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Research Article

Bloodstain Transfer: An Experimental Study

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Abstract

In criminal cases, the potential transfer of bloodstain is one possibility of discussion on Court. Therefore we developed an experimental model in which the conditions are standardized and thus reproducible. However, in this model, the transfer of blood from a first support to a second support is only possible if the bloodstain is still wet and if it is not strongly attached on the first support. In conclusion, this study defines the limiting conditions of bloodstain transfer.

Introduction

In criminal cases, blood transfer is often used as an easy explanation for the suspect. Juries understand when a person has some fresh blood on his hand, that he can transfer some of this blood to an object or to another person [1-5].

But, the conditions of the transfer itself are not very well known [2-4]. For this reason, it was necessary to elaborate an experimental model to better understand the conditions of bloodstain transfer. The purpose of this study is to investigate the possibility of blood transfer from a substrate to another depend of two parameters: air drying time and weight applied.

Materials and Methods

Blood was collected from one donor. After homogenization, different volumes of blood were layered on glass slides: 1, 10 and 100 µL. Triplicates were prepared for each condition. Control samples were also prepared in the same conditions but directly used for DNA extraction. The slides were then allowed to air-dry at room temperature (22°C) for 0, 1, 3, 6, 9 or 24 hours.

To mimic blood transfer, a piece of cotton gauze was placed on each blood spot present on the glass slides with a weight of 20 g or 200 g applied for 10 seconds. Negative Control was realized with cotton gauze without blood spot. After each time point, the cotton gauzes were collected, tested for the presence of blood using the Kastle Meyer method and then transferred to a tube for subsequent DNA extraction. DNA was extracted using the EZ1 extraction protocol (EZ1 Investigator Kit, Qiagen, US) with an EZ1 Advanced XL device according to the manufacturer's recommendations. To determine the concentration of human DNA in each sample, the Investigator Quantiplex kit (QIagen) was used in conjunction with the Applied Biosystems 7500 Real Time Investigator QuantiplexR instrument. PCR were performed on each extract using the AmpFISTR Identifiler Plus PCR amplification kit (Thermo Fischer Scientific). Products were detected using the 3500 genetic analyzer (Applied biosystems).

Results and Discussion

Detection of blood, DNA quantification and amplified STR profiles results are reported in tables 1 and 2, figures 1 and 2 according to the air drying time and the weight applied. No contamination was observed on the control cotton gauzes (without blood deposition). Without an air drying period, no matter the volume of blood layered on the glass slide or the weight applied on the cotton gauze, white and red blood cells transfers from the glass slides to the cotton gauzes were observed. After one hour air drying, using 1 and 10 µL of blood on the glass slides, DNA concentrations did not reach the detection threshold (≤ 2,17 E^{-03} ng/µL) and blood detection with the Kastle Meyer method was not possible, meaning that blood transfer from the glass slide to the cotton gauze did not occur. On the contrary, when we layered 100 µL of blood on the glass slide and applied a weight of 20 or 200 g, blood was detected and DNA profiles could be obtained after 1 hour air-dry, meaning that the transfer did occur. Beyond 1 hour air-dry, no blood could be detected and no DNA profile obtained in any conditions.

These results revealed that for blood transfer from an object A to an object B to occur, two important parameters have to be considered: blood quantity transferred and air-drying time. These results are similar to those from different studies [2-4]. Studies conditions are different (substrates, dry conditions, transfer…etc.) but results are the same: dry blood can be transfer on a substrate (secondary transfer) but dry blood couldn't.

Table 1: Blood detection, DNA quantification and amplification results for blood transfer with a weight of 20 g.

Blood Volume (µL)	Air Dried Time (hour)	Kastle Meyer Detection Results	DNA Concentration (mean; ng/µL)	Standard Deviation	DNA Profiles Result
1	0	+	2.23E-01	2.76E-02	Complete result
	1	-	3.78E-03	2.88E-03	None
	3	-	4.62E-03	S.40E-03	None
	6	-	4.l0E-03	2.44E-03	None
	9	-	5.71E-03	3.39E-03	None
	24	-	7.54E-03	5.74E-03	None
	Positive Control	+	2.06E-01		Complete result
10	0	+	4.76E+00	6.13E-01	Complete result
	1	-	2.17E-03	1.27E-03	None
	3	-	2.00E-03	1.74E-03	None
	6	-	1.83E-03	1.35E-03	None
	9	-	1.14E-03	1.61E-03	None
	24	-	6.31E-03	4.54E-03	None
	Positive Control	+	3.45E+00		Complete result
100	0	+	1.54E+01	S.22E-01	Cpmplete result
	1	+	1.21E+01	1.48E+00	Complete result
	3	-	4.41E-02	6.21E-02	None
	6	-	2.21E-02	2.l0E-02	None
	9	-	8.0SE-05	6.03E-05	None
	24	-	2.17E-03	2.34E-03	None
	Positive Control	+	1.38E+01		Complete result

For Kastle Meyer detection, +: positive detection, -: no blood detection.

Table 2: DNA quantification and amplification results for cells transfer with a weight of 200 g.

Blood Volume (µL)	Air Dried Time (hour)	Kastle Meyer Detection Results	DNA Concentration (mean; ng/µL)	Standard Deviation	DNA profiles Result
1	0	+	3.lSE-01	6.56E-02	Complete result
	1	.	9.03E-04	l.19E 03	None
	3	.	8.27E-04	5.86E-04	None
	6	.	9.65E-04	6.87E-04	None
	9	.	5.80E 03	3.52E 03	None
	24	.	7.70E-03	9.71E-03	None
	Positive Control	+	2.06E-01		Complete result
10	0	+	7.32E-02	3.77E 03	Complete result
	1	.	0.00E+00		None
	3	.	0.00E+00		None
	6	.	0.00E+00		None
	9	.	0.00E+00		None
	24	.	0.00E+00		None
	Positive Control	+	2.75E+00		Complete result
100	0	+	l.65E+0l	5.06E+00	Complete result
	1	+	8.09E+00	2.19E+00	Complete result
	3	.	l.31E-03	l.85E 03	None
	6	.	9.33E-04	l.32E-03	None
	9	.	2.64E-04	9.89E-05	None
	24	.	l.48E-03	2.09E-03	None
	Positive Control	+	l.38E+0l		Complete result

For Kastle Meyer detection, +: positive detection, -: no blood detection.

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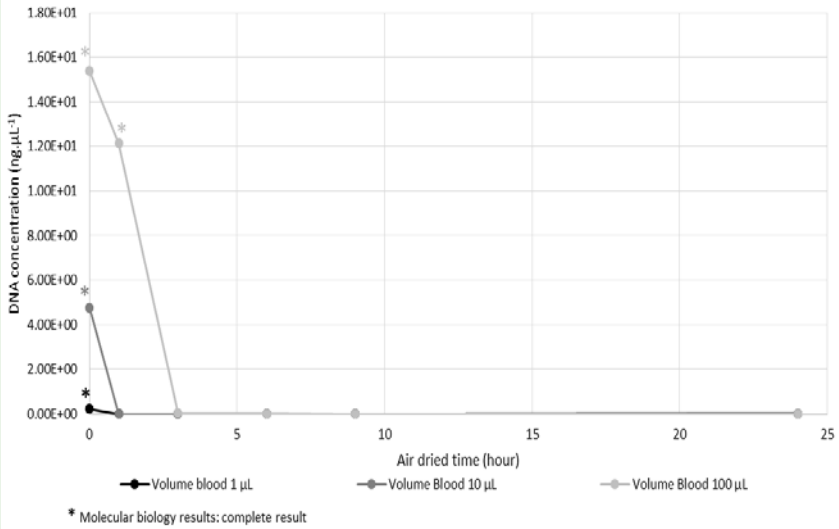

Figure 1: DNA quantification and amplification results for blood transfer with a weight of 20 g.

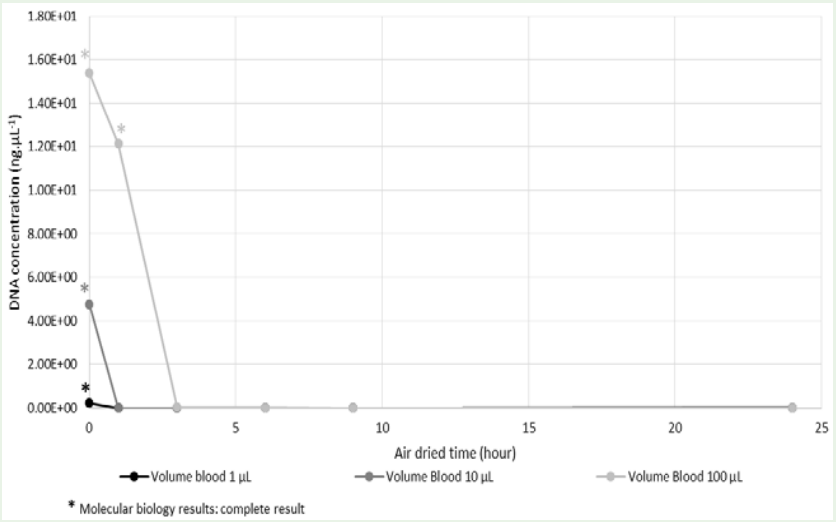

Figure 2: DNA quantification and amplification results for blood transfer with a weight of 200 g.

Conclusion

- To be possible, blood transfer from a first object to a second one depends on 2 important factors:A contact between both objects is necessary
- A sufficient volume of humid blood must be present on the first object

These two important points were demonstrated using the experimental model presented here. Nevertheless environmental conditions (temperature, air pressure, humidity…) could modify these results; it is not possible yet to precisely determine the effects of each parameter. Thus, this experimental model should constitute a guide to interpret the DNA profiles on bloodstains, particularly on Court.

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