New approach to perform a standardized post-mortem CT-angiography

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Purpose

As a new trend in forensic medicine, radiological cross-sectional imaging techniques have been introduced in postmortem investigations [1]. In the University Center of Legal Medicine Lausanne-Geneva, MDCT-scan is already a part of daily routine. In combination with conventional autopsy, this examination increases the quality of medico-legal investigations. Additionally, postmortem angiography can be performed to visualize the vascular system after death [2-4]. This technique is interesting because, by means of conventional autopsy, it is impossible to visualize the vascular system in detail.

Up to now, postmortem CT-angiography was a domain of research without application in daily routine of postmortem investigations.

The object of our study was to establish an easy applicable technique and a standardized protocol to perform post-mortem angiography of high quality in order to introduce it into the daily routine.

Methods and Materials

We investigated 45 human corpses by post-mortem CT-angiography using different perfusion protocols, a modified heart lung-machine and the new contrast-agent Angiofil®, which was specially developed for post-mortem investigations. The quality of the performed CT-angiographies has been evaluated radiologically, taking in consideration the filling of the vascular system and the interpretability of the resulting images as well as by comparing the radiological diagnosis to those of conventional autopsy.

In the beginning of the study, different protocols have been tested. While the protocol varied a lot for the first ten cases, it became more and more unified with increasing number of cases until the technique got standardized and only small modifications have been made from cases 11 to 45.
In general, the following steps were performed:

A small incision was made in the inguinal region to prepare the femoral vessels. Then cannulas were inserted into the vascular lumina, and connected with the tubes of the perfusion machine. After starting the machine, Angiofil® was injected into the vascular system, by the femoral artery. A first CT-acquisition (arterial phase) was obtained once 600-1200 ml of the contrast agent had been introduced into the vascular system. To demonstrate the venous anatomy, the contrast agent was injected into the femoral vein. A second CT-acquisition (venous phase) was obtained once 800-1600 ml of Angiofil® had been introduced into the venous system.

To increase the quality of the results, a further phase was performed by injecting about 500 ml Angiofil® into the arterial system. Hereby the contrast agent was flowing from the arterial into the venous system and left the vascular system by the femoral vein. During this perfusion period, one or two further CT-acquisitions have been performed without stopping the perfusion machine.

**Results**

In all cases, the vascular system of the head, thorax and abdomen could be demonstrated (Fig.1). However, we observed significant differences in the completeness of the filling of the vascular system by applying different perfusion protocols.

Concerning the arterial phase, best results were found by injecting 1200 ml of Angiofil®. Hereby, we observed an excellent filling of all vessels, including the intracranial arteries, the coronary arteries and the pulmonary veins, which were not completely filled using a smaller injection volume. Exceptions were cases where traumatic lesions of the arterial system lead to important extravasations of contrast agent, such as aortic rupture. Similar results were found concerning the venous phase. Best results could be observed if 1600 ml of Angiofil® were injected.

The best filling of the vascular system could be observed in the dynamic phase. In some cases, parts of the arterial or venous system were incompletely filled so that local stenoses have been suspected. This effect was especially observed in the common trunk of the left coronary artery (Fig.2). In about a quarter of our investigated cases, radiological interpretation of the coronary arteries could only be made in the dynamic phase.
Extravasation of Angiofil® correlated in all cases with sources of bleeding due to vascular lesions. In our study, different bleeding sources could be detected. They varied from traumatic lesions of single vessels (aortic dissection (Fig.3), laceration of coronary artery or intercostals artery, lesions of lumbar artery or renal vein, dissection of the carotid artery etc.) to small chronic bleeding due to gastric carcinoma or diffuse bleeding due to intraparenchymal lesion (e.g. cerebral contusion, pulmonary laceration, ruptures of the spleen or the liver). The performance of a dynamic phase allowed to show the importance of the vascular lesion. While small chronic bleedings showed nearly no differences of the extravasation, more important bleedings showed a significant increase in the volume of the extravasated liquid by comparing the arterial or venous phase with the dynamic phase (Fig. 4).

By using the Angiofil® mixture, some tissues showed an enhancement after the perfusion. Thereby "physiological" enhancement, due to the post-mortem changings and "pathological" ones could be distinguished. Typical physiological enhancements could be found in the gray matter of the brain and in the mucosa of the gastro-intestinal tract. A pathological enhancement could be observed in the myocardium in two cases of myocardial infarct (Fig. 5).

Images for this section:
Fig. 1: 3D-reconstructions showing the filled vascular system using Angiofil®. a. Image reconstructed from the data set of the venous phase (after filling of the arterial and venous system). Pulmonary vessels have been virtually cut off in order to visualize the heart. b. 3D reconstruction of the heart showing the opacified coronary arteries.
Fig. 2: Visualization of the common trunk of the left coronary artery in the different angiographic phases: a. Arterial phase: the common trunk of the left coronary artery (circle) is not opacified, leading to radiological misinterpretation. b. Venous phase: Due to the increasing pressure in the vascular system after filling of the venous system, Angiofil® penetrated further into the periphery and visualized the common trunk of the left coronary artery (circle). However, only a fine trace of contrast agent is visible in the vascular lumen that does not allow radiological interpretation. c. Dynamic phase: Finally the common trunk of the left coronary artery (circle) is completely filled with contrast agent and stenosis can be radiologically excluded.
**Fig. 3:** Case of an 88-year-old female with no medical history. CT-angiography showed aortic dissection with cardiac tamponade (a-c). The radiological findings could be verified by conventional autopsy (d: blue catheter indicates the true lumen, the grey catheter is situated in the false lumen of the aorta).
Fig. 4: Case of a 62-year-old man known as alcohol addict. His body was found in an excavation next to a road. External examination showed traces of an important bleeding from the ear and a contused wound in the right occipital region. The radiological examination could find out following diagnosis: a. Native CT-scan: MIP (Maximum intensity projection) reconstruction showing a fracture of the right sphenoid bone (flashes). b. Arterial phase: An extravasation of Angiofil® (flash) was observed in the right occipital region whose origin could be attributed radiologically to the right occipital artery. c. Venous phase: Angiofil® extravasation (flashes) was observed from the ear with its origin from the right jugular sinus. d. Dynamic phase: After further Angiofil® perfusion in the dynamic phase, the importance of the hemorrhages is visualized, due to the formation of a huge collection of contrast agent (flash) from venous as well as arterial origin.
Fig. 5: Case of a 56-year-old man with no medical history who complained of thoracic pain during the last two days of his life. CT-angiography showed an enhancement of the myocardium of the left heart chamber, visible in different reconstructions shown in a-c (L = left chamber). Conventional autopsy (d) revealed huge inhomogeneous discolorations of the myocardium (flashes) visible in the same region, corresponding to myocardial infarction.
Conclusion

In conclusion, the protocol presented in this study allows performing post-mortem angiography in a standardized way and a high quality that allows radiological diagnosis and reduces significantly misinterpretation due to the technique of post-mortem perfusion. Most important are the application of a high perfusion volume, which is possible due to the new contrast-agent mixture Angiofil® and the performance of at least 3 angiographic phases and a native CT-scan. By applying this technique in combination with conventional autopsy, the quality of post-mortem investigation is increased because additional vascular findings can be found which are not detectable by autopsy only.

References


Personal Information

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