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Forensic imaging in legal medicine in the Netherlands: Retrospective analysis of over 1700 cases in 15 years' experience

Henri M. de Bakker [a], Vidija Soerdjbalie-Maikoe [b], Bela Kubat [b,c], Ann Maes [b], Bernadette S. de Bakker [d,*]

[a] Department of Radiology, Groene Hart Hospital, Gouda, The Netherlands
[b] Department of Forensic Medicine, Area Forensic Pathology, Netherlands Forensic Institute, The Hague, The Netherlands
[c] Department of Pathology, MUMC, Maastricht, The Netherlands
[d] Department of Anatomy, Embryology & Physiology, Academic Medical Center, The Netherlands

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ABSTRACT

Introduction: Forensic radiology in the living and postmortem is a new horizon in legal medicine for the detection and documentation of forensic evidence and reconstruction of the manner of death. A collaboration was undertaken 15 years ago between the Netherlands Forensic Institute, where all forensic autopsies in the Netherlands are performed, and the department of radiology in the Groene Hart Hospital (GHH).
Methods: Without exception, all forensic radiological cases performed/interpreted in the GHH between 2000 and 2015 were included in the database. Radiologic imaging was always performed in addition to autopsy or medico-legal investigation. Retrospectively, the corresponding autopsy/forensic reports were studied to obtain case information. Imaging modalities, sex, age, cause and manner of death/trauma were analyzed in both living and postmortem cases.
Results: A total of 1734 radiology cases was included, of which 82% was post-mortem. Male/female ratio was 2:1, mean age was 36 years (0-98). Performed imaging modalities were: total body CT: 656, cranial CT: 571, skeletal x-ray: 349, larynx-hyoid x-ray: 327, MRI: 118. Reported preliminary diagnoses were: blunt trauma (battering: 458, blunt objects: 121, transportation accidents: 156, airplane accidents: 34, explosions: 8, falls: 137), penetrating trauma: 199, ballistic trauma: 150, asphyxial deaths (strangulation, suffocation): 305, submersion: 98, fire: 80, diseases: 156, no anatomical cause of death (discovered corpses: 159, exhumed bodies: 27, sudden unexplained death in infancy: 76).
Conclusion: This annually growing forensic radiological database enables data analysis in pre- and post-mortem cases and has proved to be a useful source for retrospective research and scientific collaboration.

1. Introduction

The number of research publications in legal imaging increased tremendously over the last couple of decades, due to the increased interest for legal medicine and the progressive radiologic technological progress [1–5]. Nevertheless, post-mortem imaging literature mainly comprises case studies and small sized original papers since most research data is scattered over multiple centers in countries dealing with different law systems [1,6]. Well-founded retrospective databases are therefore scarce, which hampers research on large numbers of cases in this rapidly growing field. To increase the acceptance of post-mortem imaging, especially in court, the need for validation studies in larger populations has already been stressed by Jackowski in 2013 [6]. Here we present an overview of our forensic radiological and pathological database, covering 15 years of forensic radiological practice. The aim of this manuscript is to describe the set-up and work-flow of this database, the characteristics of the population documented in the database, and potential applications of the database in research.

1.1. Goals

This database serves as a documentation tool and retrospective resource for dedicated research in the various fields of forensic radiological interest. Therefore, data of three research variables were included in the SPSS database: *patient characteristics* (age, sex), the *occasion(s)* leading to the death or trauma of/to the patient, and *imaging modalities*. This manuscript depicts the benefits of a relatively large database on forensic imaging, which enables higher quality research. Scientific collaboration is greatly encouraged.

* Corresponding author.
E-mail address: b.s.debakker@amc.nl (B.S. de Bakker).

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1.2. Background

It is the opinion of the authors that the fundament of forensic radiology in the Netherlands as implemented today started in 2000 through an informal cooperation between the first author and a forensic pathologist of the Netherlands Forensic Institute (NFI). A few years later, a collaboration between the NFI in The Hague and the radiology department of the Groene Hart Hospital (GHH) in Gouda was officially formalized. The three dedicated forensic radiologists in our department, LR, DvE and HMB were commissioned by the forensic pathologists or forensic doctor. Thereby, the forensic pathologist or doctor remains fully responsible for the case and the forensic radiologist is seldom summoned in court for expert testimony. The Dutch legal system permits the use of a written report by a forensic expert as proof in most cases, in contrast to other countries (e.g. The United Kingdom) where the expert must testify in person.

Two types of cases were presented to the forensic radiology department. First the deceased victims, in which forensic imaging is performed in addition to traditional autopsy, and second the living forensic victims, who need solid evidence for their case in court. For the first category, a discrete back entrance to the radiology department has been build and scans are performed outside office hours, whilst one computed tomography (CT) scanner always remains available for acute clinical care. A standardized workflow between pathology and radiology departments has been established (Fig. 1). Generally, all cadavers enter the CT in a body bag, before autopsy. Additional radiologic examination of the explanted hyoid-larynx complex after autopsy is often sought by the pathologist. This dedicated imaging modality has been established in our radiology department.

2. Materials and methods

2.1. Database

Without exception, all forensic radiological cases that were presented between 2000 and 2015 (Table 1) by the NFI to the radiology department of the GHH were included in the database. No cases were excluded. In retrospect, information from autopsy/forensic and radiology reports, such as *patient characteristics*, *occasion(s)* leading to the death or trauma of/to the patient and *imaging modalities*, were incorporated in an SPSS database.

The database comprised of both deceased victims in which a forensic autopsy was designated and cases of living victims, for gathering forensic evidence after maltreatment or accidents for example. A flowchart of the steps in forensic and radiologic examination and incorporation of the information in the database is shown in Fig. 1.

In retrospect, the following information from the forensic reports, autopsy reports and radiology reports was incorporated in an SPSS database: Database number/Date of the radiologic report/Folder number in which the paper reports were stored/Picture Archiving and Communication System (PACS) case number/Autopsy number or forensic research number/Hospital where radiology was performed (GHH/Other/Both)/Requesting pathologist or forensic doctor/Responsible radiologist/Radiologic modalities used (max. 3)/Age of the victim/Sex of the victim/Circumstance or cause of death or trauma (max. 3)/Additional notes. The radiologic

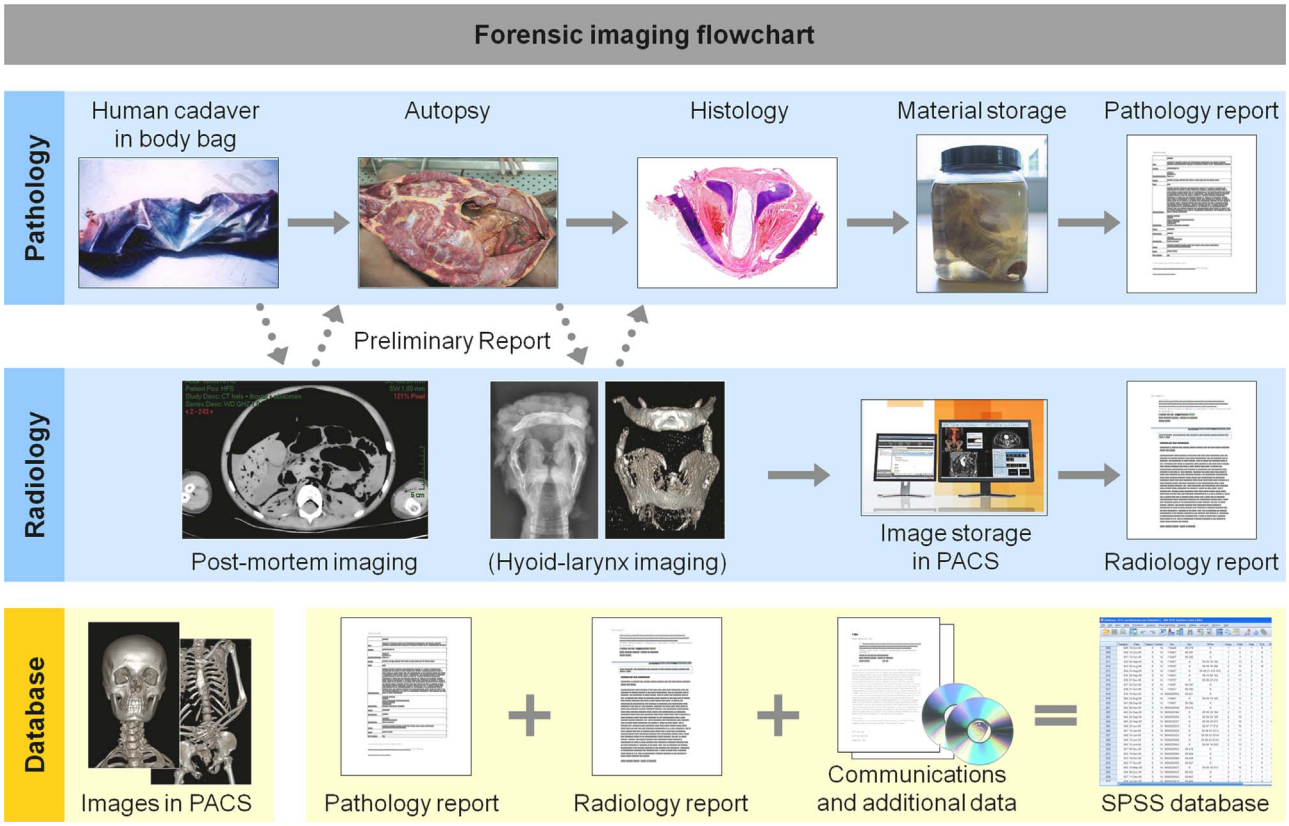

Fig. 1. Forensic imaging flowchart. Flowchart depicting the workflow between the pathology department (upper row) and radiology department (middle row). A human cadaver in a body bag can be scanned after which autopsy takes place. In some cases additional imaging of explanted anatomical structures like the hyoid-larynx complex was performed, after which the pathologist performs histology on dedicated structures. Pathology samples and radiological images were stored and both the pathologist as the radiologist wrote their reports. The bottom row shows the formation of the database. Radiological images were stored in PACS (Picture Archiving and Communication System). Details from the autopsy/forensic and radiology reports and additional communications or data were manually included in an SPSS database from which the PACS case numbers could easily be retrieved.