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Case Report

Novel application of three-dimensional technologies in a case of dismemberment

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ABSTRACT

This case study reports the novel application of three-dimensional technologies such as micro-CT and 3D printing to the forensic investigation of a complex case of dismemberment. Micro-CT was successfully employed to virtually align severed skeletal elements found in different locations, analyse tool marks created during the dismemberment process, and virtually dissect a charred piece of evidence. High resolution 3D prints of the burnt human bone contained within were created for physical visualisation to assist the investigation team. Micro-CT as a forensic radiological method provided vital information and the basis for visualisation both during the investigation and in the subsequent trial making it one of the first examples of such technology in a UK court.

1. Introduction

Although rare in the UK, cases of complete dismemberment pose a significant challenge to the police [1]. In most cases, the individual body parts are deposited separately making them difficult to locate and thereby obscuring the victim's identity. Fortunately, from an evidentiary perspective, such cases offer a great potential, as the likelihood of finding traces at the dismemberment or deposition site is high due to the inherently visceral nature of dismemberment [1]. On the body itself, further evidence such as characteristic tool marks can be identified during an anthropological examination. With this potential wealth of evidence, the overall success of the investigation can often depend on the police's ability to exploit all available resources during their inquiry.

Traditionally, dismembered bodies are analysed by forensic anthropologists who typically employ destructive methods in order to examine the evidence [2]. However, with modern advances in forensic radiology, evidence destruction can now often be avoided by employing innovative imaging techniques such as high resolution X-ray computed tomography (CT) [3,4] which allows non-invasive examination [5]. More commonly applied, 'medical' grade CT (resolution >300 μm) is useful for detecting gross skeletal injury but can obscure important anatomical detail below the scanning resolution [6]. Micro-CT however, provides much higher resolutions (0.5–120 μm) which allows the depiction of minute features such as micro-fractures which is beneficial for forensic examination [7].

In the forensic radiology literature, micro-CT has been applied to forensic trauma analysis, including gunshot injuries [8], sharp force injuries [5,9,10], and blunt force injuries [11,12]. Despite these predominantly lab based studies demonstrating micro-CTs significant potential, few live police cases have applied this technology. The case presented here is an example of how technology can assist the police, showcasing an innovative and holistic approach to criminal investigations.

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2. Case background

When canal workers removed a suitcase from a canal in the West Midlands, its weight raised suspicions about its contents and the police were called to the site. The suitcase was taken to the University Hospital Coventry and Warwickshire (UHCW) where prior to opening, it was CT scanned using 'medical' grade CT (GE Medical Systems). The scan revealed tightly packed human body parts whose initial undisturbed state of discovery was digitally preserved by the CT data. Upon opening, the initial CT scan was verified as the decomposing remains of an adult male (Fig. 1b). These remains were physically examined confirming that the head, arms, and the left lower leg of the individual were absent. The cause of death could not be determined due to the advanced state of decomposition. Given the complex findings from the suitcase multiple parallel lines of investigation were taken with four main objectives: to find the remaining body parts; identify the victim; identify the original deposition site; and identify the perpetrator (s).

The first line of enquiry saw a systematic search of the canal upstream of the initial discovery point, working under the hypothesis that the remaining elements were disposed of in the same location. This point of origin provided a starting point from where to search for the perpetrator(s). Working with a flowing body of water made the interpretation of the suitcase's movements in the canal difficult but the search strategy proved successful nevertheless and a second suitcase containing further body elements was recovered (Fig. 2) along with several tools including a saw, a kitchen knife, a hammer, and a chisel (Fig. 3). A CT scan of the second suitcase (Fig. 2b) revealed the missing leg, arms, and head of the victim but the left shoulder joint remained unaccounted for. Positive identification was achieved by analysing the victim's DNA, fingerprints, and characteristic tattoos. DNA samples were taken from both suitcases to confirm that they pertain to the same individual.

With the victim's identity known, police inquiries focussed on the victims' social relationships, witness statements and other evidence which then pointed towards the victim's former

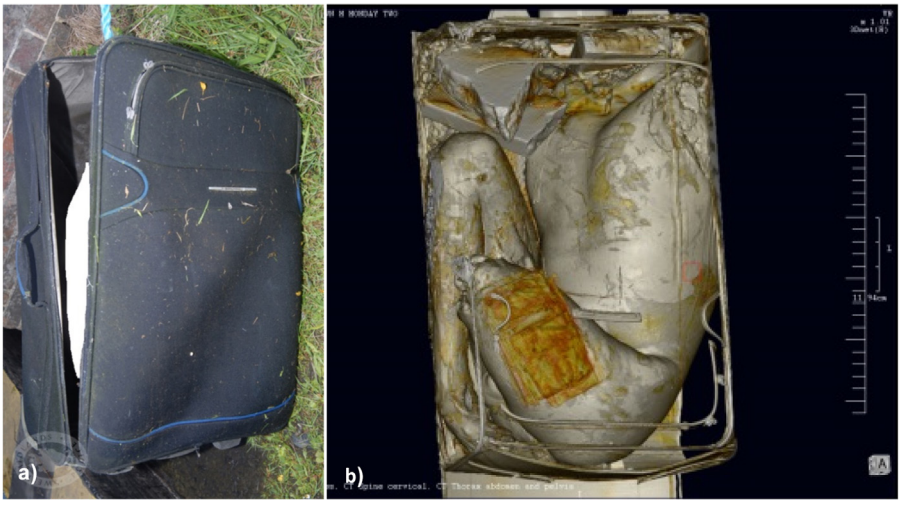

Fig. 1. (a) Crime scene photograph of first suitcase. (b) CT scan of the same suitcase containing the torso, right leg, and partial left leg.

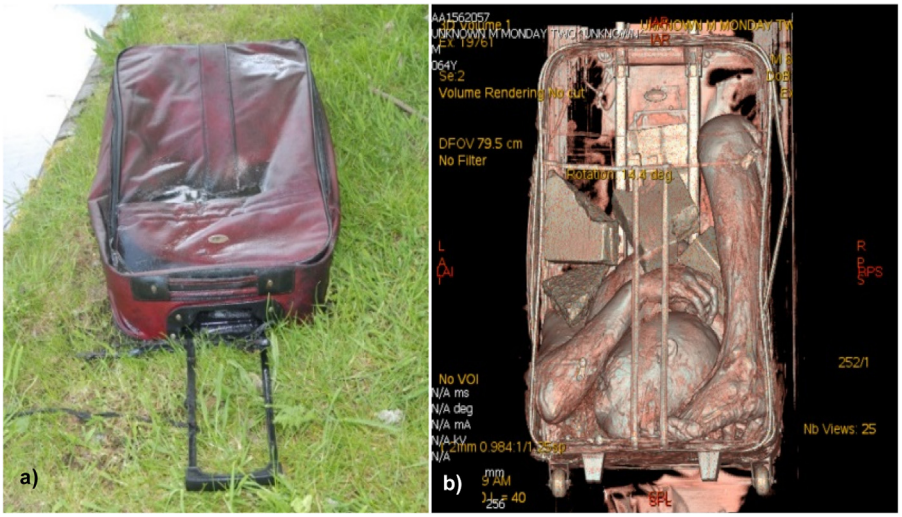

Fig. 2. (a) Crime scene photograph of suitcase 2, once dragged on land. (b) CT scan of same suitcase, containing the head, arms, and left lower leg. It had been weighed down by concrete paving slabs, visible in the centre of the suitcase.