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Bloodstain pattern analysis—Casework experience

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ABSTRACT

The morphology of bloodstain distribution patterns at the crime scene carries vital information for a reconstruction of the events. Contrary to experimental work, case reports where the reconstruction has been verified have rarely been published. This is the reason why a series of four illustrative cases is presented where bloodstain pattern analysis at the crime scene made a reconstruction of the events possible and where this reconstruction was later verified by a confession of the offender. The cases include various types of bloodstains such as contact and smear stains, drop stains, arterial blood spatter and splash stains from both impact and cast-off pattern. Problems frequently encountered in practical casework are addressed, such as unfavourable environmental conditions or combinations of different bloodstain patterns. It is also demonstrated that the analysis of bloodstain morphology can support individualisation of stains by directing the selection of a limited number of stains from a complex pattern for DNA analysis. The complexity of real situations suggests a step-by-step approach starting with a comprehensive view of the overall picture. This is followed by a differentiation and analysis of single bloodstain patterns and a search for informative details. It is ideal when the expert inspecting the crime scene has also performed the autopsy, but he definitely must have detailed knowledge of the injuries of the deceased/injured and of the possible mechanisms of production.

1. Introduction

Reconstruction of the events from autopsy and scene findings is one essential objective in death investigations. The presence of bloodstains at the crime scene can be of major importance for the investigation and reconstruction. In addition to haemogenetic individualisation, the morphology and distribution of bloodstain patterns can provide vital information on the character, number and chain of events, which have caused the bloody scene. Before such interpretation of bloodstain patterns can be carried out reliably, the expert must have built up knowledge of and experience in the types of stains and distributions, which may be caused by various forms of injuries and mechanisms. In addition to systematic studies [1–4,6,8,9,10,11,13–18,20,21,23,26], case reports [5,12,22,24,27,28] may significantly contribute to the validation of bloodstain pattern analyses, especially if the reconstruction is confirmed by witnesses or perpetrators. This is why a series of illustrative case examples involving various bloodstain distribution patterns is presented where the mechanism of production was verified by a confession of the offender. The cases originated from the Institute of Legal Medicine, University of Münster, Germany, where crime scenes are regularly investigated.

2. Case reports

2.1. Case 1: arterial blood spatters originating from a corpse?

A 23-year-old man was found dead near his car in some woods. The missing head had been severed at the level of the 6th cervical vertebra, which showed 3 deep notches. Signs of severe anaemia were obvious in the trunk of the body, but only a few bloodstains were found inside the boot of the car. A suspect, who was soon arrested, led the police to the site in the wood where he had buried the head, which showed 2 intracranial gunshot wounds from a 5.6-mm rimfire rifle. The suspect claimed that he had performed the decapitation with an axe in an aviary, after the victim was dead.

The crime scene investigation in the aviary (3 m × 3 m) (Fig. 1a) took place 5 days after the killing. On the left side of the door, the lower part of the wire netting showed abundant tiny blood deposits and a large diagonal smear stain directed downwards. Below these stains and covered by some sand, the soil was soaked with blood over an area measuring 80 cm × 25 cm and up to 20 cm deep. A wooden beam at the bottom of the wire netting also showed extensive red–brown discolouration from blood. On the

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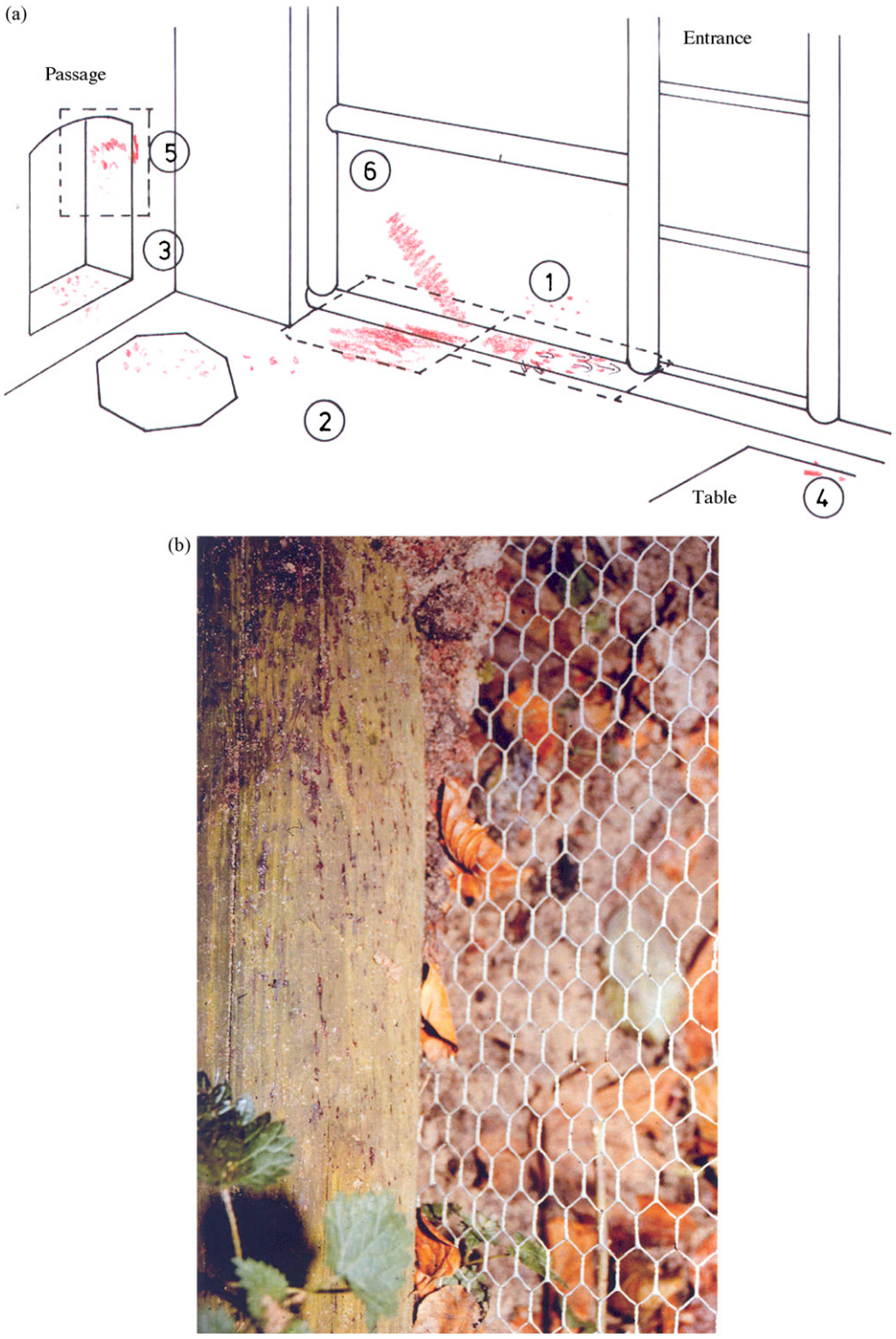

Fig. 1. (a) Sketch of the aviary 5 days after the killing. The wire netting shows a diagonal smear stain (6) and tiny splash stains (1), a wooden beam below (1) shows both tiny circular and elongated splash stains (compare with (b)). A pool of blood and dropping stains (2) are present in the sand. Additional dropping stains (3) and smear stains (5) were found in a passage and contact stains (4) on a table. (b) Remnants of arterial blood spatter: the wire netting with multiple tiny stains and the wooden beam showing multiple circular and elongated splash stains directed from left to right. The irregular morphology of the stains reflects the irregular adsorption of the wooden surface. (For interpretation of the references to color in the text, the reader is referred to the web version of the article.)

right side of this blood stain, abundant splash stains in the form of tiny circular and elongated bloodstains were still visible on the beam (Fig. 1b). The stains extended over a distance of 70 cm. On the left side of the pool of blood, large droplet stains were found beneath the sand, and a small passage to a stable showed additional droplet stains and large smear stains on the floor and walls.

The perpetrator had fired the gunshots to the head while the victim was sitting in the sand and the falling head had caused the smear stain on the wire netting. Decapitation with the axe produced most of the pool of blood as well as abundant arterial spray stains, which were still present on the right side of the beam. This and the large amount of blood present required active heart

Fig. 2. Panel behind the victim's head (covered by his blue shirt). The original position of the panel was horizontal, i.e. with an anti-clockwise rotation relative to the photograph. Note the sparing of the head on the panel (marked by the arrow), the multiplicity of splashing stains and the transition to an external zone with elongated stains radiating outwards. (For interpretation of the references to color in the figure caption, the reader is referred to the web version of the article.)

function. Therefore, the decapitation must have been performed shortly after the gunshots when the victim's heart was still beating. The corpse had subsequently been dragged through the passage, which had caused the droplet and smear stains. In court, the perpetrator verified this reconstruction.

2.2. Case 2: dynamic or static situation?

A 52-year-old man was beaten to death with a metal pipe in his living room. Autopsy verified five distinct fracture systems of the skull, each originating from a blow. The cause of death was cerebral injury. A suspect who admitted to have killed the man in a fight was arrested. An important factor in the reconstruction was the exact location where the fatal blows had been delivered and the dynamics of the chain of events.

The corpse was lying in front of a sofa in a pool of blood. A panel close to the head of the corpse showed a tight pattern of impact splash stains (Fig. 2). This and abundant radial blood spatter stains present on the sofa and walls indicated that the victim had not moved. Contrary to all other objects in the vicinity, an armchair was completely spared of bloodstains: it had been shielded by the body of the perpetrator. This means that all or most blows had been delivered while the assailant and the victim remained in the same position. This is incompatible with a dynamic situation such as a fight. In court, the defendant admitted that he had taken his acquaintance by surprise. The man collapsed in front of the sofa and the defendant had delivered additional blows to the head while standing in front of the chair.

2.3. Case 3: the sequence of events can make the difference

A young mother and her two children aged 6 months and 2 years were found dead, each lying in their bed at home. A bloody axe was present at the scene and the three victims had suffered fatal brain injuries from multiple blows with this axe. The husband claimed that his wife had first killed the two children and that he subsequently had killed her after he had seen what she had done. The crucial question was the sequence of events.

The three victims were lying in their beds in separate rooms with a large number of bloodstains present on the beds, the victims, walls and at the ceilings. The wife showed numerous tiny splash stains, among others, on the back of the left hand (Fig. 3a). A cot where the 2-year-old child had been killed had a defect in the top rail of the bed frame made up of 3 separate notches covered with blood (Fig. 3b): the perpetrator had struck the wood three times with the bloody axe.

DNA analysis demonstrated that the blood on the woman's left hand matched her own and that the blood from the notched defect on the bed frame came from both the child and the mother. The lack of the children's blood on the woman's hand and the presence of the mixed stain in the notch strongly suggested that the wife had been killed before the children. Additionally, blood spatter stains at the sleeves and pants of the husband originated from all three victims, while the clothing of the wife only carried her own blood. When the husband was confronted with this evidence, he confessed that he had first murdered his wife and then his children.

2.4. Case 4: the needle in the haystack

A young woman was found severely injured lying on a driveway (Fig. 4a). She had been sexually attacked, the trousers and pants pulled down to the ankles. She died at the scene from repeated blunt force to the head and severe blood aspiration. The head formed the centre of a blood spatter pattern present on the wall behind her (Fig. 4a). Her clothing, including the jeans (Fig. 4b), was heavily covered with blood. Blood draining from the head and face injuries, spatter and dropping stains, large smear stains and small contact stains could be distinguished, and the skin of the hands, upper legs, and abdomen also showed blood deposits.

The police later arrested a suspect who had a superficial tear injury at the hand, and there was a chance that he had been bleeding slightly during the assault. Since the perpetrator may have left small contact stains on the jeans, pants or shirt when he pulled them down with his hands, a total of 60 stains were selected on the basis of their morphology from the hundreds of distinguishable ones for DNA analysis. Stain number 41 located on the jeans was a tiny contact stain (Fig. 4c). This stain was the only one analysed which did not originate from the victim herself, and the alleles matched those of the suspect who subsequently confessed.

3. Discussion

It is clear from the presented cases that bloodstain pattern interpretation and autopsy are closely related. The type, number and location of injuries present in a victim are of great importance for the interpretation of the resulting bloody scene. In our experience, it is ideal when autopsy and scene investigation are carried out by the same person, or when the scene is also visited by the person performing the autopsy. Bloodstain pattern analysis is a traditional topic of Legal Medicine in Germany [14], in countries with a different tradition, close exchange of information between bloodstain experts and forensic pathologists should be guaranteed.

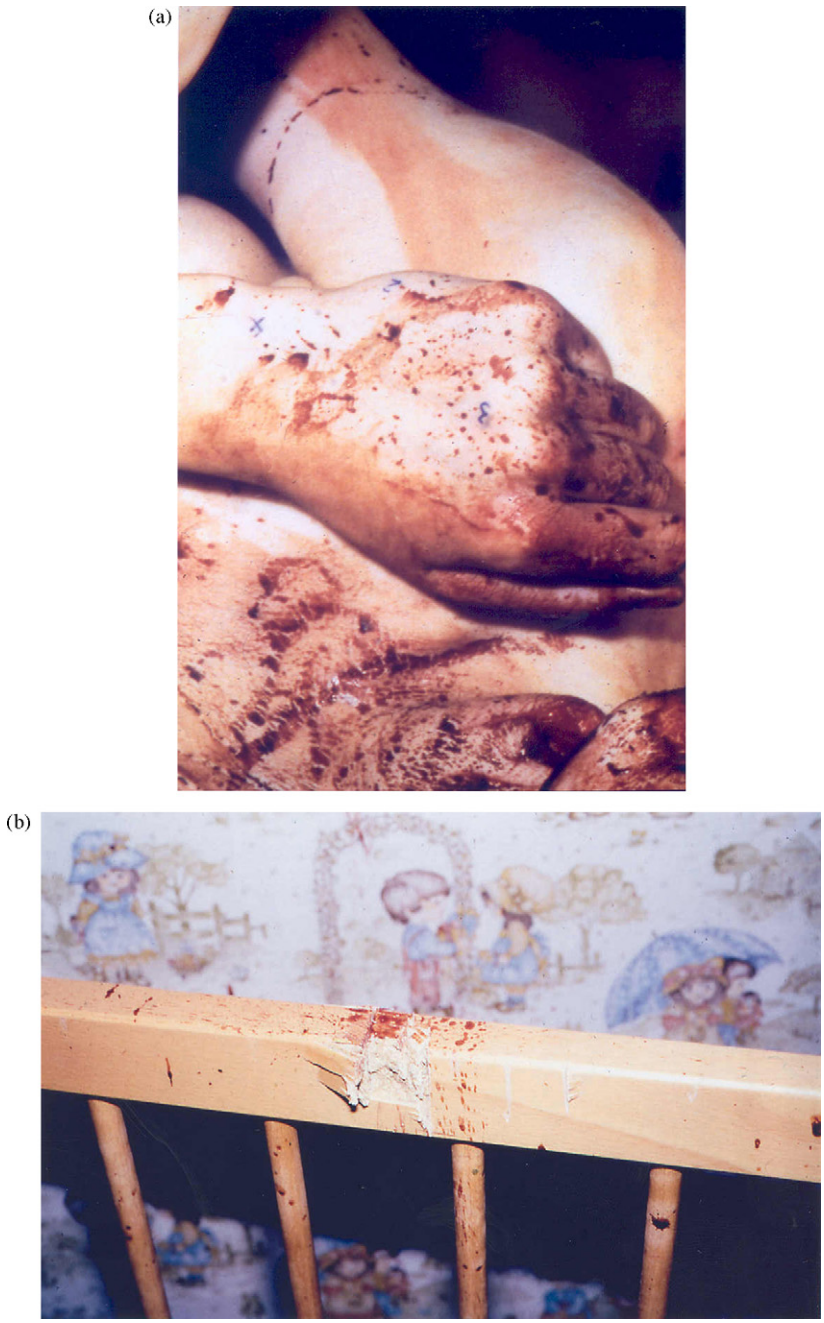

Fig. 3. (a) The back of the woman's left hand showing multiple small splash stains and larger smear stains. Some of the splash stains, including those numbered, were used for DNA analysis. (b) The notches in the top rail of the bed frame with contact and splash stains.

It is also clear that the complexity of real situations exceeds the findings in experimental simulations by far. Different bloodstain patterns may be combined (cases 1–4), the absence of bloodstains in places where stains would be expected as well as the accumulation of stains can be important (cases 2 and 4), and environmental conditions may be very unfavourable (case 1). The complexity of real situations suggests a step-by-step approach according to which bloodstain patterns should initially be evaluated as a whole. This makes it possible to gain a comprehensive view and to distinguish various bloodstain patterns, which were caused by different events. This approach is assisted by a rough sketch of the bloodstains at the scene (Fig. 1). Interpretation of single bloodstain patterns follows in a second and a search for informative details in a third step. Details may prove to be very important (cases 3 and 4), however, they should only be interpreted in the context of the pattern and the possible chain of events; otherwise, conclusions based on isolated details may prove to be incorrect. Searching for bloodstains requires imagination of the bloodstain patterns possibly produced by injuries known to be present or by actions of the perpetrator, and it should be assisted by adequate equipment such as infrared light or the luminol test [7,19,29].

In theory, individualisation of stains and analysis of bloodstain morphology are two distinct approaches but in casework both methods can assist each other. In particular, the selection of a limited number of stains from a complex bloodstain pattern for DNA analysis should be directed by the morphology of the stains. This is demonstrated by cases 3 and 4. In case 3, the events were

Fig. 4. (a) The position of the victim after unsuccessful emergency measures. The impact splash stains on the wall caused by kicking or beating the head are radially arranged around a pool of blood, which is where the head had originally been lying. (b) The front side of the jeans of the victim showing numerous blood stains including splash, smear and contact stains. (c) A detail from the upper left front side of the victim's jeans depicting stain number 41 (below and left to the lettering "41"), a tiny red–brown discolouration apparently transferred by contact. This was the only stain originating from the perpetrator. (For interpretation of the references to color in the figure caption, the reader is referred to the web version of the article.)

reconstructed by bloodstain morphology, which made it possible to select the decisive stain in the notch for DNA analysis. In case 4, the analysis of bloodstains selected with respect to the possible mechanism of production identified the perpetrator. Frequently, the differentiation of small contact stains from droplets on fabric [11,25] is relevant in this context.

In conclusion, analysis of bloodstain patterns at crime scenes should be based on detailed scientific knowledge, but the possible complexity and uniqueness of real situations also requires considerable case experience and a reserved attitude including strict adherence to scientific standards. This is necessary to reliably utilise the large potential of this method in crime scene reconstruction.

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