



# ISFRI

7 - 9 May, 2024

## 13th Annual Congress of the International Society of Forensic Radiology and Imaging

7-9 May 2024, Kraków, Poland

### Book of abstracts

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## **Agenda**

**6 May 2024**

**18:00 – 20:00 Welcome reception / registration.**

**7 May 2024**

**Session 1 Chair: Henri de Bakker / Krzysztof Woźniak**

**9:00 – 9:15 Opening Ceremony**

**9:15 – 9:45 Gil Brogdon Honorary Lecture:**

**Advanced imaging in heritage studies**

Łojewski Tomasz, Seweryn Anna

**9:45 – 10:30 O1-1**

**Radiological DVI - embracing the AI era**

Krispin Alon, Soudack - Ben Nun Michalle

**10:30 – 11:00 Coffee break**

**Session 2 Chair: Summer Decker / Fabrice Dedouit**

**11:00 – 11:20 O2-1**

**Global overview of the utilization of postmortem imaging in medicolegal casework**

de Heus Gisela, van Langen Kiki C., Latten Bartholomeus G.H., Decker Summer, Dedouit Fabrice, Hyodoh Hideki, O'Donnell Chris, Ruder Thomas D., Ruttu Guy, Thali Michael J., Woźniak Krzysztof J., van Rijn Rick R.

**11:20 – 11:30 O2-2**

**Post mortem computed tomography (PMCT) service structures in the United Kingdom for the investigation of non-suspicious deaths**

Shah Mohammad Ali, Rahimi Salman, Ahmad Fatima, Singla Nehal, Shelmerdine Susan, Davendralingam Natasha

**11:30 – 11:40 O2-3**

**A virtual model for virtual autopsy education in the United States**

Elifritz Jamie

**11:40 – 11:50 O2-4**

**The current state of using post-mortem computed tomography for personal identification beyond forensic odontology – a literature review**

Prokopowicz Victoria, Borowska-Solonyanko Aleksandra

**11:50 – 12:00 O2-5**

**Determining decedent stature from PMCT images in the New Mexico Decedent Image Database (NMDID)**

Adolphi Natalie, Edgar Heather, Haber Kethery, Kamnikar Kelly, Appel Nicollette, Rangel Esteban

**12:00 – 12:10 O2-6**

**Got you by your collar (bone)**

Decker Summer, Ruddy Guy, Ford Jonathan

**12:10 – 12:20 O2-7**

**Clavicle bone radiomics for age estimation in forensic medicine**

Leventis Dimitrios, Venâncio Joana, Pesman Blanca W., Torres Peña Paula N., Spanakis Konstantinos, Flouri Despoina E., Kranioti Elena F., Karantanas Apostolos, Klontzas Michail E.

**12:20 – 12:30 O2-8**

**Imaging signs of exposure to agents of bioterrorism and biological warfare**

Solomon Nadia, Deptula Lisa, Calle Francisco, Aswani Yashant, Donato Angel, Sailer Anne, Lino Pedro, Chammas Maria Cristina, Revzin Margarita

**12:30 – 12:40 O2-9**

**Cause of death ... or an effect? Distinguishing postmortem changes from pathology on postmortem CT**

Solomon Nadia, Elifritz Jamie, Adolphi Natalie, McCalla Aliah, Sanchez Harold, Sailer Anne, Kroll Jeroen, Daly Barry, Gascho Dominic, Thali Michael, Vermillion Billy, Thorn Stephanie, Revzin Margarita, Sinusas Albert

**12:40 – 13:00 O2-10**

**Concrete evidence: the use of extended Hounsfield unit (HU) post-mortem computed tomography (PMCT) in the recovery of concrete-encased remains**

Adolphi Natalie, Edgar Heather, Haber Kethery

**13:00 – 14:30 Lunch break**

**14:30 – 15:10 Working Groups**

**Session 3 Chair: Natalie Adolphi / Wolf Schweizer**

**15:10 – 15:20 O3-1**

**Intracranial needle insertion into an infant brain: a case report revealing an unprecedented computed tomography discovery**

Verster Janette, Ampanozi Garyfalia, Thali Michael, Goussard Pierre, Davis Razaan, Schweizer Wolf

**15:20 – 15:30 O3-2**

**Postmortem computed tomography evaluation of trauma-induced subdural haematomas**

Marosi Maria, Papp Tamás, Gergely Péter, Berényi Ervin

**15:30 – 15:40 O3-3**

**The pattern classification of cerebral blood vessels of donated cadavers using digital subtraction angiography**

Yamamoto Tomoaki, Takano Yuka, Fukami Mitsuha, Matsutomo Norikazu

**15:40 – 15:50 O3-4**

**Pneumothorax - standard or anomaly in cases with extensive head injuries?**

Borowska-Solonyko Aleksandra, Samońłowicz Dorota

**15:50 – 16:00 O3-5**

**Postmortem coronary computed tomographic angiography: exploring cardiovascular disease through cause-of-death investigation**

Solomon Nadia, Vermillion Billy, Sanchez Harold, Hoerner Matthew, Staib Lawrence, Gosangi Babina, Thorn Stephanie, Sinusas Albert

**16:00 – 16:10 O3-6**

**Assessment of the occipito-cervical junction: normal alignment measurements on PMCT in adults**

Yoshida Maiko, Vincent Cathy, O'Donnell Chris

**16:10 – 16:20 O3-7**

**Assessment of the occipito-cervical junction: normal alignment measurements on PMCT in children**

Yoshida Maiko, Vincent Cathy, O'Donnell Chris

**16:20 - 16:30 O3-8**

**Forensic imaging and its application in India - present status, scope and future aspects**  
Patil Amit

**8 May 2024**

**Session 4 Chair: Garyfalia Ampanozi / Chris O'Donnell**

**9:00 – 9:20 O4-1**

**Forensic radiology in the living: imaging of abuse and neglect**

Ruder Thomas

**9:20 – 9:40 O4-2**

**When clinical imaging helps the forensic doctor, about some interesting cases**

Dedouit Fabrice, Bascou Agathe, Ramirez Anthony, Toutin Ryan, Turkiewicz Manuelo, Savall Frederic, Mokrane Fatima Zohra, Telmon Norbeert

**9:40 – 9:50 O4-3**

**A pictorial case series of common causes of death seen in natural/non-suspicious death investigations by post mortem computed tomography (PMCT)**

Singla Nehal, Ahmad Fatima, Rahimi Salman, Shah Mohammad Ali, Davendralingam Natasha

**9:50 – 10:00 O4-4**

**Explaining life after death: manifestations of chronic medical conditions on nonenhanced postmortem CT**

Solomon Nadia, McCalla Aliah, Elifritz Jamie, Adolphi Natalie, Sanchez Harold, Sailer Anne, Gosangi Babina, Kroll Jeroen, Daly Barry, Gascho Dominic, Thali Michael, Vermillion Billy, Thorn Stephanie, Sinusas Albert, Revzin Margarita

**10:00 – 10:10 O4-5**

**A correlational study between invasive autopsy and post mortem computed tomography (PMCT) findings in cases of unascertained cause of death on PMCT at a single medical facility**

Rahimi Salman, Ahmad Fatima, Shah Mohammad Ali, Singla Nehal, Davendralingam Natasha

**10:10 – 10:20 O4-6**

**Postmortem computed tomography of COVID-positive hospital decedents: complimentary roles for antemortem and postmortem imaging and autopsy**

Solomon Nadia, Sasse Alexander, Vermillion Billy, Sanchez Harold, Masters Amanda, Staib Lawrence, Gosangi Babina, Hoerner Matthew, Israel Gary, Well David, Jang Sun-Joo, Alashi Alaa, Thorn Stephanie, Sinusas Albert

**10:20 – 10:30 O4-7**

**The cause of death was determined through a post-mortem CT scan in a fatal case following catheter ablation**

Watari Jun, Furukawa Kazuhiro, Yamada Masatoshi, Suzuki Toshihiko

**10:30 – 11:00 Coffee break**

**11:00 – 12:30 TWGPAM Session**

**Organization and Chair: Silke Grabherr**

**11:00 Introduction into Post-mortem Angiography**

Grabherr Silke

**11:20 Interests of the MPMCTA in blunt-force trauma**

Dedouit Fabrice

**11:40 Postmortem imaging and anatomy teaching at the University of Lausanne. State of the art and perspectives**

Schranz Sami

**12:00 Presentation of Fumedica and its postmortem division**

Dominguez Alejandro

**12:20 Conclusion and final discussion**

**Session 5 Chair: Thomas Ruder / Rick van Rijn**

**12:30 – 12:40 O5-1**

**Virtopsy concept around the world: institute-based survey of worldwide forensic postmortem imaging**

Khmara Natalia

**12:40 – 12:50 O5-2**

**A paradigm shift in the interpretation of posterior rib fractures in children?**

Fronczek Judith, Parsons Sarah, Rao Padma, O'Donnell Chris

**12:50 – 13:00 O5-3**

**Abdominal bleeding due to CPR: PMCTA with autopsy correlation**

O'Donnell Chris

**13:00 – 14:30 Lunch break**

**14:30 – 14:40 O5-4**

**Death by femoral artery: PMCT findings**

O'Donnell Chris

**14:40 – 14:50 O5-5**

**CT imaging of a case involving thermal and sharp trauma**

Christensen Angi, O'Reilly Kera

**14:50 – 15:00 O5-6**

**Death due to acupuncture – a case report comparing post-mortem computed tomography with autopsy findings**

Remmer Sünne, Mölder Maarja, Viitso Ann, Kruglov Aivo

**15:00 – 15:10 O5-7**

**Where the grape hoe's go? using PMCT scanning as the best tool to looking for cause of death, Indonesian case**

Untoro Evi

**Poster Session Chair: Aleksandra Borowska - Solonyenko / Rafal Skowronek**

**15:10 – 15:30 Poster Session:**

**P-1**

**Legal requirements for research in France**

Turkiewicz Manuelo, Estrade Quentin, Ducloyer Mathilde, Dedouit Fabrice



**P-2**

**Assessment of bronchiectasis on PMCT**

Vincent Catherine, O'Donnell Chris

**P-3**

**Flaring up the mesentery: applying the Lodox eXero-dr® statscan for expedited postmortem angiography**

Smith Zandr , de Bruin Elrinda, Mentoer Ilze, Verster Janette

**P-4**

**Delineation ability of one-scan fused CT with deep learning imaging reconstruction (DLIR) to visualize diseases of cerebral artery and parenchyma**

Yoshida Masahiro, Kobayashi Tomoya, Shiotani Seiji, Kaga Kazunori, Saitou Hajime, Tashiro Kazuya, Someya Satoka, Yamamori Moyu, Kuramochi Riho, Miyamoto Katsumi, Hayakawa Hideyuki, Atake Shigeru

**P-5**

**Evaluating IVIM diffusion metrics without perfusion in postmortem brain**

Kojima Masatoshi, Makino Yohsuke, Inokuchi Go, Motomura Ayumi, Torimitsu Suguru, Hoshioka Yumi, Tsuneya Shigeki, Yajima Daisuke, Yoshida Maiko, Kubota Himeko, Iwase Hirotarou

**P-6**

**Fatal complication of Fetoscopic Endotracheal Occlusion (FETO) - could postmortem computed tomography (PMCT) be helpful?**

Skowronek Rafał, Zamłyński Jacek, Borowska-Solonyńko Aleksandra

**P-7**

**Unusual brainstem complete disruption and dislocation caused by the fracture of the upper thoracic spinal column**

Matejuk Szymon, Nudga Adriana, Truszkowski Christopher, Syska-Lamb Barbara Monika, Fraszczyński Paul, Ostruszka Natalia, Fitz Emilia, Woźniak Krzysztof

**15:40 ISFRI General Assembly**

**19:00 – 23:00 Gala Dinner**

**9 May 2024**

**Session 6 Chair: Michael Thali / Bernadette de Bakker**

**9:00 – 9:30 Honorary Lecture (*pre-recorded presentations*):**

**Polish contribution to world radiology / Radiology in the footsteps of the past – the mystery of the death of general Władysław Sikorski**

Urbanik Andrzej

**9:30 – 9:50 O6-1**

**Mobile forensic photogrammetry in the field: addressing non-collaborative surfaces**

Schweitzer Wolf, Fukuda Haruki, Ebert Lars

**9:50 – 10:00 O6-2**

**Utilization of 3D surface scanning in crime scene investigation and forensic medicine – comparative analysis of various technologies and their benefits**

Kolev Yanko

**10:00 – 10:10 O6-3**

**Beyond decay: advancing PMCT for accurate bone mineral density analysis in the deceased**

Hansen Kasper, Vinther Dennis, Boel Lene WT, Ağacan Gülislam, Thygesen Jesper, Uhrenholt Lars, Lauridsen Henrik

**10:10 – 10:20 O6-4**

**Improving PMCT angiography visualization in forensic imaging - brute force methods**

Schweitzer Wolf, Thali Michael, Ebert Lars, Aldomar Eloisa

**10:20 – 10:30 O6-5**

**Applying dual energy post-processing to postmortem coronary computed tomographic angiography: a feasibility study**

Solomon Nadia, Vermillion Billy, Jang Sun-Joo, Sanchez Harold, Hoerner Matthew, Gosangi Babina, Thorn Stephanie, Liu Chi, Sinusas Albert

**10:30 – 11:00 Coffee break**

**Session 7 Chair: Hideki Hyodoh / Yanko Kolev**

**11:00 – 11:10 O7-1**

**Postmortem enhanced CT using CT guided direct puncture**

Hyodoh Hideki, Shimbashi Shogo, Yoshimiya Motoo

**11:10 – 11:20 O7-2**

**Photon Counting CT in forensic radiology; first experience**

Crombag Genevieve, Peters Nicky, Nobel Martijn, Wildberger Joachim, Postma Alida

**11:20 – 11:30 O7-3**

**Initial experience of Photon-Counting Detector CT in forensic medicine**

Makino Yohsuke, Kojima Masatoshi, Inokuchi Go, Yoshida Maiko, Chiba Fumiko, Tsuneya Shigeki, Hoshioka Yumi, Kubota Himeko, Uemura Yukiko, Tweeatsani Numfon, Kudo Masatoshi, Teramoto Fuyuhiko, Yokoi Kazuma, Kojima Shinichi, Watanabe Fumito, Iwase Hirotaro

**11:30 – 11:40 O7-4**

**Characterization of bullets by Photon-Counting CT: a phantom-based study**

Hardy Joey, Crombag Geneviève, Peters Nicky, Flohr Thomas, Hermsen Rob, Willigers Jef, Latten Bartholomeus, Wildberger Joachim, Nobel Martijn, Jacobi-Postma Linda

**11:40 – 11:50 O7-5**

**HiP-CT imaging of the human colon; novel insights in the ENS**

Docter Daniel, Gorter Ramon, Hanemaaijer- van der Veer Jermo, Hagoort Jaco, Cleypool Cindy, de Bakker Bernadette

**11:50 – 12:00 O7-6**

**HiP-CT synchrotron imaging: a new gold standard in anatomy?**

de Bakker Bernadette, Hanemaaijer-van der Veer Jermo, Docter Daniel, Dawood Yousif, Hagoort Jaco, Lobe Nick

**12:00 – 12:10 O7-7**

**The added value of post-mortem MRI in forensic imaging: filling in the missing pieces – a case series of five stabbing incidents**

van de Voorde Paulien, Gregoire Cédrique, Crombag Geneviève, Nobel Martijn, Peters Nicky

**12:10 – 12:20 O7-8**

**Scoping review regarding the evidence of the use of magnetic resonance imaging in the adult, forensic setting**

Gregoire Cédrique, Crombag Geneviève, Peters Nicky, Nobel Martijn, Jacobi-Postma Linda

**12:20 – 12:30 O7-9**

**Forensic individual identification and weapon estimation in unlawful cat killing using micro-CT and 3D printing**

Kihara Yuko, Chiba Fumiko, Kojima Masatoshi, Okada Hiroyuki, Tanaka Aki, Hayama Shin-ichi, Torimitsu Suguru, Iwase Hirotaro, Makino Yohsuke

**12:30 – 12:40 O7-10**

**Objective evaluation of changes in serum transmittance over time in vitro**

Shimbashi Shogo, Yoshimiya Moto, Hyodoh Hideki

**12:40 – 12:50 O7-11**

**Spectrum of forensic cases using conventional radiology for postmortem imaging – experience of a tertiary care medical institution**

Patil Amit

**12:50 – 13:00 O7-12**

**Utility of postmortem computed tomography (PMCT) in the diagnosis of coronary and cerebral arterial air embolism:-a pilot study**

Chauhan Aditya Pratap Singh, Chandran Varun, Gupta Sudhir, S Abhilash

**13:00 – 13:30 ISFRI Board Closing ceremony**

## Gil Brogdon Honorary Lecture: Advanced imaging in heritage studies

Łojewski Tomasz<sup>1</sup>, Seweryn Anna<sup>2</sup>

<sup>1</sup> AGH University of Krakow

<sup>2</sup> National Archives in Krakow

Forensic analysis and study of cultural heritage artefacts can share common research methods and benefit from their development arriving from both fields. The development of imaging techniques has opened up new possibilities for documentation and content analysis for the holders of historic objects, in particular for museums/libraries/archives whose collections often contain manuscripts or prints with damaged, erased or obscured writing. Multispectral imaging has been used with a great success in palaeography, in particular its application for palimpsests analysis has resulted in spectacular discoveries of texts that were considered irrevocably lost (e.g. the Archimedes palimpsest). Also another technique of computational photography – the Reflectance Transformation Imaging (RTI) – allows to obtain unique information about the studied objects, both its contents and physical condition. RTI enables to re-light subjects' surface from any direction and to enhance texture details which cannot be accessed with any other imaging method or a naked eye.

During the lecture both imaging techniques and selected examples of their application for heritage objects will be presented to illustrate the power of these methods in revealing objects' content and texture details.

## O1-1

### Radiological DVI - embracing the AI era

Krispin Alon<sup>1</sup>, Soudack - Ben Nun Michalle<sup>2</sup>

<sup>1</sup> Forensic Imaging, National Center for Forensic Medicine, Israel

<sup>2</sup> Radiology, Sheba Medical Center, Israel

### Objectives

On 7/10/2023, Israel suffered a terrorist attack with over 1000 murdered. Many victims were mutilated or burnt and scattered over a large area for weeks.

We describe our experience with DVI by imaging, including methodological, organizational, integrational and professional aspects. An AI-based system has been established, which claims to make the identification by imaging techniques automatic and virtual cloud based.

### Methods

An AM and PM DICOM databases were established of the missing persons and scanned bodies respectively. 40 volunteer radiologists, anthropologists, data analyzers and PACS professionals worked in shifts comparing AM and PM data, using the leads of medical PM findings and morphology of frontal sinuses, sterna and lumbar spines.

### Results

11 bodies were identified, 8 based on surgical treatments and two based on morphology similarity. PMCT enabled investigation of cases of multiple persons within a single body bag.

During the DVI, a comparison tool based on CT segmentation of skeletal parts was invented by hi-tech professionals and global companies. This AI model may identify and match skeletal parts in X-rays and CT by analyzing the subtle similarities and differences.

### Conclusions

Identification by imaging is easy for bodies with medical implants and devices, given medical information or other quick leads. Documentation of the body bags AS IS allows re-check and case investigation. Automatic segmentation tools allows quick AI based biometric comparison, similar to DNA or fingerprints.

## O2-1

Global overview of the utilization of postmortem imaging in medicolegal casework

de Heus Gisela<sup>1</sup>, van Langen Kiki C.<sup>2</sup>, Latten Bartholomeus G.H.<sup>2</sup>, Decker Summer<sup>3</sup>, Dedouit Fabrice<sup>4</sup>, Hyodoh Hideki<sup>5</sup>, O' Donnell Chris<sup>6</sup>, Ruder Thomas D.<sup>7</sup>, Rutty Guy<sup>8</sup>, Thali Michael J.<sup>7</sup>, Woźniak Krzysztof J.<sup>9</sup>, van Rijn Rick R.<sup>10</sup>

<sup>1</sup> Department of Forensic Medicine, Netherlands Forensic Institute, Netherlands

<sup>2</sup> Department of Forensic Medicine, Section on Forensic Pathology, Netherlands Forensic Institute, Netherlands

<sup>3</sup> Department of Radiology, University of Southern California Keck School of Medicine, United States

<sup>4</sup> Department of Forensics, University Hospital, Rangueil, Toulouse, France

<sup>5</sup> Department of Forensic Medicine, Hokkaido University Faculty of Medicine, Japan

<sup>6</sup> Department of Forensic Medicine, Victorian Institute of Forensic Medicine, Monash University, Australia

<sup>7</sup> Department of Forensic Medicine and Imaging, Institute of Forensic Medicine, University of Zurich, Switzerland

<sup>8</sup> East Midlands Forensic Pathology Unit, University of Leicester, United Kingdom

<sup>9</sup> Department of Forensic Medicine, Faculty of Medicine, Jagiellonian University Medical College, Poland

<sup>10</sup> Department of Forensic Medicine, Section on Forensic Paediatrics, Netherlands Forensic Institute, Netherlands

## Objectives

During the 2023 International Society of Forensic Radiology and Imaging (ISFRI) congress, an inspiring discussion arose on how often an autopsy is still performed after a whole-body PMCT. The objective of this ISFRI endorsed study is to provide a global outline of the current application of postmortem imaging techniques, especially PMCT, in relation to autopsy practices within forensic casework.

## Methods

An online survey using Qualtrics® was created addressing the use of postmortem imaging in forensic casework. It was sent to current ISFRI members, an attendance lists of ISFRI congresses as well as to corresponding authors of recent publications (2013 to 2023) addressing forensic imaging with a deadline on March 1st 2024.

## Results

The survey included questions about which postmortem imaging techniques are applied, the average amount of postmortem imaging studies performed, who reads and reports the PMCT images, who decides whether or not to perform a full autopsy after PMCT, the legal aspects of this decision, in what kind of cases is postmortem imaging applied, and if the use of postmortem imaging affects the autopsy rate.

## Conclusions

We expect that with the diversity of questions from this survey the results will show a variety of approaches on how to implement postmortem imaging in different forensic cases within a variety of legal systems. It will enhance our understanding of the application of these methods in forensic casework and can therefore contribute to national and international guidelines.

## O2-2

Post mortem computed tomography (PMCT) service structures in the United Kingdom for the investigation of non-suspicious deaths

Shah Mohammad Ali, Rahimi Salman<sup>2</sup>, Ahmad Fatima, Singla Nehal, Shelmerdine Susan, Davendralingam Natasha<sup>1</sup>,

<sup>1</sup> Anubix Ltd., United Kingdom

<sup>2</sup> Clinical Radiology, Bedfordshire NHS Trust, United Kingdom

### Objectives

#### Introduction:

The United Kingdom (UK) is unique to other countries in its adoption of a coronial system for death investigations in which both natural and unnatural deaths are investigated. As a consequence of this, there are multiple new PMCT services that have been recently developed.

#### Objectives:

1. To illustrate the different PMCT structures in the United Kingdom in the investigation of non-suspicious/natural death.
2. To compare the advantages and disadvantages of different PMCT service structures in the investigation of non-suspicious/natural death

### Methods

A literature review of available publications on post mortem imaging services in the UK was completed and interviews were carried out with staff working at new PMCT services who provided information on the inner workings and pathways of the PMCT death investigation at their respective institutions.

### Results

The PMCT service structures identified include:

1. NHS clinical scanner
2. NHS clinical scanner and teleradiology
3. NHS dedicated PMCT scanner
4. NHS dedicated PMCT scanner and teleradiology
5. Private PMCT scanner
6. Mobile PMCT service

Advantages and disadvantages of each will be covered in more detail in poster/lecture.

### Conclusions

There are multiple different PMCT service structures which suit the needs of different coronial jurisdictions in the investigation of non-suspicious/natural death which each have their unique advantages and disadvantages; which should be considered if wanting to employ these models to other jurisdictions.



O2-3

A virtual model for virtual autopsy education in the United States

Elifritz Jamie<sup>1</sup>

<sup>1</sup> Forensic Radiology Group, United States

### Objectives

Analyze the status of PMCT utilization in the U.S.

Review forensic imaging education offerings.

Describe details regarding the online forensic imaging educational model.

Evaluate future directions for forensic imaging education.

### Methods

Forensic Imaging Education Online Model:

FRG has partnered with local, national, and global experts, assembling presentations by forensic radiologists, forensic pathologists, and legal experts. Originally developed as a PMCT interpretive course, we expanded our topics to cover operational and legal subject matter from a variety of perspectives. Our goal is to provide U.S. forensic pathologists with a panoramic view of forensic imaging. All courses provide learners with continuing medical education (CME) credit.

### Results

Preliminary results/feedback is anticipated before May 2024.

### Conclusions

Forensic imaging education is limited in the U.S. More and more medical investigator offices are embracing PMCT. It is essential that forensic pathologists have access to training for proper utilization of this tool. Online forensic imaging educational resources can help bridge this gap in knowledge.

O2-4

The current state of using post-mortem computed tomography for personal identification beyond forensic odontology – a literature review

Prokopowicz Victoria<sup>1</sup>, Borowska-Solonyanko Aleksandra<sup>1</sup>

<sup>1</sup> Chair and Department of Forensic Medicine, Medical University of Warsaw, Poland

### Objectives

From everyday medicolegal practice to disaster victim identification (DVI), personal identification of unknown bodies or body fragments is an important task. One of the potential tools that can help with this type of identification is post-mortem computed tomography (PMCT). The aim of this study was to conduct a review of the current literature available on the Web of Science platform regarding the use of PMCT for individual identification beyond the scope of forensic odontology.

### Methods

We used the inbuilt search engine to look through all databases on Web of Science for articles or thesis dissertations under the topic of PMCT and personal or individual identification. Articles with the topic “odontology” were excluded during this initial search. The results provided 95 articles. The authors then manually went through the abstracts of each of these and selected only those articles which focused on personal identification using PMCT, with a particular interest in studies which used quantitative methods.

### Results

Initial analysis of the remaining articles showed a predominance of research studies focused on personal identification through the use of structures of the skull, especially facial sinuses. Several articles mentioned the value of using pathological changes to individually identify the deceased.

### Conclusions

The literature is currently undergoing further analysis, the results of which will be presented together with conclusions during the conference.

## O2-5

### Determining decedent stature from PMCT images in the New Mexico Decedent Image Database (NMDID)

Adolphi Natalie<sup>1</sup>, Edgar Heather<sup>1</sup>, Haber Kethery<sup>1</sup>, Kamnikar Kelly<sup>2</sup>, Appel Nicollette<sup>2</sup>, Rangel Esteban<sup>2</sup>

<sup>1</sup> Office of the Medical Investigator, University of New Mexico, United States

<sup>2</sup> Department of Anthropology, University of New Mexico, United States

#### Objectives

NMDID is a database of >15,000 whole body post-mortem CTs and associated metadata, freely available to researchers, created under funding from the U.S. Department of Justice using PMCT image data from 2010-2017 obtained at the Office of the Medical Investigator. An important component of biological profile estimation is stature, corresponding to the standing height of the individual during life. Stature estimation from PMCT may be straightforward, if the whole body is imaged in one continuous scan, and the body is well-positioned and free of significant injury. Our objective was to determine the stature of adult subjects in NMDID, who were typically scanned in 3 volumes: 1) head, neck, and upper extremities, 2) torso, arms raised, and 3) lower extremities.

#### Methods

For each scan volume, images were displayed as thick slab MPRs in the optimal plane for each skeletal element. Anatomic landmarks were used to verify the extent of overlap of each scan volume, and corrections were applied when needed to account for injuries that impact stature (e.g., femur fracture with overlapping ends).

#### Results

The method enables measurement of all body elements that contribute to stature (head, neck, torso, and lower extremities) and accounts for non ideal body positions and skeletal disruption.

#### Conclusions

This method is an alternative to measuring the physical cadaver length using a tape measure or by a simple digital measurement from a CT localizer, which may be inaccurate due to body positioning or condition.

O2-6

Got you by your collar (bone)

Decker Summer<sup>1</sup>, Ruddy Guy<sup>2</sup>, Ford Jonathan<sup>1</sup>

<sup>1</sup> Radiology, University of Southern California, United States

<sup>2</sup> East Midlands Forensic Pathology Unit, University of Leicester, United Kingdom

### Objectives

The clavicle is routinely used in forensic identification. This study aims to evaluate the efficacy of part comparison of CT-derived three-dimensional (3D) clavicle bone models in establishing a forensic identification. By comparing antemortem and postmortem scans, the research seeks to establish a reliable, non-invasive method for identifying individuals in forensic contexts.

### Methods

A total of 10 paired antemortem (AM) and postmortem (PM) CT scans were obtained in collaboration with the University of Leicester. The clavicle bones were digitally extracted to create 3D models in the Mimics Innovation Suite. The resultant model AM clavicles were analyzed in 3-Matic via part comparison to establish a match ratio. Every PM clavicle was compared against every AM clavicle.

### Results

The geometric comparison of 3D clavicle models derived from AM and PM CT scans demonstrated a 100% accuracy rate, with no false positives or false negatives recorded. Positive accurate matches had an average match ratio of  $0.98 \pm 0.02$  with negative accurate matches having an average match ratio of  $0.25 \pm 0.09$ . A ROC curve was generated with a suggested cut off point of 0.73.

### Conclusions

This pilot study demonstrates the potential of 3D clavicle models from CT as a useful tool for personal identification. This non-invasive method, inspired by our previous Lumbar-based techniques suggest that anatomical uniqueness of a variety of structures can be used for personal identification, providing a reliable tool for forensic practitioners.

O2-7

Clavicle bone radiomics for age estimation in forensic medicine

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### Objectives

Age-at-death (AAD) is crucial in biological profiling of remains. Despite issues with age prediction methods, radiomics analysis of compact bone tissue from post-mortem CT scans offers a semi-automated, unbiased AAD estimation technique.

### Methods

PMCT examinations of 150 individuals over 18 years old were retrospectively evaluated. Only right clavicles were employed for consistency. The cortical bone of the clavicles was segmented semiautomatically and radiomics features were extracted with the use of PyRadiomics. Data were divided in training (70%) and validation (30%) groups. Significant features were selected with the Boruta algorithm and were used to train an XGBoost regression model, which was optimized with “random search”. Model performance was evaluated in the validation set with root mean square error (RMSE), R<sup>2</sup>, mean absolute error (MAE), and mean squared error (MSE).

### Results

The mean age of individuals was  $57.3 \pm 20.5$  years (standard deviation). Boruta extracted 14 significant features, which were used for further model development. XGBoost regression achieved a high performance with RMSE: 11.164, R-squared: 0.655, MAE: 8.909 and MSE: 124.646.

### Conclusions

The numerical values obtained by this method are reliable for estimating AAD in forensic contexts. This needs to be further validated to confirm the results.

## O2-8

### Imaging signs of exposure to agents of bioterrorism and biological warfare

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### Objectives

Infectious diseases have long been recognized for their capacity to be weaponized. While some agents have well-known and infamous histories, many other agents are feared for the potential roles they may play in future conflicts. In cases where the etiology of an illness is initially unclear, knowing what to look for on imaging studies can be vital to rapidly detect, diagnose, and ultimately contain a threat to public health.

### Methods

This exhibit will review the history of bioterrorism and biological warfare and provide an overview of various historical and potential agents. The presentation will review the medical sequelae of exposure and provide case examples demonstrating associated imaging findings.

### Results

A wide variety of agents and the diseases they cause will be reviewed, including bacterial infections like anthrax, brucellosis, and rickettsial diseases; viral encephalitis and hemorrhagic fevers; fungal infections like histoplasmosis and coccidiomycosis; protozoan infections like cryptosporidiosis; and many more.

### Conclusions

As imaging is increasingly used in postmortem and forensic investigations, including wartime and other circumstances associated with mass casualties, it behooves forensic imagers to have knowledge of agents of bioterrorism and biological warfare and be able to recognize the radiologic signs of exposure to these agents.

## O2-9

### Cause of death ... or an effect? Distinguishing postmortem changes from pathology on postmortem CT

Solomon Nadia<sup>1</sup>, Elifritz Jamie<sup>2</sup>, Adolphi Natalie<sup>2</sup>, McCalla Aliah<sup>3</sup>, Sanchez Harold<sup>4</sup>, Sailer Anne<sup>1</sup>, Kroll Jeroen<sup>5</sup>, Daly Barry<sup>6</sup>, Gascho Dominic<sup>7</sup>, Thali Michael<sup>7</sup>, Vermillion Billy<sup>8</sup>, Thorn Stephanie<sup>8</sup>, Revzin Margarita<sup>1</sup>, Sinusas Albert<sup>8</sup>

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## Objectives

With the increasing application of postmortem CT (PMCT) to cause of death investigation, it is not uncommon for clinical radiologists to assume PMCT can be interpreted in the same manner as clinical CT. This can be problematic when those with limited experience are unaware of the common imaging artefacts which occur due to changes to the body in the postmortem state. In such scenarios, mistaking postmortem changes for true pathology can lead to erroneous conclusions regarding cause, mechanism, or even manner of death.

## Methods

This presentation will provide a review of postmortem changes, the mechanisms behind them, and the resultant artefacts which can be appreciated on PMCT. Comparison cases demonstrating true pathology will be provided.

## Results

Early (e.g., algor, rigor, livor mortis) and late (e.g., autolysis, putrefaction, saponification, mummification) postmortem changes will be discussed, including the circumstances under which different types of decomposition occur. PMCT images showing various forms and stages of decomposition will be included. Case-based comparisons will include findings and pathologies related to the presence of air, brain parenchymal abnormalities, vascular changes, and findings related to resuscitation.

## Conclusions

As PMCT gains popularity, it is vital for all those who read it to develop a thorough understanding of postmortem changes, an ability to recognize their associated artefacts on imaging, and the acumen to differentiate these findings from true pathology.

O2-10

Concrete evidence: the use of extended Hounsfield unit (HU) post-mortem computed tomography (PMCT) in the recovery of concrete-encased remains

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### Objectives

CT images are normally reconstructed to have a grayscale ranging from -1000 to +3070 Hounsfield Units (HU), appropriate for the human body. A material denser than the cutoff (e.g., lead or steel) is represented by the maximum HU value available (+3070). If there are multiple dense materials, each near the maximum HU value, they cannot be easily differentiated. However, CT data can be reconstructed using an extended HU option (-1000 to +30,000), enabling improved contrast between high-density materials. We applied the extended HU technique to a case involving fragmented human remains encased in concrete.

### Methods

The concrete block was too large for the CT scanner and was broken into 9 large chunks (maximum breadth 47 cm) and scanned in a Philips Brilliance Big Bore 16-detector row CT scanner (140 kVp, automatic current selection). The Extended HU option was selected, and images were reconstructed using soft tissue (B) and bone (YD) kernels into 0.8 mm axial slices (0.4 mm spacing).

### Results

The materials present included human tissue, cloth, wood, aluminum, lead, cement, and stones. Imaging was used to guide the hammer-and-chisel extraction of materials of interest., which saved time and effort. The recovered materials, still coated in cement, were imaged again, enabling recovery of a lead projectile.

### Conclusions

Extended HU CT scanning succeeded in locating human remains and other evidence within concrete, which aided in identification of the victim and determining the cause of death.



### O3-1

Intracranial needle insertion into an infant brain: a case report revealing an unprecedented computed tomography discovery

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<sup>4</sup> Department of Radiology, Stellenbosch University, South Africa

#### Objectives

This case report documents a rare and unexpected discovery during a CT head scan for an infant presenting with new-onset seizures. In a startling revelation, six needles were found within the intra-cranial cavity, with five of them having penetrated the delicate brain tissue. The infant had been hospitalized his entire life, making this finding even more perplexing.

#### Methods

Although this rare phenomenon had previously been reported in the literature in some European, American and Asian countries, it has only been reported in once in an African country and it is the first known case to be recorded in South Africa.

#### Results

The incident underscores the pivotal role of CT triage in cases where medical symptoms or fatalities lack a clear explanation, especially in infants. The report delves into the circumstances surrounding the infant's presentation and the subsequent medico-legal death investigation through detailed imaging analyses, alongside clinical observations, and post-mortem findings. Additionally, it raises questions about the mechanisms leading to intracranial needle penetration and the subsequent investigation challenges.

#### Conclusions

The unanticipated nature of the discovery serves as a stark reminder for healthcare practitioners to maintain a high index of suspicion, even in cases with seemingly unrelated symptoms. The findings underscore the critical importance of advanced imaging modalities in unraveling mysteries that may lie hidden within the intricate confines of the body.

O3-2

Postmortem computed tomography evaluation of trauma-induced subdural haematomas

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<sup>2</sup> Department of Forensic Medicine, University of Debrecen, Hungary

### Objectives

This research aims to investigate the accuracy of postmortem computed tomography (CT) in incidental trauma-induced subdural haematoma and skull fracture concerning the most relevant radiologic features.

### Methods

From the New Mexico Decedent Image Database (NMDID) from 2010 to 2017, 9 head CT was selected, where the manner of death was an accident in all cases. Three cases were excluded because of the antemortem surgical intervention and advanced decomposition. The intracranial haematoma's type, location, and volume, such as the presence and location of the skull fractures, brain herniation and midline shifts, were identified and evaluated.

### Results

In 6 cases, patients had subdural haematoma at the convexity, but skull fracture was detected only in one case. Midline shift was presented in every examined case in different grades; however, significant brain herniation could not be conferred.

### Conclusions

The examined cases presented a correlation between the volume of the subdural haematoma and the size of the midline shift, but there was no relation between the presence or absence of skull fracture and the subdural haematoma.

Postmortem head CT in trauma cases can be a valuable tool to evaluate the most relevant radiological features with the application of sufficient protocols and within the appropriate timeframe concerning the postmortem intervals.

### O3-3

The pattern classification of cerebral blood vessels of donated cadavers using digital subtraction angiography

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#### Objectives

Digital Subtraction Angiography (DSA) has an advantage of high spatial resolution and high temporal resolution and can clearly image for vessels. There are few papers using DSA for cerebral blood vessels of cadavers. We performed DSA of cerebral blood vessels with donated cadavers and evaluated the pattern classification of cerebral vessels of cadavers.

#### Methods

Twenty-three donated cadavers (male; 11, female; 12) were registered in this study. The ages of males and females were  $90\pm 6$  and  $88\pm 9$ , and time since death was  $79\pm 65$  hours. Amidotrizoic Acid which was diluted by 2 times as the contrast agent was injected via right or left common carotid artery with 2 mL/sec of 50 mL, and the frame rate was set 2 fps. First, DSA of Anterior-Posterior view of head was performed, the next, the vessels were flushed using saline, and examined to Lateral view. Visual assessment and scoring of cerebral vessels were used to the pattern classification. Also, we assessed the correlation with time since death and cerebral vessels depiction performance.

#### Results

We were able to classify 5 patterns using visual assessment, however, scoring of cerebral vessels was shown satisfied results as 3 patterns for the pattern classification of cerebral vessels of cadavers. There was no correlation with time since death and cerebral vessels depiction performance ( $r=0.308$ ,  $p=0.147$ ).

#### Conclusions

DSA and scoring method were useful for imaging and assessment of cerebral vessels for cadaver regardless of time since death.

O3-4

Pneumothorax - standard or anomaly in cases with extensive head injuries?

Borowska-Solonyanko Aleksandra<sup>1</sup>, Samojłowicz Dorota<sup>1</sup>

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### Objectives

Chest injuries are not the only factor necessary for pneumothorax to develop – it also needs time. The aim of this study was to determine whether pneumothorax occurs in cases that also feature extensive head injuries – i.e. injuries that should near immediately lead to clinical death.

### Methods

A preliminary analysis was carried out on 2,018 post-mortem computed tomography (PMCT) scans performed in 2014-2017, from which 67 cases of head trauma with extensive fractures and deformation of the skull were selected for further analysis. In 91% (n=61), autopsy data were also analyzed.

### Results

Chest injuries were present in 71.64% of cases (n=48) with extensive head injuries. Pneumothorax occurred in 85.42% (n=41) of these. In three of the seven remaining cases, chest injuries were most likely caused by resuscitation, and in another three cases, chest injuries were related to opening of the chest wall. Taking into account the cases where lung damage was found at autopsy (n=36), pneumothorax occurred in 91.67% (n=33) – all cases except the above-mentioned three cases with open chest injuries.

### Conclusions

Pneumothorax is a typical consequence of chest injuries, even in cases with the presence of extensive head injuries. If a penetrating injury to the chest leading to the escape of air is excluded, the absence of pneumothorax may indicate the post-mortem nature of the chest injuries.

### O3-5

Postmortem coronary computed tomographic angiography: exploring cardiovascular disease through cause-of-death investigation

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<sup>4</sup> Internal Medicine - Cardiology, Yale University, United States

#### Objectives

While studies on postmortem coronary CT angiography (PMCCTA) have shown promising results, most utilize aqueous contrast agents which are not ideal in the postmortem setting.

#### Methods

6 hearts underwent ex vivo PMCCTA with 6% Angiofil® in paraffin oil. The coronaries were cannulated and flushed with normal saline. The hearts were imaged before and after contrast injections. PMCCTA findings were compared to findings of autopsy and cardiovascular pathology examination.

#### Results

Six male decedents, age 59-92 years, were included. On autopsy, cardiovascular disease (CVD) was identified as directly causing or significantly contributing to death in 5 decedents (83%). Prominent septal collaterals were noted in 1 decedent who died directly of CVD and 2 in whom CVD contributed to death (50%). On imaging, severe CVD presented with either abrupt vessel non-opacification (corresponding in 3 decedents with complete obstruction in 1 artery and 75-99% stenosis in 4 arteries), or low-density intra-luminal filling defects with distal opacification (corresponding in 2 decedents with 70-95% stenosis in 4 arteries). In 1 decedent, non-opacification distal to 2 stents was the only indication of stent obstruction.

#### Conclusions

PMCCTA with Angiofil®/paraffin oil is a promising tool for death investigation and exploration of CVD pathophysiology. Collateralization, suggesting increased CVD chronicity and severity, and stent obstruction are useful findings difficult to evaluate via standard cardiovascular pathology examination.

### O3-6

#### Assessment of the occipito-cervical junction: normal alignment measurements on PMCT in adults

Yoshida Maiko<sup>1</sup>, Vincent Cathy<sup>1</sup>, O'Donnell Chris<sup>1</sup>

<sup>1</sup> VIFM, Australia

#### Objectives

Occipito-cervical junction (OCJ) dissociation reflects high-force injury and is important in forensic pathology practice as it is often fatal. Clinically, radiological diagnosis of OCJ dissociation is aided by measuring five distances on CT known as basion-axial interval (BAI), basion-dens interval (BDI), atlanto-dental interval (ADI), atlanto-occipital interval (AOI), and Powers ratio. A previous report (1) presented the normal measurements of the BDI and the BAI on PMCT. In this research, we obtained all five measurements on PMCT and compared them with ante-mortem values.

#### Methods

100 consecutive cases admitted to our institution in 2023 and 2024, ranging from 20 to 60 years old (mean age 46.5 years), were selected for the study. We excluded cases with injury or bony abnormality at the OCJ, whilst we included those cases with radiological putrefaction. On PMCT, we measured the five parameters on high resolution, bone algorithm images as follows: BAI, BDI, ADI, AOI, and Powers ratio using syngo.via software.

#### Results

The BAI score ranged from 2.2 to 10.6 mm (mean=5.55, SD=1.91). The BDI score ranged from 1.6 to 8.5 mm (mean=5.25, SD=1.47). The ADI score ranged from 0.4 to 2.3 mm (mean=1.0, SD=0.03). The AOI score ranged from 0.5 to 2.8 mm (mean=1.2, SD=0.34). The Power ratio ranged from 0.567 to 0.954 (mean=0.745, SD=0.075).

#### Conclusions

Normal values of five measurements at the OCJ were obtained. Based on clinical studies, these results should be valuable in assessing injuries at the OCJ using PMCT.

O3-7

Assessment of the occipito-cervical junction: normal alignment measurements on PMCT in children

Yoshida Maiko<sup>1</sup>, Vincent Cathy<sup>1</sup>, O'Donnell Chris<sup>1</sup>

<sup>1</sup> VIFM, Australia

### Objectives

We divided the group into 4 age distributions: Group A (age 0-2), Group B (age 3-5), Group C (age 6-10), and Group D (age 11-15). In each group, 40 consecutive cases admitted to our institution were selected. We excluded cases with injury or bony abnormality at the OCJ, whilst we included those with radiological putrefaction. On PMCT, we measured the five parameters on high-resolution bone algorithm images: BAI, BDI, ADI, AOI, and Powers ratio using Syngo.via software.

### Methods

We divided the group into 4 age distributions: Group A (age 0-2), Group B (age 3-5), Group C (age 6-10), and Group D (age 11-15). In each group, 40 consecutive cases admitted to our institution were selected. We excluded cases with injury or bony abnormality at the OCJ, whilst we included those with radiological putrefaction. On PMCT, we measured the five parameters on high-resolution bone algorithm images: BAI, BDI, ADI, AOI, and Powers ratio using Syngo.via software.

### Results

The results are as follows.

Group BAI (mm) BDI (mm) ADI (mm) AOI (mm) P ratio

A 0 to 6.7 5.2 to 10.2 0.9 to 3.8 1.6 to 4.5 0.32 to 0.92

B 3 to 10.2 4.8 to 10 1.4 to 4.0 1.8 to 3.6 0.59 to 0.87

C 0 to 13.2 1.7 to 9.3 1.2 to 3.5 1.2 to 4.5 0.58 to 0.82

D 1.1 to 9.8 2.1 to 8.3 0.3 to 3.3 0.7 to 5.0 0.60 to 0.82

### Conclusions

Normal values of five measurements at the OCJ in children were obtained. These results should be valuable in assessing injuries at the OCJ using PMCT.

O3-8

Forensic imaging and its application in India - present status, scope and future aspects

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### Objectives

The scope of forensic imaging is limited in many developing countries, including India, due to the cost, expertise, and infrastructure required to carry out the radiological procedures. In India, forensic radiology services are mainly utilised for age determination and assessment of injuries in traumatic cases like assault, child abuse, etc. Postmortem use of radiological imaging is primarily restricted to the use of conventional radiology (X-rays) in locating projectiles in firearm fatalities.

### Methods

Literature search has revealed that forensic services vary wildly across the geographical regions in India in their functioning related to postmortem examination, clinical forensic medicine, forensic anthropology cases, etc.

### Results

The primary challenges identified in establishing and developing forensic radiological services are the expenditure, infrastructure and expertise required to carry out these services.

### Conclusions

The growing awareness regarding the utilization of post-mortem radiological imaging in forensic pathology, forensic anthropology and academic research has given hope for progressing this field of forensic imaging and forensic radiology. The establishment of higher academic institutes like AIIMS and NFSU and support from research funding agencies like ICMR have played pivotal roles in advancing imaging in forensic investigations and academic research.



## O4-1

### Forensic radiology in the living: imaging of abuse and neglect

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#### Objectives

The objectives of this presentation are:

1. To review radiologic signs suggestive of non-accidental injuries.
2. To provide an overview of typical injury patterns in victims of physical violence.
3. To offer recommendations on how to write radiology reports in cases concerning non-accidental injury.

#### Methods

A review of current radiologic literature was conducted to examine imaging findings related to non-accidental injuries.

#### Results

1. The majority of adult patients presenting for medical care with non-accidental injuries in adults are women. A frequent common denominator among victims of abuse is a relationship of dependency with the perpetrator, leading to a high number of unreported cases.
2. Suspicious signs on imaging include (1) a mismatch between patient history and imaging findings, (2) injuries in target areas and defensive locations, and (3) the presence of acute and old injuries on the same imaging study.
3. Radiology reports must include a description of all acute, healing and healed injuries on the current imaging study. In cases with a mismatch between the imaging findings and the patient history, it may be appropriate to describe the typical mechanism for the present injury. There is strong agreement in the literature that any concern for non-accidental injury should be discussed with the referring clinician.

#### Conclusions

Radiologists may be able to detect unreported cases of non-accidental injury, which may contribute to freeing a victim from their abuser.

## O4-2

When clinical imaging helps the forensic doctor, about some interesting cases

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SAVALL Frederic<sup>1</sup>, MOKRANE Fatima Zohra<sup>2</sup>, Telmon Norbeert<sup>1</sup>

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<sup>2</sup> Radiology department, CHU Toulouse-Rangueil, France

### Objectives

- forensic imaging is not just for the cadavers!
- to understand the essential synergy between radiology and forensic medicine

### Methods

Forensic imaging of the living is a part of forensic imaging alongside postmortem imaging. In addition to assess sequelae, objectify lesions, and estimate the age of living individuals, clinical forensic imaging can be critical in some clinical forensic cases.

The forensic physician's understanding of the trauma can be done by re-reading the images. The concepts of compatibility and specificity are familiar to the forensic pathologist, but may be less so to the radiologist.

The integration of radiological data into the forensic pathologist's report is sometimes the only objective data, given the sometimes long delay between the examination of the victim and the date of the traumatic event.

### Results

The integration of clinical forensic radiological data can provide answers, even partial answers, to investigators or magistrates.

The identification of a medical history from the victim's imaging can sometimes help to understand the cause of the injuries and the force required to cause them. Indeed, the radiologist may diagnose previously unknown pathologies in a patient, which may help to explain the case.

### Conclusions

The possibilities of radiological documentation after non-lethal ballistic or stab wounds are also of great importance for the forensic physician in order to assess the lesion. Numerous examples will be given during this lecture.

#### O4-3

A pictorial case series of common causes of death seen in natural/non-suspicious death investigations by post mortem computed tomography (PMCT)

Singla Nehal, Ahmad Fatima, Rahimi Salman, Shah Mohammad Ali, Davendralingam Natasha<sup>1</sup>

<sup>1</sup> Anubix Ltd., United Kingdom

#### Objectives

To demonstrate a case series illustrating the radiological features on PMCT of the most common causes of death identified in the investigation of natural/non-suspicious deaths in the United Kingdom.

#### Methods

Retrieval of appropriate cases of PMCTs from the local picture and archiving system (PACS) of 2 medical institutions illustrating the most common causes of death on PMCT; and the associated radiological features.

#### Results

Case series demonstrates the following pathology:

1. Ruptured abdominal and thoracic aorta
2. Ruptured myocardial infarction
3. Coronary artery calcification
4. Coronary artery soft atheromatous occlusion
5. Bronchopneumonia
6. Intracranial haemorrhage
7. Malignancy and metastatic disease
8. Congestive cardiac failure
9. Acute pulmonary embolism and deep venous thrombosis (DVT)
10. Cerebrovascular accident

#### Conclusions

The case series demonstrates the most common causes of natural death found on a PMCT series and its associated radiological features to guide radiologists in training to have confidence in diagnosing these findings alongside post mortem modifications.

#### O4-4

### Explaining life after death: manifestations of chronic medical conditions on nonenhanced postmortem CT

Solomon Nadia<sup>1</sup>, McCalla Aliah<sup>2</sup>, Elifritz Jamie<sup>3</sup>, Adolphi Natalie<sup>3</sup>, Sanchez Harold<sup>4</sup>, Sailer Anne<sup>1</sup>, Gosangi Babina<sup>1</sup>, Kroll Jeroen<sup>5</sup>, Daly Barry<sup>6</sup>, Gascho Dominic<sup>7</sup>, Thali Michael<sup>7</sup>, Vermillion Billy<sup>1</sup>, Thorn Stephanie<sup>1</sup>, Sinusas Albert<sup>1</sup>, Revzin Margarita<sup>1</sup>

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#### Objectives

While postmortem CT (PMCT) is increasingly appreciated for its ability to identify cause of death, it can also reveal valuable information about a decedent's life. Although the scope of nonenhanced PMCT has acknowledged limitations, its capacity to reveal a wide variety of acute medical pathologies is similar to that of nonenhanced clinical CT. It can also reveal numerous findings reflecting various chronic medical conditions that may have contributed to death, as well as findings related to consequences of events, habits, or lifestyle choices that bore the ultimate cost.

#### Methods

Imaging findings related to various common medical conditions will be discussed and demonstrated in case examples. A few less common examples will also be included. Healthy comparison cases will be provided to help emphasize the relevant imaging findings.

#### Results

This presentation will review a variety of medical conditions and their associated imaging findings on non-enhanced PMCT, including pulmonary emphysema, hepatic steatosis, alcoholic cirrhosis, medical renal disease, atherosclerotic cardiovascular disease, heart failure, cerebrovascular disease, diabetes mellitus, and more.

#### Conclusions

In the absence of a bullet or a smoking gun, the identification of PMCT findings related to various medical diseases—especially in the presence of potentially associated acute findings—can provide confirmation that death occurred secondary to natural causes and increase confidence in the diagnosis of a medical cause of death.

#### O4-5

A correlational study between invasive autopsy and post mortem computed tomography (PMCT) findings in cases of unascertained cause of death on PMCT at a single medical facility

Rahimi Salman, Ahmad Fatima, Shah Mohammad Ali, Singla Nehal, Davendralingam Natasha<sup>1</sup>

<sup>1</sup> Anubix Ltd., United Kingdom

#### Objectives

To investigate and establish the correlation between the results of invasive autopsy and PMCT findings in cases where the cause of death was unascertained on PMCT at a single medical institution.

#### Methods

A retrospective audit of 35 autopsy reports and PMCT report and images (of cases of unascertained death at PMCT), accessible via a secure PACS (picture archiving and communicating systems) teleradiology platform.

#### Results

1. PMCT had a good pick up rate of all the pertinent descriptive findings however there as a difference in interpretation between pathology and radiology regarding lung findings: infection versus congestion.
2. PMCT was poor at identifying acute pulmonary embolism (PE) versus post mortem clot in cases where deep venous thrombosis (DVT) was not evident.

#### Conclusions

1. PMCT has limitations in the assessment of acute PE versus post mortem clot.
2. Difference in interpretation between radiology and pathology on lung findings. It remains a conundrum on whether radiology is undercalling minor lung infection or pathologist overcalling this as a primary cause of death.

## O4-6

Postmortem computed tomography of COVID-positive hospital decedents: complimentary roles for antemortem and postmortem imaging and autopsy

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### Objectives

Fear of COVID-19 transmissibility led to a temporary halt in autopsies early on. Although valuable data was lost, an opportunity arose to apply postmortem imaging to cause-of-death investigation in the setting of infectious disease and hospital medicine.

### Methods

In an academic teaching hospital, 19 COVID-positive decedents underwent full-body postmortem CT (PMCT) within 48 hours of death. PMCTs were interpreted by fellowship-trained radiologists. Findings were compared to autopsy findings and antemortem imaging.

### Results

10 male and 9 female decedents were scanned (age 34-94 years). Autopsy-determined causes of death were categorized as 'cardiovascular disease' (CVD, 4/19), 'COVID' (8/19), combination 'CVD/COVID' (5/19), and 'other' (2/19). At least one CT from the visit/admission leading up to death was available for 11 decedents. 5 PMCTs showed worsened findings (mainly lung disease). 3 PMCTs showed pertinent new findings: massive pneumomediastinum (1/3), a known necrotic pancreatic collection with a new adjacent layering hematoma and diffuse air emboli (1/3), and strokes which were not apparent on clinical head CT on the day of death (1/3).

### Conclusions

The hospital setting uniquely facilitates rapid postmortem imaging prior to onset of significant decomposition, as well as correlation with autopsy and other medical data. PMCT can identify findings difficult to detect via traditional autopsy (i.e., pathology related to air) and even suggest the acuity of findings when antemortem imaging is available.

O4-7

The cause of death was determined through a post-mortem CT scan in a fatal case following catheter ablation

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### Objectives

In the case of a male patient in his 50s with heart failure due to atrial fibrillation, catheter ablation was performed. However, on the 6th day post-procedure, he experienced sudden death, prompting an investigation into the cause of death.

### Methods

To assess the relationship between the catheter ablation procedure and the occurrence of death, post-mortem CT was followed by a pathological autopsy.

### Results

CT scan was performed to determine the cause of death 30 minutes after death. The post-mortem CT scan revealed acute aortic dissection and cardiac tamponade, which was considered to be the cause of death.

Pathological autopsy performed two days later showed dissection of the ascending aorta, hematoma from the base of the aortic valve to the distal part of the aortic arch, and accumulation of hemorrhagic pericardial fluid. There were no obvious defects in the right ventricle, right atrium, left atrium, inferior vena cava, or superior vena cava, and yellowish-white punctate spots were observed in the left atrium, which were considered to be changes after ablation. As a result of the autopsy findings, the cause of death was diagnosed as cardiac tamponade due to Stanford type A acute aortic dissection, and there was no correlation with the ablation technique.

### Conclusions

We reported a case in which the cause of death was elucidated by performing a post-mortem CT scan on a patient who died after catheter ablation for atrial fibrillation.

## O5-1

Virtopsy concept around the world: institute-based survey of worldwide forensic postmortem imaging

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### Objectives

Our study analyzes a survey focusing on the global adoption and application of postmortem imaging, aiming to identify and understand regional differences in its use.

### Methods

We designed a survey with 18 mixed-format questions and distributed it worldwide via email and social networks. The survey covered aspects like autopsy rates, imaging techniques, reasons for postmortem imaging, involved personnel, evaluation methods, and communication of findings. Initially sent to institutes known for postmortem imaging research, it was later shared through international forensic radiology and radiographer associations.

### Results

We received responses from 100 institutions across 29 countries, representing 6 continents, with Europe being the most represented (69%). Autopsy numbers at these institutions typically ranged from 100-500 yearly. The most common imaging method was Postmortem Computed Tomography (PMCT, 89%), with requests often coming from forensic medicine institutes (51%), researchers (42%), police (43%), or public prosecutor's offices (54%). Radiology technicians predominantly performed PMCT (65%), and clinical radiologists were primarily responsible for interpreting the images (32%). Most image interpreters had specialized training (64%).

### Conclusions

This study sheds light on the varied global practices and adoption of postmortem imaging in forensic medicine. It underscores its significance in forensic investigations and provides insight into the personnel, techniques, and procedures used worldwide.



O5-2

A paradigm shift in the interpretation of posterior rib fractures in children?

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### Objectives

Posterior rib fractures in children are considered to be highly suggestive of non-accidental injury [1-4].

### Methods

Several studies have concluded that posterior rib fractures are not encountered after cardiopulmonary resuscitation (CPR) [2, 4-7]. In these studies, rib fractures were diagnosed on radiographs and not on post-mortem CT scan (PMCT). However, PMCT is superior to radiography in diagnosing rib fractures [8, 9].

### Results

Around 2000 a new technique for CPR in infants was recommended in the United States of America and Australia, the so-called two thumb chest compression method [10-12]. Several cases of posterior rib fractures in infants have been described in the literature after the use of this technique [13].

### Conclusions

The authors will give an overview of the literature and will present two thought-provoking cases of infants with posterior rib fractures after CPR.

O5-3

Abdominal bleeding due to CPR: PMCTA with autopsy correlation

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### Objectives

Postmortem CT (PMCT) is used for autopsy triage after sudden unexpected death. Significance of intrabdominal (IA) or retroperitoneal (RP) haematoma is uncertain if external cardiac massage (ECM) has been undertaken prior to death.

### Methods

Review of cases of ECM associated IA or RP haematoma on PMCT with PMCT angiography (PMCTA) and autopsy correlation.

### Results

ECM-associated complications are common on PMCT including buckle rib fractures and pulmonary injury. Abdominal bleeding is less common. Based on PMCTA, IA haematoma is associated with hepatic laceration between right and left lobes extending into the inferior vena cava or hepatic veins. RP haematoma is localized around the renal or adrenal veins and associated with rupture of draining veins. This is thought to be a “water hammer” effect.

### Conclusions

In sudden unexpected death, IA or RP haematoma on PMCT must be differentiated between ECM-associated artefact and pathology causing death. PMCTA (notably venous phase) is helpful in this task. Such artefacts are more likely to be seen due to the increasing prevalence of mechanical assist devices and GoodSAM applications.

O5-4

Death by femoral artery: PMCT findings

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### Objectives

The femoral artery is of large caliber and superficial thus vulnerable to penetrating trauma. Postmortem CT (PMCT) is routinely used for triage at our institution.

### Methods

Over an 11 year period, all cases of fatal, isolated femoral artery rupture were identified. Circumstances of death, PMCT and autopsy findings were retrospectively reviewed.

### Results

29 cases were identified including 11 (38%) post angiography, 6 (21%) post surgery, 5 (17%) sepsis, 4 (14%) penetrating trauma, 2 (7%) spontaneous and 1 (3%) gunshot. PMCT identification of groin haematoma was useful in localizing the site of bleeding but this was not invariable as blood loss can be external rather than into soft tissues. PMCT assisted in determining trajectory or path of penetration, and in isolated cases PMCT angiography (PMCTA) confirmed disruption to the artery by way of contrast leak, prior to autopsy. Underlying pathology leading to rupture could also be detected on PMCT, especially aneurysms.

### Conclusions

PMCT may suggest the diagnosis of femoral artery injury on the basis of skin defects or penetrating objects and groin haematoma, although this is not always prominent due to external bleeding. PMCTA can be useful to confirm arterial wall disruption prior to autopsy, allowing the pathologist to plan their dissection.

O5-5

CT imaging of a case involving thermal and sharp trauma

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### Objectives

The objective of this presentation is to share a case study highlighting the advantages of CT imaging in a case where thermal alterations obscured sharp trauma.

### Methods

This case involved a multi-agency investigation of a fire in which an adult female and her three young children were found deceased. For the remains of the four victims, bone fragments were reconstructed to the extent possible, and skulls were CT scanned using a high-resolution industrial micro-CT scanner.

### Results

Due to fire-related discoloration of the bone, sharp traumas on the cranium of the adult were difficult to appreciate visually, but CT imaging helped to significantly improve visualization of the alterations. CT imaging also facilitated the preservation of the conditions of all four crania, which were appreciably altered by the fire, and for the adult individual reconstructed from multiple fragments.

### Conclusions

The contributions of various agencies and laboratory analyses including forensic anthropological imaging helped contribute to the successful resolution of the case.

## O5-6

Death due to acupuncture – a case report comparing post-mortem computed tomography with autopsy findings

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### Objectives

We present the case of an elderly woman who died unexpectedly a few hours after acupuncture therapy.

### Methods

Unenhanced post-mortem computed tomography (PMCT) and complete autopsy were performed, including visual inspection, internal inspection, microscopy, and toxicological analyses.

### Results

PMCT revealed bilateral tension pneumothorax, chest wall hematomas, and right lower pulmonary lobe laceration. Upon visual inspection of the body, more than 40 puncture wounds were found on the back.

During autopsy, 6 of the puncture wounds reached lung parenchyma (3 in each lung). The cause of death was determined as acupuncture-induced bilateral tension pneumothorax resulting in acute respiratory and circulatory failure.

### Conclusions

It was possible to determine the cause of death using PMCT, although autopsy was needed to detect the total number of injuries. The acupuncture therapist was prosecuted for causing the death and practicing without a license.

O5-7

Where the grape hoe's go? using PMCT scanning as the best tool to looking for cause of death, Indonesian case

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### Objectives

Autopsy, the standard procedure for looking the cause of death in Forensic Cases. Sometimes the cases need more screening to preserve the evidence and looking for others causes that could involved in the COD of the victim. the PMCT Scanning can be use, first is to screening the biohazard of the victim's body that might dangerous to the forensic pathologist, second is to screening the victim's body that might contain some of the evidence we need to conclude in the report of the autopsy and we might found others findings that could be help in the further investigations of the case. The sexual assault case of the 18 years old girl by 2 men and 1 boy at one night in the bedroom dormitory of the girl's workplace. She was sent to our mortuary within the grape hoe's wooden handle inside her vagina.

### Methods

Using the "Hitachi" CT Scanning device.

### Results

The wooden handle of the Grape Hoe, stagnant at the right chest in the cavum of pleura, go inside the vagina got through the uterus rupture the liver, and rupture the aortic abdomen, lastly rupture the second pleura of the lungs. The cause of the death of the victim is the bleeding of the rupture of abdominal aortic.

### Conclusions

In this case to explore the channel of the Grape Hoe's wooden handle goes from the victim's vagina, PMCT Scanning see through her body and found the cause of death immediately. PMCT Scanning is the useful and best tool to looking for the cause of death in some cases of the victim's death on Forensic investigation.

P-1

Legal requirements for research in France

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<sup>3</sup> CHU Nantes, Medico-legal department, France

### Objectives

Forensic imaging is a relatively young medical specialty in France. Like any specialty, it tends to develop through medical and scientific research.

However, forensic imaging research must meet specific legal standards to be valid.

The aim of this work is to clarify for doctors the legal requirements to be respected depending on the type of studies carried out.

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P-2

Assessment of bronchiectasis on PMCT

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### Objectives

The Bronchiectasis Radiologically Indexed CT Score (BRICS) is an established technique to quantify the severity of bronchiectasis, combining the parameters of bronchial dilatation and number of bronchopulmonary segments affected by emphysema. This study is designed to determine if BRICS criteria can be applied on PMCT.

### Methods

PMCT lung images of 26 non-intubated heroin overdose cases were reviewed and BRICS criteria applied using Syngo.via® software. A further 21 PMCT scans of intubated deceased persons were also reviewed. These cases were compared with the PMCT scans of 25 deceased persons with known thermal inhalation injury requiring a period of intubation prior to death. Data were analysed using ordinal logistic regression (SPSS, Version 29).

### Results

For the thermal inhalation injury with intubation group, there was a significant positive association between intubation time and BRICS assessment ( $p = 0.04$ ). Analysis of the intubation group (without thermal injury) revealed no significant association between intubation time and BRICS assessment ( $p = 0.35$ ). For the non-intubated group (heroin overdose deaths) there was no association between age and BRICS assessment ( $p = 0.26$ ).

### Conclusions

BRICS assessment can be performed on PMCT and is a valid technique for assessment of bronchiectasis after death, with or without upper respiratory intubation. Bronchiectasis is more prevalent and severe in cases of prolonged intubation after an accelerant-fueled inhalational thermal injury.



P-3

Flaring up the mesentery: applying the Lodox eXero-dr ® statscan for expedited postmortem angiography

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### Objectives

In resource-constrained forensic settings, the LODOX eXero-DR® Statscan emerges as an affordable and effective tool for aiding Forensic Pathologists. This study presents a noteworthy case involving a 63-year-old male diagnosed with follicular lymphoma, who experienced small bowel perforation 11 days post a mesenteric lymph node biopsy. The post-mortem examination revealed lymphadenopathy and bowel perforation, prompting further investigation.

### Methods

To enhance the autopsy process, post-mortem angiography using LODOX eXero-DR® was employed. The mesentery was excised during the examination, exposing the origin of the Superior Mesenteric Artery. Contrast medium was injected into the artery, allowing for precise identification of the vascular obstruction site.

### Results

The angiography with LODOX eXero-DR® proved instrumental in providing vital information, facilitating the identification of underlying pathology and aiding in record creation.

### Conclusions

This case demonstrates the potential of angiography with emerging technologies, assisting countries lacking access to PMCT angiography. Notably, this represents the inaugural documentation of LODOX eXero-DR® Statscan use in post-mortem angiography.

P-4

Delineation ability of one-scan fused CT with deep learning imaging reconstruction (DLIR) to visualize diseases of cerebral artery and parenchyma

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### Objectives

Fused PMCT which we previously reported is to add multiple scans of the same site in order to reduce image noise, especially for vascular disease delineation.

We reported the usefulness of fused deep learning imaging reconstruction (DLIR)-processed one CT image (i.e. "one-scan fused CT") of aortic dissection lesions in ISFRI2023.

In this study, the delineation ability of diseases of cerebral artery and parenchyma using one-scan fused CT.

### Methods

This study contrasts the efficacy of conventional PMCT and one-scan fused PMCT in visualizing cerebral artery and parenchyma for two cases of suspected cerebral artery thrombosis and one case of brain stem injury accompanied by traumatic subarachnoid hemorrhage.

### Results

By way of 3-times fused DLIR-processed one-scan PMCT, the cerebral artery and parenchyma was more clearly delineated, and reduced noise.

Both high absorptive areas of cerebral arteries where fresh thrombus is suspected, and brain stem injury and hemorrhage became more visible.

However, it was difficult to distinguish fresh thrombus from hypostasis of blood because an autopsy was not performed.

### Conclusions

3-time-fused DLIR-processed one-scan PMCT can clearly delineate diseases of cerebral artery and parenchyma.

We would contend that an autopsy should be performed in case of cerebral artery thrombosis.

One-scan fused CT technique may be useful as a diagnostic imaging using head CT scan when performing mechanical thrombectomy for acute ischemic stroke of living bodies.

P-5

Evaluating IVIM diffusion metrics without perfusion in postmortem brain

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### Objectives

This research focuses on the application of intravoxel incoherent motion (IVIM) imaging to understand diffusion signals in the postmortem brain where perfusion is absent. IVIM parameters are considered to reflect blood flow but no studies have proved that as the condition without blood flow is not replicable in living organisms.

### Methods

We conducted MRI scans on 18 cadavers, capturing diffusion-weighted images of specific brain regions before autopsy. The regions of interest (ROIs) included the lateral ventricles, white matter, and gray matter of both the frontal and occipital lobes. Through IVIM analysis, we measured apparent diffusion coefficient (ADC), D (indicative of water molecule movement), D\* (reflective of fast diffusion components like blood flow), and f (blood flow volume fraction).

### Results

Across all ROIs, the ADC and D values matched, indicating that diffusion in the post-mortem brain is unaffected by blood flow. The consistency of ADC and D across areas with typically different blood flow patterns—like white and gray matter—strengthens the evidence of absent perfusion impact. The volume fraction of blood flow, f, was lower in deceased brains, aligning with the absence of blood circulation.

### Conclusions

The study effectively demonstrates that post-mortem IVIM can reveal the absence of blood flow, offering a unique perspective on brain structures unaffected by perfusion. These insights could be instrumental in enhancing our understanding of IVIM imaging in living brains.

P-6

Fatal complication of Fetoscopic Endotracheal Occlusion (FETO) - could postmortem computed tomography (PMCT) be helpful?

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### Objectives

Analysis of the suitability of PMCT in the case of neonatal death occurred after fetoscopic endotracheal occlusion (FETO) performed due to the severe isolated left-sided congenital diaphragmatic hernia (CDH).

### Methods

After the sudden death of the neonate, the family notified the prosecutor's office about the possibility of medical malpractice. A specially trained forensic pathologist performed the CT scan with a 16-row Astelion CT scanner (Toshiba). Full forensic autopsy, followed by histopathological and toxicological analyses were performed. A multidisciplinary team of medical experts analyzed the collected medical documentation and prosecutor's case files.

### Results

PMCT revealed the presence of intact balloon in the trachea, atelectasis of both lungs and the presence of gas in the veins of the neck, in the heart and in the sinuses of the skull. This was evidence that after the birth of the child, when an attempt was made to percutaneously puncture the balloon stuck in the trachea, a vein was punctured and the balloon remained intact. This made it impossible to ventilate the lungs. Autopsy confirmed radiological findings. The adverse event was classified as a rare but possible medical complication of FETO in the treatment of CDH.

### Conclusions

PMCT can be helpful in case of neonatal death after fetoscopic endotracheal occlusion procedure because it allows for an objective assessment of whether the procedures used after the birth of the newborn enabled effective lung ventilation.

P-7

Unusual brainstem complete disruption and dislocation caused by the fracture of the upper thoracic spinal column

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### Introduction

Post-mortem CT imaging may give the opportunity to visualize extraordinary findings. The authors present a case of a 59-year-old female, with a history of psychiatric illness, that suffered multilocal injuries due to falling from a 10-story building in Krakow, Poland.

### Methods

A post-mortem CT imaging and a consecutive conventional forensic autopsy were performed to examine the extent of the injuries.

### Results

Post-mortem CT imaging discoveries included the finding of a total pontomedullary avulsion and displacement due to apparent complete disruption of the upper thoracic spine with traction injury on the brainstem. Almost no other such case has been previously reported. Several variables are involved in brainstem injury including head hyperextension, torsion, bone fractures, degree of inversion, padding of the fall surface, among others.

### Conclusions

Complete fracture of any spinal column fragment usually causes spinal cord damage almost on the same level, but traction injuries with pontomedullary avulsion should also be taken into account as this is potentially the weakest part of the brainstem-spinal cord axis.

O6-1

Mobile forensic photogrammetry in the field: addressing non-collaborative surfaces

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<sup>3</sup> Biometrie und Bildforensik, Forensisches Institut Zürich, Switzerland

### Objectives

3D documentation of actual forensic casework poses unique challenges that differ significantly from those from ideal setting such as lab mounted camera installation where photographic quality is usually so high that technical details such as file format or photo technique may be less relevant.

When we discussed how to best approach technically difficult (non-collaborative) surfaces from angle of on-scene forensic pathologist with mobile camera, we explored various strategies. In that context, even minor photographic parameter changes can significantly impact processing of images and quality of resulting models [1].

### Methods

Experiments focused on challenging surfaces. Using DSLR camera, photos were taken with exposure bracketing and saved in both JPG and RAW formats. Typical standard software was used for data reconstruction, post processing and quality evaluation.

### Results

RAW files and exposure bracketing improved 3D meshes for smooth and colored surfaces, like decomposed skin. Highly structured surfaces, such as burned body, produced satisfactory meshes from JPGs alone.

### Conclusions

Fieldwork photogrammetry of non-collaborative surfaces benefits from exposure bracketing and RAW formats, in line with prior landscape and building photogrammetry research [2]. Further optimization is necessary."

[1] <https://doi.org/10.3846/1392-1541.2009.35.29-33>

[2] <https://doi.org/10.3390/jimaging6050030>

O6-2

Utilization of 3D surface scanning in crime scene investigation and forensic medicine – comparative analysis of various technologies and their benefits

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### Objectives

In the past decade, digital surface scanning technologies have advanced significantly, with notable integration into forensic science and medicine over the last 5 years. Laser and LiDAR scanning have emerged as primary tools for CSI, alongside the adoption of photogrammetry, structured light scanning, and hybrid methods. The recent development of hybrid mobile scanning, utilizing LiDAR sensors in smartphones with specialized software, highlights the need for critical evaluation.

### Methods

Over three years, we conducted extensive experiments with various 3D surface scanning technologies in routine forensic operations, including CSI and post-mortem examinations. Our findings offer nuanced insights into the strengths and limitations of each technology.

### Results

We discuss the practical application of these technologies, emphasizing their specific advantages and considerations across different scenarios. Recommendations are provided for leveraging their strengths, including their utility in event reconstruction and legal proceedings. Mobile variants like structured light and LiDAR+photogrammetry scanning are particularly emphasized, along with software applications enhancing forensic practice.

### Conclusions

While surface 3D scanning in forensic medicine offers undeniable benefits, its effective use requires a nuanced understanding of each technology's advantages and accessibility within forensic units. This presentation elucidates practical applications and implementation nuances for real-world scenarios.

## O6-3

Beyond decay: advancing PMCT for accurate bone mineral density analysis in the deceased

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### Objectives

In quantitative postmortem computed tomography (qPMCT) the presence of gas from intracorporeal putrefaction can obscure measurements, including bone mineral density (BMD).

The objective of the project was to develop and test an unbiased open-source volumetric BMD analysis procedure for PMCT.

### Methods

The retrospective study was based on 154 cadavers who had PMCT performed during routine forensic examinations. Cadavers were assigned into three putrefaction groups: “None” (n=95), “Mild” (n=54), and “Moderate” (n=10).

We tested and compared three different analysis procedures (AP1-3) for BMD analysis of the lumbar vertebrae (L1-3) from PMCT data based on synchronous PMCT acquisition with a solid five-phase phantom.

AP1 was based on commercially available software, which required the operator to subjectively place region of interest (ROIs) in areas without gas.

For AP2 and AP3 the open-source software “FIJI” (ImageJ) was used, which enabled comparison of objectively placed ROIs with AP1.

In AP3, prior to BMD calculation, threshold-filtering was applied to remove signal from gas. Interobserver correlation was used to assess the reproducibility of AP3 results.

### Results

The developed open-source approach (AP3) yielded BMD measurements comparable to in vivo values published in clinical studies and provided great interobserver correlation.

### Conclusions

The study successfully enabled sound objective and precise BMD measurements in PMCT, even in putrefied cadavers.



O6-4

Improving PMCT angiography visualization in forensic imaging - brute force methods

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### Objectives

Post mortem CT angiography (PMCTA) enhances contrast by intravascular administration of contrast agent, yet excess density can introduce artifacts like beam hardening during data reconstruction via Radon transform. High-definition CT scans increase resolution but accompanied by noise, while 3D rendering techniques such as SSD and VRT depend on thresholding, while PMCTA visualizations may be compromised by the partial volume effect.

### Methods

Brute force visualization methods (advanced post processing / filtering using 3D texture and data conditioning methods as available in standard software [1]) are used to improve visualization. Data: method use is illustrated using adult PMCTA and experimental micro PMCTA development on piglet.

### Results

Vascular definition in 2D and 3D is enhanced using advanced post processing methods. The parameters identified to produce good results are dependent on specific density values and noise.

### Conclusions

PMCTA data evaluation may benefit from brute force visualization enhancements. More research to better streamline workflow may be required.

[1] <https://doi.org/10.1007/s00414-021-02581-4>

## O6-5

### Applying dual energy post-processing to postmortem coronary computed tomographic angiography: a feasibility study

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#### Objectives

Research suggests almost two-thirds of autopsies may be forgone by using postmortem CT angiography. While dual energy (DE) post-processing has been applied in both ante- and postmortem settings, research on its application to postmortem coronary computed tomographic angiography (PMCCTA) is limited.

#### Methods

Phantoms were created using combinations of iodinated (nonaqueous Angiofil®, aqueous Omnipaque™) and gadolinium (Dotarem®) contrast, with water dilutions. Phantoms were imaged using DE single-source CT (Definition Edge, Siemens; Dual Energy, 80/140 kV). Ex-vivo PMCCTA of a porcine heart was then performed using a cone beam fluoroscopy system (Allura Xper FD20, Philips) before and serially after injection of gadolinium 0.25 mmol/mL, followed by 6% Angiofil®. The heart was then imaged using DE single-source CT. DE post-processing was performed with SyngoVia software (Siemens).

#### Results

DE analysis successfully discriminated between iodine and gadolinium in the first phantom. In the second phantom, 6% Angiofil® layered on top of aqueous gadolinium, facilitating differentiation. In the heart, Angiofil® opacified the epicardial vessels while gadolinium diffused into the myocardium.

#### Conclusions

DE post-processing may be useful for isolating iodinated from gadolinium contrast in ex vivo PMCCTA. Serial injection of gadolinium and Angiofil® may allow for simultaneous characterization of vascular patency and changes in myocardial perfusion associated with either infarction or reperfusion injury.

## O7-1

### Postmortem enhanced CT using CT guided direct puncture

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#### Objectives

To assess the usefulness of postmortem contrast-enhanced CT (PMeCT) performed using CT guided direct puncture.

#### Methods

PMeCT was performed in 9 cases (4 male, 5 female) of mean age 76 (52–92) years. The mean time elapsed since death was 29.1 (12.0–72.0) hours. The location of the target vessel for puncture was determined based on the CT table position and a grid placed on the body surface. An 18-G spinal needle was advanced to the puncture site, and the needle tip was confirmed to have reached the intended blood vessel. Using negative pressure with a 20-ml syringe, the needle tip was advanced until reverse bleeding was confirmed. Diluted contrast medium was injected slowly to ensure its dispersion within the blood vessels. Following confirmation of no extravasation, additional doses of diluted contrast agent were injected in 3–4 divided doses, with CT scans obtained at each step to track the distribution of contrast agent over time.

#### Results

PMeCT was successful in all cases, revealing cardiac tamponade in 7 (ascending aortic dissection, 6; cardiac rupture, 1), and thoracic aortic aneurysm rupture and iliac artery aneurysm rupture in one case each. No procedure-related extravasation (pseudo-lesion) was observed.

#### Conclusions

When postmortem CT reveals pericardial hematoma or bleeding in the thoracic or abdominal cavity, PMeCT can identify the source of bleeding.

## O7-2

### Photon Counting CT in forensic radiology; first experience

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#### Objectives

To explore the potential role of photon counting computed tomography (CT) in the field of forensic and post-mortem imaging. This newly introduced scanning technique not only benefits from improved spatial resolution with less noise, but also enables material differentiation based on spectral information (for example potential bone marrow edema).

#### Methods

Several forensic cases have been imaged on a first generation photon counting CT (Naeotom Alpha, Siemens Healthineers). Non-contrast enhanced images were acquired and reconstructed with various soft and hard kernels for different radiological assessment.

#### Results

A pictorial overview of several cases demonstrating the different advantages of implementing photon counting CT in forensic and post-mortem imaging and their radiological interpretation.

#### Conclusions

This study demonstrates case examples of the additional benefit of photon counting CT in forensic and post-mortem imaging.

## O7-3

### Initial experience of Photon-Counting Detector CT in forensic medicine

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### Objectives

Photon-counting detector CT (PCD-CT) is a new CT that detects X-ray by counting photons with semiconductor detectors rather than by integrating the energy of photons. Although clinical applications of PCD-CT have started, as far as we know, there are no reports on its use in forensics. We report our initial experiences with PCD-CT in forensics.

### Methods

The CT to be evaluated was a prototype PCD-CT at FUJIFILM Healthcare, and both ultra-high resolution (UHR) mode and multi-energy discrimination (MED) mode were studied. For 6 months, 62 forensic cases were scanned by both a conventional CT and the PCD-CT prior to autopsy. Also, specimen such as hearts or gastric contents were scanned by the PCD-CT.

### Results

In the UHR mode, microfractures that was difficult to be seen with conventional CT could be noted. In contrast-enhanced CT of the heart specimen, the peripheral blood vessels and the stent lumen could be evaluated more clearly than with conventional CT. In MED mode, bone contusions or bone marrow edema could be evaluated with virtual non-calcium images. The energy analysis of some poisoning cases showed the usefulness.

### Conclusions

In forensics, PCD-CT was useful in our experiences. While high-resolution CT and dual-energy CT with conventional detectors are available, PCD-CT is capable of both in one machine, which is more efficient. Although cost is an issue, PCD-CT is likely to become more widespread in forensic medicine in the future, replacing conventional CT.

O7-4

Characterization of bullets by Photon-Counting CT: a phantom-based study

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### Objectives

Radiological analyses of a bullet lodged in a body could provide crucial information for the forensic investigation. The aim of this study was to assess the value of the newly introduced photon-counting CT in the characterisation of bullets, based on its: (1) material composition; (2) shape; and (3) dimensions.

### Methods

Eleven bullets from most frequently encountered calibers in forensic cases in the Netherlands were placed in separate agar-based phantoms. Images were acquired on a first generation photon-counting CT-scanner (NAEOTOM Alpha, Siemens Healthineers) and obtained at 140 kV and 400 mAs at several slice thicknesses (i.e. 0,2 to 2,0 mm). Images were reconstructed with various soft - and hard kernels and iterative metal artefact reduction was applied. Material composition was examined based on dual-energy ratio's (DER) and - indices (DEI). Ultra-high resolution CT-images were used to assess the bullets' shape and dimensions and were compared to an assessment by a ballistic expert as the reference standard.

### Results

Analyses of DER's and DEI's of the bullets clearly differentiated bullets that contained materials with a high and a low atomic number, between a bullet's jacket and core and identified bullets without a jacket. Preliminary analyses showed accurate assessment of bullets' shape, as well as its dimensions.

### Conclusions

This study demonstrates the value of photon-counting CT in characterizing bullets based on their material composition, shape and dimensions in a forensic setting.

O7-5

HiP-CT imaging of the human colon; novel insights in the ENS

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### Objectives

The Human Organ Atlas hub (HOAHUB) aims to image human organs in microscale resolution. This research will aim to investigate the 3D architecture and functionality of the human Enteric Nervous System (ENS) using cutting-edge imaging of Hierarchical Phase-Contrast CT (HiP-CT) through the European Radiation Synchrotron Facility. By focusing on the microscale structures we aim to provide a unique perspective on ENS morphology in humans.

### Methods

Through the HOAHUB, HiP-CT was made available for a feasibility study of the human colon. This entails an overview scan of 20 micrometer voxel size and zoomscans reaching 4 and 1 micrometer. This will enable us to study microscale structure while maintaining tissue integrity allowing for downstream research like micro-CT and histology.

### Results

This research is yet to be conducted at time of submission. We hypothesize that the ENS has a more complicated 3D morphology than is currently suspected. We anticipate new insights into its morphology and offer diagnostic criteria for specific intestinal motility disorders and will identify potential pathogenic pathways suitable for therapeutic interventions.

### Conclusions

The research holds promise in anatomical research and in particular for understanding the ENS in humans. By studying the fundamentals of the ENS we anticipate that we can shed new light on normal physiology and lay the foundation for using this technique to study diseased colons.

O7-6

HiP-CT synchrotron imaging: a new gold standard in anatomy?

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### Objectives

The Human Organ Atlas Hub (HOAHub) is comprised of an international consortium of eight research groups from diverse backgrounds, both medical and physical, aiming to map entire human organs in cellular detail. This team, including Bernadette de Bakker from Amsterdam UMC, in collaboration with the European Synchrotron (ESRF) in Grenoble, France, has developed a new research technique; Hierarchical Phase-Contrast Tomography (HiP-CT).

### Methods

Thanks to this scanning technology, utilizing the world's most powerful X-ray source, it is now possible for the first time to non-destructively examine whole organs at multiple resolution levels. Overview scans of a complete organ generally have a resolution of 20 micrometers, while zoomed-in images of specific regions can achieve a voxel of

### Results

More than 50 organs, including lungs, brains, hearts, kidneys, spleen, and liver, have already been imaged in 3D. This reference database is being expanded to include pathological samples and is publicly accessible worldwide. Thanks to financial contributions from the European Union and the Chan Zuckerberg Initiative (CZI), HiP-CT scanning time for clinical/anatomical inquiries is available for the coming years.

### Conclusions

The HOAHub provides a unique opportunity for anatomists, physicians, and researchers to use HiP-CT to map tissue in unprecedented detail and correlate this with morphological and molecular data. We view the HOAHub as an important bridge between anatomy, clinical pathology, and (forensic) radiology. For more information, please contact us or visit: <https://www.3dhumandevlopment.com/synchrotron-imaging/>.



## O7-7

The added value of post-mortem MRI in forensic imaging: filling in the missing pieces – a case series of five stabbing incidents

van de Voorde Paulien<sup>1</sup>, Gregoire Cédrique<sup>1</sup>, Crombag Geneviève<sup>1</sup>, Nobel Martijn<sup>2</sup>, Peters Nicky<sup>2</sup>

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### Objectives

This case series demonstrates the added value of Post-Mortem Magnetic Resonance Imaging (PMMRI) in forensic cases.

### Methods

In five fatal stabbing incidents, a PMMRI of the affected region was performed in addition to the standard total-body non-contrast enhanced Post-Mortem Computed Tomography (PMCT).

### Results

This case series describes five fatal stabbing incidents. Three cases concern a stab wound of the heart, one case a stab wound of the liver and one case had a stabbing injury of the pancreas. All cases showed multiple injuries on PMCT, which were confirmed on PMMRI. Additionally, PMMRI clearly demonstrated the stabbing trajectories and organ defects, not visible on PMCT. Cardiac defects with injury of the ventricle wall were seen in three cases, the trajectory of a stab wound in the liver was seen in one case and injury of the pancreatic head was seen in another case. Because of the better visualisation of the organ defects on PMMRI, a more precise cause of death could be determined with a higher level of diagnostic certainty.

### Conclusions

This case series shows the added value of PMMRI in forensic imaging and therefore, in case of stabbing incidents, PMMRI should be considered. Future research is required to further establish the role of PMMRI in Forensic Radiology.

O7-8

Scoping review regarding the evidence of the use of magnetic resonance imaging in the adult, forensic setting

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### Objectives

The role of Magnetic Resonance Imaging (MRI) in forensic investigations is still indeterminate. Currently, Post-Mortem Computed Tomography (PMCT) is the most commonly used imaging modality in forensic radiology. The aim of this study is to scope and identify the evidence for the use of MRI in medicolegal practice.

### Methods

Using the methodological framework for a scoping review, a thorough search of all the literature available was conducted in October 2023 including Medline, Web of Science, Embase and the Cochrane Library. The focus of this scoping review is the adult forensic field. The selection process is documented following the PRISMA guidelines. Eligibility for inclusion was performed by two independent reviewers based on title, abstract and full article screening.

### Results

The initial extensive search resulted in 10697 papers. Selection based on title and later on title and abstract identified 1341 studies involving the use of MRI in forensic and post mortem radiology. Using thematic analysis, the following main themes will be included: fatal forensic cases, medicolegal investigations in the living, worldwide practice, identification and imaging parameters.

### Conclusions

This scoping review is the first study to broadly report all available evidence in literature regarding the use of MRI in forensic radiology. These outcomes provide insights into the value of embedding MRI in forensic practice and identify topics that require further research.

## O7-9

### Forensic individual identification and weapon estimation in unlawful cat killing using micro-CT and 3D printing

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#### Objectives

The dismembered body of a cat was found in the park and the elementary school. The suspect confessed to the crime, and animal teeth were found among the suspect's belongings. The police requested individual identification of the cut mandible and teeth and sought to determine the weapon used in the cat's dismemberment to establish the perpetrator. This study aimed to achieve these goals using micro-CT and a 3D printer.

#### Methods

DNA testing for species identification was scheduled, so the cut mandible and teeth could not be examined for identity by bonding to prevent contamination during necropsy. The samples were imaged separately using a tabletop micro-CT. Weapon estimation and individual identification were performed by generating a restored model or images of the samples using a 3D printer or a 3D image workstation and video processing software.

#### Results

DNA testing confirmed the teeth belonged to a cat. In the mandible, the right canine was cut at the cervical line. The cut sections of restored canine model and image were not completely bonded, but the similarity of the width and shape of the canine was suggested. The weapon used to cut the canine was estimated to be a sharp blade.

#### Conclusions

In forensic investigations, micro-CT and 3D printers can store the morphological data of samples used in the DNA testing and help identify individual and estimate the weapon by bonding the cut sections using restored images and model without contaminating samples.

O7-10

Objective evaluation of changes in serum transmittance over time in vitro

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### Objectives

Forensic pathologists empirically understand that postmortem changes can decrease serum transparency and change its color. Such changes are potential indicators for estimating postmortem intervals; however, reports on color changes focusing on postmortem changes in serum are scarce. To elucidate the effect of postmortem changes on serum, we quantitatively evaluated the relationship between serum coloration and time course in vitro using blood specimens collected from living subjects.

### Methods

Venous blood samples were collected from three male volunteers. The serum samples were separated at 0 (1 h), 1, 2, 3, 4, 7, 10, 16, 21, and 28 days of storage. Serum transmittance were measured using a portable color digitizer, respectively. Additionally, serum sodium (Na) and potassium (K) concentrations were measured.

### Results

Serum transmittance showed a logistic curve-like decrease from  $0.652 \pm 0.016$  (0 days) to  $0.101 \pm 0.014$  (28 days) over time. Serum Na concentration decreased, whereas serum K concentration increased. Strong correlations ( $\rho = 0.89$ ) and strong inverse correlations ( $\rho = -0.93$ ) were observed between the serum transmittance decrease and the Na concentration decrease and the K concentration increase, respectively.

### Conclusions

Serum transmittance decreased over time, indicating a transition from bright to dark. Moreover, a strong correlation was observed between serum transmittance and electrolytes. These findings may contribute to the estimation of postmortem intervals in the future.

O7-11

Spectrum of forensic cases using conventional radiology for postmortem imaging – experience of a tertiary care medical institution

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### Objectives

Conventional radiology (CR) is the oldest and most established forensic imaging and examination technique. It is very rapid, cost-efficient and easy to perform. Conventional X-ray has been eclipsed with the advent and use of newer postmortem imaging techniques like computed tomography and MRI. However, CR remains the most common modality used in a forensic setting and the gold standard for many forensic challenging cases like firearm fatalities, age determination, traumatic injuries etc.

### Methods

At our Institution, we use Mobile Digital Radiography Machine (Mobile DRM) for taking postmortem X-rays in the deceased brought for medicolegal autopsies. Postmortem digital images have been used at our institution in varied forensic cases like gunshot wounds, skeleton examinations, asphyxial deaths, age determination etc.

### Results

Postmortem imaging using conventional radiography in forensic cases of fatal gunshot, forensic anthropology skeletal examinations, age determination, road traffic fatalities, fatal fall from height, asphyxial deaths etc.

### Conclusions

Conventional radiology is still an important imaging modality with wide application in forensic cases.

O7-12

Utility of postmortem computed tomography (PMCT) in the diagnosis of coronary and cerebral arterial air embolism:-a pilot study

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### Objectives

Interruption of the blood circulation by air bubbles is broadly classified into two pathophysiological distinct groups, arterial, and venous air embolisms. Arterial air embolism, though fatal de facto, has been considered a relatively rare occurrence in routine medico-legal autopsy work probably due to the difficulty in identifying the same with conventional dissection techniques.

### Methods

#### Radiological Examination:

Computed Tomographic of whole body will be performed before starting the traditional autopsy dissection by using 16 slice multidetector row CT scanner (Canon Medical Systems Aquilion Lightning TSX-035A). Image acquisition will be performed on a volumetric spiral scanning with detector collimation of 0.5 mm.

### Results

Whole-body PMCT study along with many pathologies, revealed massive arterial (systemic) air embolism. Possible obstruction of flow in both coronary arteries due to air bubbles was identified. Completely air-filled right carotid artery and right cerebral arterial circulation were also demonstrated.

### Conclusions

With routine dissection techniques, beyond theoretical discussions, proving coronary artery air embolism is considered virtually impossible. Due to inexperience or lack of high suspicions, cerebral artery air embolism may be underreported during conventional dissections of corpses. Authors are discussing the utility of PMCT as a tool to diagnose these rare findings which will be useful in concluding a variety of cases.

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