SAMS	Swiss Academy of Medical Sciences



3. CLINICAL INFORMATIONS

The following information should be gathered, especially for deaths presumed to be cardiac related, preferentially before the autopsy is performed:

- circumstances of death: time and place (e.g. at home, at rest or during exercise, during sleep, during emotional stress). Was the death witnessed? Resuscitation? Time between the onset of symptoms and death,
- past medical history: general health status, previous significant illnesses (e.g. syncope, palpitations, epilepsy and respiratory disease), metabolic disease such as obesity, diabetes, hepatic or renal disease,
- history of alcohol or drug abuse,
- usual pattern of exercise or athletic activity, sport level and type of sport, pre-participation screening,
- any type of ECG including ECG tracing during resuscitation,
- serum or blood laboratory results (especially lipid profiles),
- last medication,
- family cardiac history: ischemic heart disease and sudden premature death, arrhythmias.



4. HEART EXAMINATION

4.1 Specific health and safety aspects

In medico-legal autopsies and postmortem examinations of individuals, who contain an Active Implantable Medical Devices (AIMD), it is important to determine, if complications during or after implantation or dysfunction of systems could be related to the cause of death. Correct post-mortem handling of implantable cardioverter defibrillators (ICD) are of utmost importance. Pacemakers and defibrillators can also be useful for identification.

4.2 Radiological examination

Before autopsy, radiological imaging (chest-ray/ CT/ MRI) of the heart may be performed.

4.3 Macroscopic heart examination

The heart should be examined according to the general principles of pathological anatomy.

- 1) Check the pericardium, open it and explore the pericardial cavity. Assess the aspect and quantity of the pericardial fluid.
- 2) Check the anatomy of the great arteries before transecting them about 3 cm above the aortic and pulmonary valves.
- 3) Check and transect the pulmonary veins. Transect the superior vena cava about 2 cm above the point where the crest of the right atrial appendage meets the superior vena cava. Transect the inferior vena cava close to the diaphragm.
- 4) Remove the heart from the body and perform the examination of external features (general shape, petechiae).
- 5) Open the right atrium from the inferior vena cava to the apex of the appendage. Open the left atrium between the pulmonary veins, and then to the atrial appendage. Inspect the atrial cavities and the inter-atrial septum and then determine whether the foramen ovale is patent. Examine the mitral and tricuspid valves (or valve prostheses) from above and check the integrity of the papillary muscles and chordae tendineae.
- 6) Inspect the aorta, the pulmonary artery and the aortic and pulmonary valves (or valve prosthesis) from above.



7) Check coronary arteries:

- examine the size, shape, position, number and patency of the ostia,
- assess the size and course of the major coronary arteries, note intramyocardial course,
- in cases where a precise assessment of coronary stenosis is required, make multiple transverse cuts at about 3 mm intervals along the course of the main coronary arteries and branches, such as the diagonal and obtuse marginal, and check patency,
- in cases where a precise assessment of any possible degree of stenosis is not required, a longitudinal opening may be also permitted,
- heavily calcified coronary arteries, if possible, should be removed intact, decalcified and opened transversely. They may be opened longitudinally with sharp scissors to expose the distribution of pathological changes, but one forgoes a precise assessment of any possible degree of stenosis,
- coronary artery bypass grafts (saphenous veins, internal mammary arteries, radial arteries etc.) may be examined with longitudinal or transverse cuts. Both proximal and distal anastomoses may be examined with particular care. Side branch clips or sutures may facilitate their identification. One might consider removing anastomotic coronary artery junctions en bloc for later histological serial sections.

8) Complete transverse (short-axis) parallel, roughly 1 cm thick slices of the heart are recommended from the mid-ventricular level towards the apex. Dissect the basal half of the heart in the direction of blood flow and complete the examination of atrial and ventricular septa, atrio-ventricular valves, ventricular inflows and outflows and semi-lunar valves. Check both atria.

9) Once emptied of blood, the heart should be measured for the following values:

- heart weight,
- wall thickness: measure thickness of mid cavity free wall of the left ventricle, right ventricle and septum (excluding trabeculae),
- valvular circumferences.

4.4 Photographic documentation

The following photographs should be taken:

- anterior and posterior general view,
- one slice of the heart,
- any suspected lesions.



4.5 Sampling for histological examination

As a minimum, the following samples for presumed non-cardiac deaths should be taken and fixed:

- two samples of the left ventricle (anterior and posterior walls) with papillary muscles,
- one sample of the septum with containing the region of AV node and bundle of His
- one sample of right ventricular outflow tract.

For deaths presumed to be cardiac related, a number of additional samples is recommended for sampling:

- a mid-ventricular slice of the heart,
- any areas with macroscopic abnormalities,
- the most severe focal lesions in the setting of coronary artery disease.

Other cardiac samples (of valvular tissue, pericardium and aorta) should be taken when indicated.

If there is a clinical history or ECG tracing suggestive of a conduction abnormality, a conduction system investigation containing serial sections might be considered.

If one suspects a rare cardiomyopathy (e.g. mitochondrial, storage, infiltrative, etc), cardiac samples fixation in 2.5% glutaraldehyde or deep freezing is recommended.

4.6 Other samples

If a potentially heritable cardiac disorder is suspected, EDTA-blood or a part of the spleen should be frozen. The transfer and genetic analyses should respect the legal restrictions and follow the guidelines of the SAMS.

4.7 The minimal standard for histological examination of the heart

Histological examination of cardiac samples mentioned in point 3.5.1 is recommended for all cases.



For deaths presumed to be cardiac related, labelled histological slides are recommended from the anterior and posterior walls of the left ventricle, the right ventricular outflow tract and the interventricular septum with the AV node and the bundle of His.

Hematoxylin eosin staining and a connective tissue stain as van Gieson, CAB (Chromotrope Aniline Blue) are standardly recommended.

Other special stains (for example AB PAS for mucins and mucosubstances deposits, Congo Red for amyloid deposits) and immunohistochemistry can be performed, if required.

4.8 Retaining of the entire heart

In some particular cases the heart may be retained after autopsy for a more detailed examination. Cardiac retention should respect the legal restrictions and follow the guidelines of the Swiss Academy of Medical Sciences. If the entire heart is retained, this should be mentioned in the autopsy protocol.

4.9 Results of examinations

In the majority of cardiac related deaths a clear pathological cause can be identified, albeit with varying degrees of confidence. A level of certainty should accompany the anatomo-pathological diagnosis (certain, highly probable or uncertain).



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