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Abstracts

Cadaveric body weight estimation from regression analysis of corpse length and anterior abdominal subcutaneous fat thickness using Computed Tomography.

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Objective: The aim was to derive a regression formula for weight estimation using length and anterior abdominal subcutaneous fat thickness (ASCFT) of corpses measured on post-mortem computed tomography (PMCT).

Methods: Retrospectively, 79 corpses were analyzed to assess the correlation between the length on PMCT by measuring the topogram length (TL), sternal length (SL) and thoracic column length (TCL) and compared them to the autopsy length (AL) using regression analysis. Similarly we measured the anterior subcutaneous fat thickness (ASCFT) at the level of the umbilicus and compared them to the autopsy weight (AW). Subsequently, multiple regression analysis was done to assess the correlation and significance between TL, SL, TCL and ASCFT with AW in order to derive regression equations for body weight estimation.

Results: Good linear relationship between the TL, SL and TCL when compared to AL. TL has the best correlation with coefficient of determination (R^2) of 0.93 and standard error of the estimation (SEE) of 2.6, TCL with R^2 of 0.63 and SEE of 5.96 and SL with R^2 of 0.56 and SEE of 6.46. ASCFT measurements showed a good correlation for both side with no significant different but poor correlation with AW. Multiple regression analysis showed a significant linear relationship using TL, SL, TCL and ASCFT with AW. TL has the best correlation with R^2 of 0.6768 and SEE of 9.602 with regression formula: -106.106 + (0.914 x TL) + (9.807 x ASCFT), followed by SL (R^2: 0.578, SEE: 10.975) and TCL (R^2: 0.544, SEE: 11.406).

Conclusion: PMCT can be used in the estimation of cadaveric height and weight. This is particularly important when dealing with incomplete corpses, DVI or mass disaster. The regression equation could also be applied for patients in emergency circumstances.

Keywords: Cadaveric body weight estimation, post-mortem computed tomography, regression analysis

Does enzymatical maceration change the morphology of bone structures? - A computed tomography evaluation study

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Purpose: Enzymatical bone maceration is frequently used as preparation technique in forensic investigations. Morphological changes due to the maceration process may negatively affect the subsequent interpretation. The aim of this study was to compare native and macerated bone samples by computed tomography (CT) with regard to the occurrence of morphological alterations.

Materials and Methods: High resolution CT scans of fifteen samples of flat and long bones (four sternums, four ribs, one clavicle, one thoracic vertebra, two skullcaps, one ulna, one pelvic bone and one femur) were performed. The first scan was performed directly after extraction - a thin layer of soft tissue and the bone marrow were not removed -, and the second scan was performed after completed enzymatical maceration, which on average took between 3 and 5 days. Corresponding CT datasets were registered by a semiautomatic rigid registration using a mean squares metric followed by finite element based non-rigid registration. Registration errors in the resulting deformation field were measured.

Results: All fifteen samples showed a very good match in morphology before and after maceration with a mean registration error of 0.35 mm (range 0.10 to 0.88 mm). Slight changes in the curvature of the skullcaps and the ribs were found, while all other samples did not show any remarkable alteration.

Conclusions: Bone preparation by enzymatical maceration does not significantly change the bone morphology.

Determination of PMI using non-invasive MRI measurement of the ADC

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Post-mortem Magnetic Resonance Imaging (MRI) examination of the brain with Diffusion Weighted Imaging (DWI) and Apparent Diffusion Coefficient (ADC) mapping has the potential to be developed as a method for estimating post mortem interval (PMI) of a decedent. In previous reports, post-mortem tissue degradation has been shown to be correlated with a decrease in the ADC of water in brain tissue. The preliminary method for scanning and testing this protocol involves scanning a mammal brain in situ in a 1.5 T MRI scanner over the period of two weeks while allowing the specimen to decompose at room temperature. At each post-mortem time point, six echo planar images are acquired with increasing levels of diffusion weighting, corresponding to b-values of 0, 500, 1000, 1500, 2000, and 2500 s/mm^2. The b-values are a measure of the strength of the diffusion-sensitizing gradients used in the DWI experiment. For each pixel in the image, the signal intensity is plotted as a function of b-value, and the slope of the resulting curve is the ADC in units of mm^2/s. The ADC values for all pixels in the image series (i.e. all locations in the brain) are displayed as an ADC map. The ADC map allows a region of interest (ROI) to be drawn on a specific area of the brain (for example, gray matter), from which the average ADC for that tissue is computed. The average gray matter and white matter ADC values will be recorded and plotted as a function of PMI. After scanning many specimens (N > 10), we expect to obtain "standard curves" quantifying the continuous change in the ADC of gray and white matter with increasing PMI; in a future study, we anticipate that the standard curves will enable determination of PMI by a non-invasive MRI measurement of the ADC.

Can post mortem CT reliably distinguish between drowning and non-drowning asphyxiation? A prospective study

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Purpose: To document and confirm post mortem CT findings in bodies recovered from water after drowning.

Materials & Methods: We performed a prospective, comparative study of post mortem CT-scans obtained for medico-legal purposes in a 2 year interval. All CT-examinations were performed on a 64-slice MDCT-scan. Case inclusion criterion (n=14): body recovered from water with clear circumstantial evidence of drowning. Control inclusion criterion (n=11): body with autopsy confirmed, non-drowning asphyxiation. Images were evaluated for the presence of fluid in the paranasal sinuses (FPS), mastoid air cells (FMA) and lower airways (FLA), frothy foam in upper airways (FFUA), ground-glass opacity (GGO) within the lungs, the level of the right hemi-diaphragm, interpulmonary distance at the level of the aortic valve (IPD), the area of the esophagus at the carina (AAE), the mean density of intracardiac blood (MDICB) gastric (MDGC) and esophageal contents (MDEC).

Results: The following observations were made in cases and controls respectively: FPS: 92.9% vs. 77.8%; FMA: 14.3% vs. 20%; FLA: 85.7% vs 66.7%; FFUA: 7.1% vs. 36.4%; GGO: 90% vs. 88.9%. The MDICB was 61.9 HU in cases and 57.1 HU in controls. The MDGC was 15.9HU in cases and 13.1 HU in controls. The MDEC was -111.5 in cases and -33.3 HU in controls. The mean IPD at the cardiac level was 8.9 mm in cases and 17 mm in controls. The mean AAE was 1.3 cm² in cases and 1.1 cm² in controls. The average position of the right hemi-diaphragm was at the level of the 5th rib in cases and the 4th rib in controls.

Conclusion: Our provisional results indicate that it is very difficult to distinguish drowning from non-drowning asphyxiation on CT. Only the level of the right hemi-diaphragm differed significantly ($p<0.05$). CT-indicators for drowning as the cause of death should be defined with caution.

Fatal hypothermia effect on lung evaluating using postmortem CT imaging

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Purpose

Our aim was to identify the effect of hypothermia on the lung in post-mortem CT imaging.

Methods

Whole-body CT was used followed by inspection/ blood test / and full autopsy to investigate a series of deaths. Using CT images, chest volumetry including chest cavity, volume of respiratory / non-respiratory space, percentage aerated field, and tracheal volume were measured before conducting any autopsies. According to the autopsy findings, the fatal hypothermia group (group A) was compared and evaluated statistically with other causes of death (group B).

Results

From July 2010 to November 2011, 131 bodies were assessed (76 males, 55 females). The gender ratio, age, emphysema, and the time from death to CT imaging were: 9 males / 4 females, 23 – 86 (mean 61.4) years old, one case, 1 – 60 (8.2 ± 4.8) days in group A, and 67 males / 51 females, 21 – 89 (mean 57.5) years old, 23 cases, 0 – 180 (5.1 ± 1.6) days in group B. There was no background difference between the 2 groups. Groups A and B were compared for the following: the chest cavity, dead space (including fluid/pneumothorax), lung aerated volume, percentage aerated lung field, and tracheal volume. The measurements for group A were 2601.0 ± 247.4 (ml), 281.1 ± 136.5 (ml), 1564.5 ± 281.1 (ml), 62.1 ± 6.2 (%), 21.8 ± 2.7 (ml). For group B: 2339.2 ± 67.7 (ml), 241.1 ± 38.0 (ml), 739.9 ± 67.0 (ml), 31.4 ± 2.3 (%), 15.9 ± 0.8 (ml). There were statistical differences between group A and B for lung aerated volume, percentage aerated lung field, and tracheal volume.

Conclusions

Comparing post-mortem CT image, the percentage aerated lung field was clearer in fatal hypothermia than other causes of death. It is the new finding for fatal hypothermia on post-mortem CT imaging.

The use of skin breach markers in plain radiography of live gunshot patients

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Gunshot wounds are often seen in busy trauma units such as Area 163 of the Charlotte Maxeke Hospital in Johannesburg, South Africa. The use of skin breach markers in plain film radiography as a clinical aid to evaluate gunshot injuries has been described by Brooks (2002).

When dealing with live gunshot patients the clinical benefits of using skin breach markers are paramount, but the potential forensic benefits should not be forgotten as the radiographs can be analysed retrospectively for this purpose.

Here the author will discuss the use of skin breach markers with reference to a sample of 150 patients from an unpublished research project in South Africa. Some minor modifications to X-ray technique are recommended, illustrated by selected examples from the author's research cases and with reference to relevant experience of more than 2000 other gunshot wounds.

BROOKS, A., BOWLEY, D. M. & BOFFARD, K. D. (2002). Bullet markers - a simple technique to assist in the evaluation of penetrating trauma. J R Army Med Corps, 148, 259-61.

Differentiation of bodypacks by computed tomography: CT attenuation values at different tube voltage levels and the dual-energy index

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Purpose: To investigate the computed tomography (CT) attenuation values and the dual-energy index (DEI) of cocaine and heroin at different tube voltage settings in a phantom study.

Materials and Methods: Thirty-three hand-wrapped bodypacks prepared of heroin (n=17) and cocaine (n=16) at varying concentrations were submerged in a 28-cm water tank and imaged four times with a dual-source 64-detector row CT at peak tube voltage levels of 80 kVp, 100 kVp, 120 kVp, and 140 kVp. Tube current in each protocol was adjusted for similar CT volume dose index of 8.0 mGy. Image noise and the CT attenuation values were measured in each drug container three times at each tube voltage level by two independent observers, and the DEI was calculated from measurements at 80 kVp and 140 kVp.

Results: Image noise at the four tube voltage levels was similar (p=.32). Intra- and interobserver agreement was good (r=.89 to .93; p<.001). CT attenuation values were different between cocaine and heroin at any tube voltage and in the DEI (p<.01) with the smallest overlap of attenuation values between both drugs at 80 kVp and the DEI. The drug concentration had a strong negative relationship with the DEI for heroin (r=-.67; p<.01) but not for cocaine (r=-.15; p=.23).

Conclusions: CT attenuation values measured at low tube voltage level and using the DEI improve the differentiation of cocaine and heroin-containing bodypacks compared to measurements at higher tube voltage settings.

K-edge Imaging in Post-Mortem CTA: Potential of Combined Usage of Iodine and Gadolinium in Post-Mortem Dual-Energy CT Angiography (PmDECTA)

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Purpose: The purpose of this study was to investigate whether dual-energy computed tomography has the potential to improve vascular depiction by differentiating between intravascular gadolinium- and iodine-based contrast agent by using the characteristic k edge for each contrast.

Method and Material: For initial evaluation a water filled phantom (25 cm diameter) with submerged syringes filled with dilutions of iodinated and gadolinium contrast agent (Ultravist 370mg I/ml; Gadovist 1,0 mmol/ml) and polyethylene glycol (PEG200) were used. PmDECTA of the corpse was performed after injection of iodinated contrast solution in the arterial system (1:10; 1.2L) and gadolinium based contrast solution in the venous system (1:10; 1.5L). Access to the vascular system was gained with cannulation of the femoral artery and vein. DECT scanning was undertaken at 100kV and 140kV with tin filter using a dual energy CT scanner (Somatom Flash, Siemens).

Results: The reconstructed images showed an effective isolation of gadolinium from iodine with subsequent clear depiction of the perfused vessel lumen, both in the phantom model as well as in a human corpse. Furthermore it was possible to visualize tissues with a mainly arterial perfusion with iodine, a mixed arterial and venous perfusion with iodine and gadolinium and an almost exclusive venous perfusion with gadolinium.

Conclusion: PmDECTA allows for a superimposition-free depiction of the arterial and venous system after separate injection of iodinated and gadolinium based contrast solution. Furthermore, it provides the possibility of a quantification of iodine and gadolinium in the vascular lumen in traumatized cases, where also the quantification of the lost blood volume separate for the arterial and venous system can be done. This information is not retrievable with classic autopsy nor with iodine-only pmCTA.

Use of postmortem CT angiography to detect causes of gastrointestinal hemorrhage

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Introduction: Postmortem CT angiography (PMCTA) is being used as an adjunct to autopsy in cases of suspected gastrointestinal (GI) hemorrhage.

Methods: A retrospective analysis of all cases in which PMCTA was undertaken for suspected GI haemorrhage based on a review of circumstances and/or radiological findings on admission CT scan. Arterial phase PMCTA was performed in all 9 cases and additional venous phase examination in 6. Full autopsies were performed. The degree of portal vein contrast filling (PVCF) was assessed using a 3 tiered grading scheme and the presence of gastro-esophageal varices (GEV) and/or sites of contrast leak recorded.

Results: In 8 of 9 cases PVCF was observed in the arterial phase. Contrast density in the portal vein increased in all 6 additional venous phase studies. PMCTA demonstrated GEV in 4 of 5 cases where they were detected at autopsy but only on the venous phase. In 1 case contrast leak from the GEV was detected. In 3 of the remaining 4 cases, a bleeding point was identified on PMCTA notably a cystic artery stump post cholecystectomy, duodenal ulcer and superior mesenteric artery branch post Whipple procedure. Findings were confirmed at autopsy.

Discussion: CT angiography is routinely used to diagnose and localize GI bleeding in the clinical setting. The exact point of hemorrhage and demonstration of GEV can be difficult to detect at autopsy. The demonstration of such findings prior to autopsy alerts the pathologist to the likely site and pathology to be encountered and allows focused dissection. PMCTA also provides additional findings if autopsy dissection fails to detect an abnormality.

Conclusion: PMCTA is a useful adjunct to autopsy in cases of GI hemorrhage as it can demonstrate GEV if both arterial and venous phases are employed and in some cases sites of contrast extravasation especially if arterial bleeding is responsible.