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Original communication

Age estimation of decomposed bodies based on a combined arteriosclerotic index

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ABSTRACT

Several methods exist for the estimation of the age at the time of death, ranging from mere visual inspection to costly laboratory examinations. The "combined arteriosclerotic index (CAI)" is considered to be a suitable low-budget tool for undecayed corpses. It defines the ratio between diameter and longitudinal pre-strain of the abdominal aorta. Its applicability in cases of decomposed corpses has not been studied yet. We examined whether it is a valid parameter in putrefied bodies as well and whether there is a correlation between CAI and the stage of decomposition. In conclusion the CAI becomes less accurate with increasing putrefaction. Nonetheless, even in case of high-grade putrefaction it remains a useful tool for instant age estimation which should be followed by the application of methods with higher accuracy.

1. Introduction

The estimation of the age at the time of death is a common challenge in forensic practice for the identification of unknown corpses. Several methods with significantly differing accuracy exist, ranging from mere visual inspection[1] to costly laboratory examinations.[2–5] The method of choice does not only depend on the available specimen (e.g. bones,[1] teeth[2–4] or corpse[5–7]) but also on the vaguely suspected age (e.g. children[8] versus adults[2–4]) and the available time (e.g. first impression[1] versus accurate, costly determination[2–5]). It has to be considered that unidentified corpses are often found in a state of decomposition for which methods that depend on the availability of soft tissue[5,6] might not be suitable.

According to Horny et al.[7] the "combined arteriosclerotic index (CAI)" is a suitable low-budget tool for the estimation of the age at death of recently deceased persons. The CAI defines the ratio of diameter and longitudinal pre-strain of the abdominal aorta. The pre-strain reflects the ratio of lengths of the abdominal aorta in situ and ex situ, measured from the origin of the renal arteries to the aortoiliac bifurcation. CAI correlated even better with age (linear correlation coefficient $R_{male} = 0.916$; $R_{female} = 0.921$) than with diameter (linear correlation coefficient $R_{male} = 0.888$; $R_{female} = 0.878$) or pre-strain (linear correlation coefficient $R_{male} = -0.820$; $R_{female} = -0.840$).

However, Horny et al. applied their method solely to non-putrefied bodies, The question of the applicability of the method to putrefied bodies has not been investigated yet. We therefore examined whether CAI is a useful and valid parameter for age estimation not only in bodies of recently deceased persons but also in putrefied bodies and whether there is a correlation of CAI with the stage of putrefaction. In theory, a complete loss of elastic fibres due to decomposition could result in a loss of pre-strain, similar to the effect of severe arteriosclerotic changes found in non-putrefied bodies.

2. Methods

Data was collected by BH and CM in the period of time from June 2012 until February 2014 from 69 corpses of Caucasian race. All decayed corpses during this period of time were considered to be potentially relevant; only corpses with abdominal aortic aneurysms just above the aortoiliac bifurcation were excluded from the study. 24 corpses (12 males, 12 females) did not show any macroscopic signs of putrefaction and were used for the validation of the method; 45 corpses (27 males, 18 females) showed different stages of decomposition, ranging from abdominal putrefaction to whole body putrefaction with partial skeletonisation (Table 1). The gender specific post-mortem intervals can be seen in Table 1.

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Table 1
Stages of decomposition (pmi = 0–180 days; N = number of cases; pmi = post mortem interval; total N = 69).

Decomposition	N (total)	pmi [days]	Male	Female
Stage 0	24	0–4	0–4	1–3
Stage 1	10	2–8	1–4	2–8
Stage 2	8	3–10	6–10	3–7
Stage 3	27	8–180	8–180	7–120

Furthermore age [years], (assumed) post-mortem interval (pmi) [days], cause of death, longitudinal pre-strain [without unit], aortic circumference [mm] and degree of arteriosclerosis [stages 0, 1, 2, 3] were documented. The degree of arteriosclerosis (Table 2) was graduated into normal to fatty streaks [0], fibrofatty plaques [1], advanced non-calcified plaques [2] and calcified plaques with or without ulceration [3].

2.1. Staging of the decomposition/determination of the post mortem interval

All corpses were rated into four stages regarding the signs of decomposition. Stages were based on the macroscopical signs of decay of the skin (Table 1). Stage 0 meant undecayed corpses without any macroscopical signs of putrefaction. Stage 1 (beginning putrefaction) was assigned to corpses with green discolouration of the abdomen and/or partial discolouration of face and shoulders. Stage 2 (advanced putrefaction) was allocated to different discolourations of abdomen and thorax with or without discolouration of superficial veins. Stage 3 (high-grade putrefaction) was allocated to completely discoloured bodies with or without partial skeletonisation. Maggot infestation of the body was not taken into account for the staging of decomposition. The duration of the (assumed) post-mortem interval was obtained from the files of enquiry and autopsy reports.

2.2. Combined arteriosclerotic index defined by Horny et al.[7]

CAI was defined by Horny et al. as the ratio of diameter ("D") and longitudinal aortic pre-strain ("λ"):

$$\text{CAI} = \text{"D"}/\text{"}\lambda\text{"}$$

Longitudinal aortic pre-strain and diameter were defined as follows:

2.3. Longitudinal pre-strain

To calculate the aortic longitudinal pre-strain the abdominal aorta was freed from connective tissue in situ. Measurements were taken in situ ("l", Fig. 1) and ex situ ("L", Fig. 2) from the origin of the left renal artery to the aortoiliac bifurcation. Longitudinal pre-strain ("λ") was calculated by:

$$\text{"}\lambda\text{"} = \text{"l"}/\text{"L"}$$

Table 2
Stages of arteriosclerosis (total N = 69; N = number of cases).

Arteriosclerosis	N
Stage 0	17
Stage 1	18
Stage 2	10
Stage 3	24

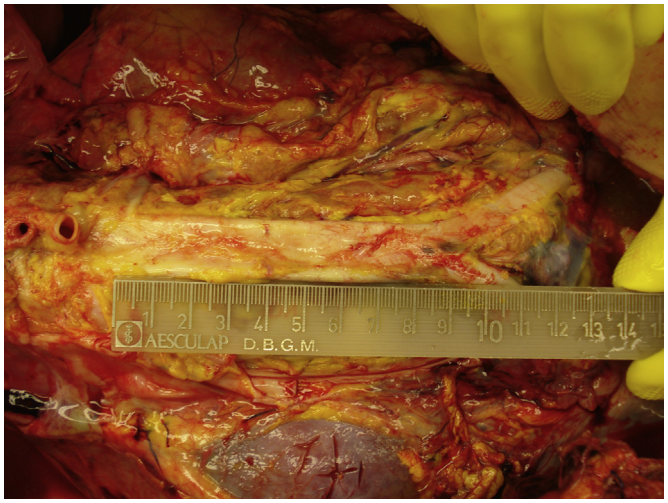

Fig. 1. In situ length of the abdominal aorta ("l").

Fig. 2. Ex situ length of the abdominal aorta ("L").

2.4. Aortic diameter

The aortic circumference ("C") was measured approximately 2 cm above the aortoiliac bifurcation (Fig. 3). The aortic diameter ("D") was calculated as follows:

$$\text{"D"} = \text{"C"}/\pi$$

2.5. Statistical analysis

Linear correlation coefficients "R" were calculated according to the method described by Spearman.[9]

3. Results

Bodies without signs of putrefaction (stage 0; total N = 24; N = number of cases):

Bodies without signs of putrefaction showed the following descriptive statistical data [mean ± standard deviation; male/female]:

- age 48 ± 21/50 ± 21 years;