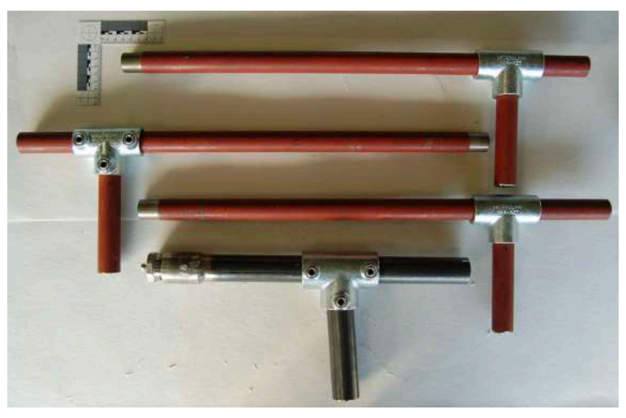
Analysis of Inorganic Gunshot Residue (IGSR) from Slam Guns: Using SEM/EDS

Level 6 Research Project by Sarah Danielle Hartley, Supervised by Dr Rachel Bolton-King
18017996 MSci Forensic Investigation
h017996i@student.staffs.ac.uk www.linkedin.com/in/sarahdhartley

1. INTRODUCTION

Craft-produced firearms, often referred to as "improvised", "clandestine", or "homemade", are the greatest challenge for Police forces across the UK (Hales, Lewis and Silverstone, 2006). Slam guns, or "pipe guns", are typically made from scratch, and are the most-frequently produced form of craft-produced firearm (Karp, 2018), as the items required for manufacture can be found at home or bought at low cost in a local store (Crown Office & Procurator Fiscal Service, 2000).



As such, the decision was made to focus on craft-produced firearms, specifically slam guns. The ammunition usually used in slam guns are 12-gauge shotgun cartridges, due to the large diameter of the pipe (Chinmayi, 2021; Waghmare *et al.*, 2012; Eger, 2017). Also, they are more readily available and accessible than alternative cartridges (Home Office, 2021). Gunshot Residue (GSR) is found within these cartridges.

In this research, the Inorganic Gunshot Residue (IGSR) was analysed, rather than the Organic Gunshot Residue (OGSR) (The Royal Society, 2021). To be classed as IGSR, three components must be present: lead, barium, and antimony. As such, this composition was the primary focus. The IGSR was collected through direct SEM stubbing and swabbing, as detailed below.

2. AIM AND OBJECTIVES

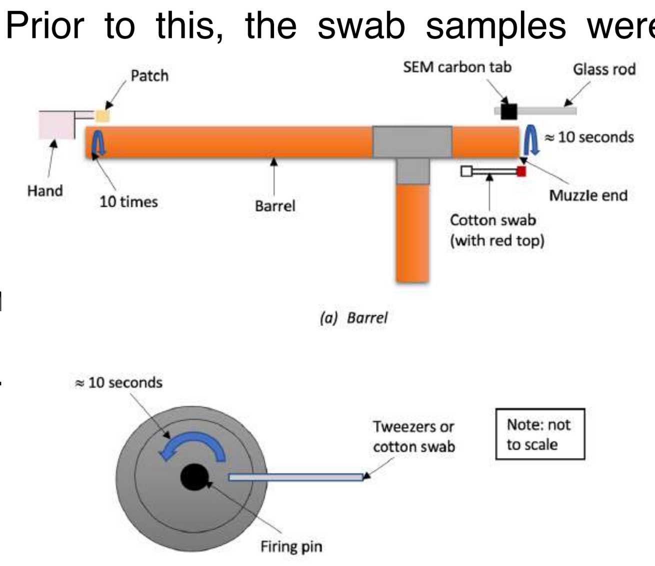
Police forces currently utilise swabs in their GSR collection, and then use Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM/EDS) to analyse these samples. However, there is currently a lack of a standard method for slam guns.

The aim of this research was to maximise IGSR recovery from slam guns; the ideal result showing one method to be more effective, based on the number of recovered and identified IGSR particles. The complete thin, GSR sample collection methods and analysis of slam guns were compared and evaluated. Investigations into the approaches to SEM stubbing and GSR swabbing were undertaken, to allow for recommendations around the process.

3. METHOD

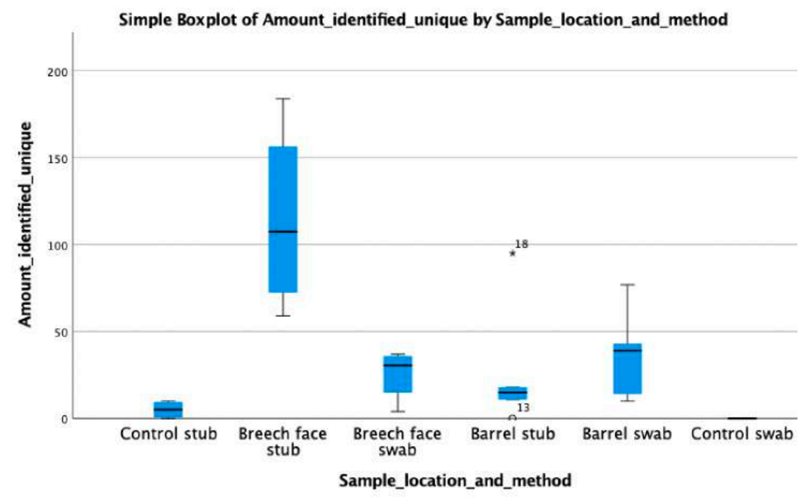
SEM/EDS was utilised to analyse the samples. Prior to this, the swab samples were transferred to SEM stubs – the top and sides of the swab was tapped onto the stub tab for approximately 10 seconds.

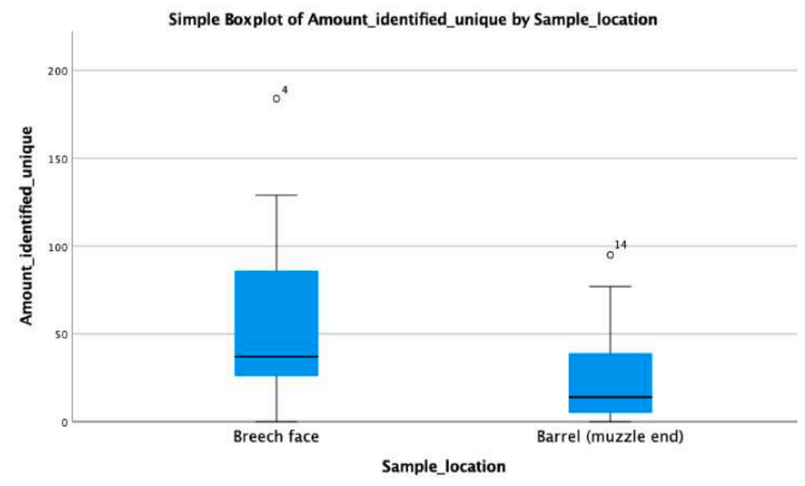
Detected particles were deemed as "characteristic" of GSR in accordance with E1588-20 (Organization Committees for Forensic Science, 2022). Particles identified were manually verified (by analysing their composition). After SEM/EDS, statistical analysis of the data was undertaken, using SPSS statistical software.

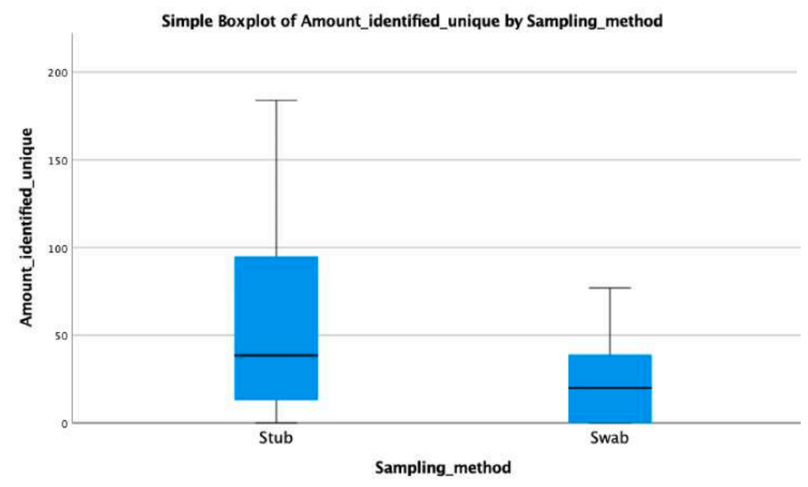


4. RESULTS AND DISCUSSION

Initial potential issue regarding the SEM controls and GSR samples, resulted in the following alternative perspective (first figure):

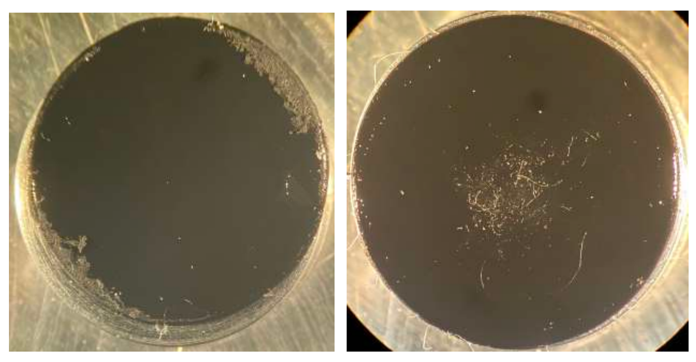






Direct SEM stubbing was found to be more successful at collecting IGSR from the breech face, whereas the swabs were better for the barrels. Overall, the SEM stubs collected more "unique" particles – which are the focus of GSR analysis – compared to the swabs. The ideal sample collection method and location appeared to be to use the SEM stubs on the breech face. There were no statistically significant differences between the different sample locations and methods (Nuzzo, 2016); resulting in the retention of the null hypothesis.

Stubs collected the GSR predominantly around the edges of the stub, and there was minimal debris to interfere with the SEM/EDS instrumentation. In contrast, cotton fibres and debris were consistently present on the swab-transfer stubs. This may have resulted in the lower count of "unique" GSR particles, as it would likely interfere with the SEM/EDS analysis (Dobarceanu, 2020).



5. CONCLUSION

It was shown that IGSR can be successfully recovered through different sampling methods and from different locations, then successfully analysed using SEM/EDS. Collecting IGSR samples from the breech face using the stubs was found to be the most effective method; suggesting this should be used to maximise the recovery of IGSR from slam guns. This outcome does not match the method currently being used (swabbing the barrels).

Further work:

- Analyse remaining stub and swab samples to produce a more sound conclusion (more representative findings).
- Further analysis around sampling from the breech face.
- Investigate the process of control sampling, to help to reduce the risk of contamination.
- Create an easier way of utilising the stubs for sample collection.

References

- Chinmayi, B. (2021) Improvised Firearm and Regular Firearms – Forensic Yard. Available at https://forensicyard.com/improvised-firearm-and-regular-firearms/ (Accessed: 10 March 2022).
- Crown Office & Procurator Fiscal Service (2020) Man jailed for manufacturing 'slam guns' in garden shed. Available at https://www.copfs.gov.uk/media-site/media-releases/1893-man-jailed-for-manufacturing-slam-guns-in-garden-shed (Accessed: 10 March 2022).
- Dobarceanu, V. (2020) Persistency of Gunshot Residue in the Head Area. Practical Approach. Available at: http://rais.education/wp-content/uploads/2020/06/033VD.pdf (Accessed: 23 March 2022).
- Eger, C. (2017) Richardson Industries M5 Philippine guerrilla gun: A gun to get a gun. Available at https://www.guns.com/news/2017/05/14/richardsons-philippine-guerrilla-gun-a-gun-to-get-a-gun (Accessed: 11 March 2022).
- Hales, G., Lewis, C. and Silverstone, D. (2006) Gun crime: the market in and use of illegal firearms. Available at: https://www.ligali.org/pdf/home_office_gun_crime_the_market_in_and_use_of_illegal_firearms.pdf (Accessed: 7 March 2022).
- Home Office (2021) Guide on Firearms Licensing Law. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1042069/Firearms_Guide_17122021.pdf (Accessed: 8 March 2022).
- Karp, A. (2018) Estimating Global Civilian-Held Firearms Numbers. Available at: https://www.jstor.org/stable/pdf/resrep20049.pdf (Accessed: 8 March 2022).
- Nuzzo, R. L. (2016) 'The Box Plots Alternative for Visualising Quantitative Data', PM&R Journal, 8, pp. 268-272. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1016/j.pmrj.2016.02.001 (Accessed: 20 March 2022).
- Organization of Scientific Area Committees for Forensic Science (2020) Standard Practice for Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry. Available at: https://www.nist.gov/system/files/documents/2020/03/20/OSAC%20GSR%20SC%20E1588%20for%20SAC.pdf (Accessed: 15th March 2022).
- The Royal Society (2021) Understanding ballistics A PRIMER FOR COURTS. Available at https://royalsociety.org/-/media/about-us/programmes/science-and-law/royal-society-ballistics-primer.pdf (Accessed: 11 March 2022).
- Waghmare, N., Suresh, R., Puri, P., Varshney, K., Anand, V., Kompal and Anubha, L. (2012) Modern Trend of Country Made /Improvised Pistols Used in the Capital of India. Journal of Forensic Research, 04(01). Available at: https://www.hilarispublisher.com/open-access/modern-trend-of-country-made-improvised-pistols-used-in-the-capital-of-india-2157-7145.S1-003.pdf (Accessed: 10 March 2022).

STAFFORDSHIRE UNIVERSITY