B194 Investigations on the Use of Tissue MicroRNA Markers to Correlate Bloodstains With Wounds for Bloodstain Pattern Analysis

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After attending this presentation, attendees will have an understanding of: (1) current limitations in bloodstain pattern analysis; (2) the probative value of wound tissue in bloodstains; and, (3) the effectiveness of micro RNA assays to identify trace quantities of wound cells in bloodstains and determine the wound-of-origin.

This presentation will impact the forensic science community by demonstrating that molecular markers can reveal information about the circumstances surrounding the deposition of blood evidence, namely the wound-of-origin. Otherwise indistinguishable and/or non-specific bloodstains can be further characterized by use of this technique. The implementation of the technique may enhance the work of forensic investigations and the administration of justice.

Certain bloodstain patterns can indicate the cause of the bloodshed. For example, an "arterial" bloodstain pattern indicates a breach to the arterial circulatory system; however, many patterns can be created by more than one mechanism. A pattern of several circular bloodstains on the floor, for example, could be the result of a minor injury or a life-threating/fatal wound. During the course of a homicide investigation, investigators may find blood from the victim or suspect, but the blood is found where one might expect to find victim's or suspect's blood for reasons other than the crime. The finding is further problematic in that the blood is in low quantities and in the form of a non-specific bloodstain pattern. The relationship of the blood to the crime then comes into question because of the circumstances of the case and the uninformative pattern of the blood. The blood may be evidence of the crime or the blood may be a coincidental finding unrelated to the crime. The finding may be used against a suspect or defendant, but the suspect/defendant may have a plausible alternate explanation for the finding; however, current forensic methods in this situation are greatly limited in the ability to test the different explanations and determine the correct circumstances under which the blood was shed.

In several homicide cases, evidentiary bloodstains with particular wounds based on the histological identification of wound tissue in the stains were able to be correlated; however, the finding of discernible pieces of wound tissue in bloodstains is rare in cases where the question is the bodily source of the stain, It is hypothesized that evidentiary bloodstains may contain trace quantities of wound cells, which can serve as markers to identify the specific wound or wound site from which the bloodstains originated and thus provide a means to answer questions as to the cause and significance of otherwise ambiguous blood evidence.

It has been reported that bloodstains can contain additional information about their origin in the form of wound cells. Using an animal model, bloodstains from a gunshot wound to the head were distinguished from bloodstains resulting from a gunshot wound to the chest by testing the stains for a brain micro RNA marker. The head shot and chest shot spatter patterns and the two sets of tested bloodstains were otherwise indistinguishable. Whereas proof-of-concept was achieved with the shooting experiments, the question then became whether the technique would be successful with bloodstains from injuries produced by less force; specifically, sharp force injuries. Hence, a proof-of-concept study was conducted on the use of micro RNA tissue markers to detect wound cells in blood drops resultant of stab wounds.

Specifically, investigations were conducted on the rat liver micro RNA marker, rno-mir-122-3p, with the QIAGEN® miScript® System and real-time Polymerase Chain Reaction (PCR) analysis. Intact rat carcasses were stabbed manually and with a mechanical device. Scalpel blades were used to stab the liver through the skin of the rat carcasses, and the blood on the scalpel blades tested positive for rno-mir-122-3p, whereas blood on the scalpel blade used to stab the lung through the chest wall tested negative for rno-mir-122-3p. Additionally, blood drops shed externally from the liver stab wounds tested positive for liver cells. The amount of the marker/cells in the stains appeared to be related to the sequence of the blood drops and the velocity of the blade. This research illustrates that molecular markers can reveal information about the circumstances surrounding the deposition of blood evidence, namely the wound-of-origin. The implementation of this technique may enhance forensic investigations and the administration of justice.

MicroRNA, Wound-of-Origin, Bloodstain Pattern Analysis