Australian Journal of Forensic Sciences, Volume 53, Issue 1, January 2021, pp. 50-61
DOI: 10.1080/00450618.2019.1655094

Post-mortem dismemberment using chainsaws.

Clare Knock[a*] and Alison George[b]

[a] Centre for Defence Engineering, Cranfield University, United Kingdom; [b] Cranfield Forensic Institute, Cranfield University, United Kingdom

Corresponding author Dr Clare Knock Centre for Defence Engineering, Cranfield University at the Defence Academy, Shrivenham, Swindon, SN6 8LA, United Kingdom. C.knock@cranfield.ac.uk

Word count: 3502

Post-mortem dismemberment using chainsaws.

Experiments were carried out to quantify the size of the tissue spatter distribution from post-mortem dismemberment. Pig joints were used with the same diameters as human arms. Two chainsaws were used: a petrol chainsaw and an electric chainsaw. For both chainsaws and all joint sizes, the tissue spatter distribution showed three distinct regions: i) a line of tissue in front of the cut, ii) tissue particles either side of the line of tissue in front of the cut and iii) a line of tissue behind the cut. The size of the tissue spatter distribution differed between the two chainsaws. The tissue pattern distribution was longer for the petrol chainsaw. The size of the tissue spatter distribution did not depend on joint size for joints with a cross-sectional area greater than 300 cm^2.

Keywords: post-mortem dismemberment; chainsaw; tissue spatter distribution.

Introduction

Bodies are sometimes dismembered post-mortem as this can aide a criminal through i) helping to conceal the victim's identity and ii) ease of disposal [1-3]. The percentage of post-mortem dismemberment of autopsied deaths was 0.2 % for Turkey between 2000 and 2007 [4], Sweden between 1961 and 1990 [1], and Germany [5]. It was 0.21 % in Brazil between 2012 and 2016 [6].

The majority of post-mortem dismemberment cases are performed at the site of the homicide. This site is usually the place inhabited by the perpetrator who is known by the victim [4]. In most homicides the dismemberment is not premeditated and the tools used are those readily available to the perpetrator [5]. Both petrol and electric chainsaws have been used for post-mortem dismemberment [2,7-10].

Chain saws are easy to use, inexpensive to purchase and 'the killer saves time and effort' [11, pg 64]. In most cases of post-mortem dismemberment the head and limbs are removed from the torso [1,5,12]. However, the cuts or combination of cuts do not always display a specific pattern [1,5,12].

Studying bones cut by saws the kerf and striations made by the saws can be used to help identify the saw used [3,9,13-16]. This includes chainsaws [9].

Experimental work on bone and bone fragments [17] concluded that more waste material is produced when using power saws. The size of the by products are influenced by the power source [17].

Use of a chainsaw in post-mortem dismemberment results in a pattern of tissue at the site of dismemberment [8]. A qualitative description of this is given by Randal [8]. When held parallel to the floor, chainsaws produced 'a trail of tissue deposited largely directly beneath the chainsaw bar and a somewhat larger puddle of tissue on the floor directly under the discharge chute' [8]. Very few high velocity spatter droplets were seen on the test chamber walls. A few larger pieces of bone and soft tissue were found on the side walls. These were similar to those at an actual dismemberment scene. None were more than one meter above the ground [8].

Tissue is also left inside a chainsaw after post-mortem dismemberment but this has not been described in published cases [7,9].

The aim of the work in this paper was to study and quantify the tissue spatter pattern created by post-mortem dismemberment and to understand the mechanism that created the tissue spatter distribution.

Two hypotheses were proposed; 1) a chainsaw used in post-mortem dismemberment will produce an identifiable and consistent tissue spatter distribution and 2) there is no difference in the tissue spatter pattern distribution produced by a petrol or electric chainsaw.

Material and Methods

Experiments were carried out to determine whether a chainsaw used in post-mortem dismemberment will produce an identifiable and consistent tissue spatter distribution.

Chainsaws

Background information on chainsaws and how they work can be found in the supplementary information, Moreschi et al [18] and Hainsworth [19]. For this work, one electric chain saw and one petrol chainsaw were used. The petrol chainsaw used was a two-stroke petrol chainsaw, a Stihl 024, Figure 1. This petrol chainsaw is suitable for forestry work and has a chain speed of 20 ms^{-1}. The electric chainsaw was a Challenge Xtreme chainsaw with a chain velocity of 10 ms^{-1}. It is suitable for home use and garden maintenance. Both chainsaws were fitted with 35 cm bars.

The Stihl petrol chainsaw was fitted with semi chisel cutters. Semi chisel cutters are a standard professional chain cutter that produce a tearing type cut. This can make the chainsaw hard to control. The Challenge electric chainsaw was fitted with a micro chisel chain. The micro chisel is less aggressive and narrower than a semi chisel chain. It produces a kerf approximately two-thirds the width of the semi chisel and therefore displacing less material. The shape and narrower width of the micro chisel creates a slicing action through the material.

Rapeseed oil was used to lubricate the chain and bar on both chainsaws.

Before use, both chainsaws were serviced, cleaned with compressed air and the chain cutters sharpened according to thr manufacturer’s specification. Between cuts the chainsaw was run at full throttle away from the test area until only chain oil was flung off. On completion of the final cut on each joint the chainsaw was cleaned and the chain sharpened.

For health and safety reasons, all experimental work was carried out by a trained chainsaw user. Health and safety rules also meant that the operator was limited to vertical cuts with the operator using a crouching position, Figure 2. The same operator was used throughout the experiments.

Pig joint

Pig joints were used to replicate the human body. This replicates the work by Randall [8]. The domestic pig (Sus scrofra) is a recognized human substitute for forensic and medical experimental work. Their anatomy and physiology are similar to humans [20, pg 170], their bones have a similar hardness [21] and when cut with saws show the same type of marks [21]. As a result pigs are regularly used in forensic work including to study saw marks on bone [14,19] and the impact of bullets into the body [22] and bone [23].

Ethical, bio-hazard implications and cost prevented the use of whole freshly euthanized pigs. Instead joints prepared to the standards of the food trade and purchased from a commercial butcher were used. The joints were from Large Whites pigs with a weight of 70-75 kg after removal of blood and offal. The pigs were slaughtered and drained of blood the day before the experiments.

A hind shank and hock joint were used. These were the correct size to represent the human arm. Each joint was large enough to allow three different anatomical cuts to be made on it, Figure 3. Six joints were used in total. Three were cut with the electric chainsaw and three with the petrol chainsaw. The cross-sectional areas of the cuts were: Cut A 604 – 716 cm^2, Cut B 378 – 477 cm^2 and Cut C 150 – 204 cm^2.

To prevent kickback of the chain saw, the joint was left 'naked'. This would represent a body with the clothes removed. Each joint was secured to a plank of wood to avoid movement of the joint.

Results

Details on the parts of a chainsaw and how a chainsaw works, can be found in the supplementary information.

The operator described the petrol Stihl chainsaw as ripping and tearing the joint. The electric Challenge chainsaw was described as cutting through the joint. The operator also felt there was less control of the petrol Stihl chainsaw.

All of the cuts with both chainsaws were carried out with no evidence of snagging and stalling.

Distribution of tissue on the chainsaws

The petrol Stihl and electric Challenge chainsaws produced the same tissue spatter distribution on their exterior. Tissue was deposited around the area where the chain enters the side cover and at the rear of the side cover. A small amount of tissue was seen on the bar and chain. Inside the cover, both chainsaws had tissue deposited around the chain sprocket and chain catcher. The tissue deposited inside the side cover was a different texture and colour to that on the ground. There was more oil present on the tissue inside the cover. On the internal surface of the side cover, a greater volume of tissue was deposited inside the electric Challenge chainsaw.

Tissue distribution on the ground

For all cuts, the tissue spatter distribution for both chainsaws could be divided into three areas, Figure 4. There is a void where the plank was placed. Then the three areas of tissue spatter distribution are i) a line of tissue in front of the cut, ii) tissue particles on either side of the line in front of the cut and iii) a line of tissue behind the void.

In front of the cut, close to the cut the particles formed a line. For the petrol Stihl chainsaw only, the line of tissue widened to a slight V shape (see at about 50 cm in Figure 4) forming a slight curve in the tissue spatter distribution.

To the right of the chainsaw position, larger tissue particles were seen. They were more numerous in the petrol Stihl chainsaw tissue spatter distribution. These included large tissue particles, such as that in Figure 5, found at 60 - 70 cm behind the joint. The colour and texture were the same as that observed internally in the chainsaw.

Length of tissue spatter distribution behind the cut

A plot of the length of the tissue spatter distribution behind the cut against cross sectional area of the joint is given in Figure 6. Behind the cut the length of the tissue spatter distribution varied from 110 to 149 cm for the petrol Stihl chainsaw and from 36 to 90 cm for the electric Challenge chainsaw. A straight line was fitted to the data for each of the two chainsaws using a least-squares fit.

A univariate ANOVA analysis was carried out to compare the length of the tissue spatter distribution behind the cut for the petrol and electric chainsaws. The results showed that the difference between the means was significant ($F_{1,16} = 161.6$, $\rho \leq 0.001$).

Length of tissue spatter distribution in front of the cut

A plot of the length of the tissue spatter distribution in front of the cut against cross sectional area of the joint is given in Figure 7. The maximum length in front of the cut varied from 57 to 454 cm for the petrol Stihl chainsaw and from 133 to 198 cm for the electric Challenge chainsaw.

The length of the tissue pattern distribution for the petrol chainsaw was roughly constant for a cross-sectional area of greater than 300 mm^2. However it decreased rapidly for two of the three smaller joints. As a result, a straight line was only fitted to the data for a cross-sectional area greater than 300 mm^2.

A statistical analysis was carried out to compare the length of the tissue spatter distribution in front of the cut for electric and petrol chainsaws. The results showed that the only significant difference in results was for cross-sectional areas greater than 300 mm^2 ($F_{1,10}$ = 83.8, $\rho \leq 0.001$ for log(tissue spatter distribution length in front of the cut)). Full details of the analysis are given in the supplementary information.

Particle size

For the largest cut, cut A, the particle size was examined for the distance 0 - 100 cm in front of the cut, for the Stihl and Challenge chainsaws. The area covered by particles was measured from photographs using the computer imaging software ImageJ©. A range of particle sizes was found for both chainsaws. The maximum particle size seen was 4.4 cm² at 340 cm in front of the joint for the petrol Stihl chainsaw and 2.1 cm² at 25 cm behind the joint for the electric Challenge chainsaw. Plots of the average area covered by particles to the left and right of the cut are given in Figures 8 and 9 respectively.

ANOVA tests were carried out to determine if the particle size varied between two ranges of distances i) 1 to 50 cm and ii) 50 to 100cm. Only two significant differences were found: for the particle size for the petrol chainsaw to the left of the cut for 0 to 50 cm compares to 50 to 100 cm ($F_{1,4}$ = 15.5, $\rho \leq 0.05$) and for the electric chainsaw to the right of the cut for 0 to 50 cm compares to 50 to 100 cm ($F_{1,4}$ = 9.46, $\rho \leq 0.05$).

ANOVA tests were carried out to determine if it was possible to distinguish between the size of the particles in front of the cut from the electric and petrol chainsaws. The only significant difference was for comparing the electric and petrol chainsaws on the right between 0 and 50 cm ($F_{1,4}$ = 8.6, $\rho \leq 0.05$). Full details of the statistical analysis results are given in the supplementary information.

Discussion

The joints in this work were drained of blood. Randall [8] found that a pig left to lie on the floor for two days, produced less blood spatter than a fresh pig. Hence, the results in this work would underestimate the amount of spatter found at a crime scene from a body dismembered shortly after death.

When cutting the pig joints, the operator described the petrol Stihl chainsaw as ripping and tearing the joint. In contrast, the electric Challenge chainsaw was described as cutting through the joint. The operator also felt there was less control of the petrol Stihl chainsaw. This could be due to the faster velocity or the more aggressive nature of the cutters on the petrol Stihl chainsaw.

Tissue distribution mechanisms

The rotating chain undergoes four very abrupt changes in direction. These points are labelled **1**, **2**, **3**, and **4** in Figure 10. Points **1** and **2** are when the chain moves round the sprocket. Points **3** and **4** are when the chain goes round the nose. Point **5** is where the chain leaves the casing.

Particles of tissue were created as the chainsaw cut through the joint. Tissue was cast off at point **1** as the chain begins to turn round the sprocket. This tissue was then discharged through the discharge chute and created the line of tissue observed behind the cut. Some particles of tissue extruded from the discharge chute. The texture of these particles was different to the other particles but was consistent with tissue cast-off internally.

The chain then turns around the sprocket, **2**. Particles are cast of at this point and impact the side cover. This resulted in a build-up of tissue within the side cover. As the accumulation increased the tissue came away. The tissue was then either discharged via the discharge chute or deposited on the chain and discharged where the cover ends, at **5**. Video stills from both chainsaws showed particles discharged at **5** where the cover ends. An example for the petrol Stihl chainsaw is given in Figure 11.

Small particles continued forwards on the chain until the chain rotated around the nose at **3**. This results in a change of velocity as the direction of the chain's movement changes, whilst the speed remains constant. This change in velocity caused tissue to be cast-off ahead of the chainsaw. The slight V-shaped distribution in front of the linear pattern in the Stihl may be caused by slight lateral movements in the chainsaw bar during cutting.

At **4** the chain completes its turn around the nose. This reversal in direction caused cast off in the direction of the travelling chain. This created the line of tissue and oil beneath the bar.

Length of tissue spatter distribution behind the cut

The correlation of the length of tissue spatter distribution behind the cut to the cross-sectional area of the joint, is low for both the electric Challenge chainsaw and petrol Stihl chainsaws, Figure 6. For each case the correlation coefficient, R^2, is less than 0.3. This implies that the length of the tissue spatter distribution is independent of the joint size.

The two chainsaws gave significantly different lengths of tissue spatter distribution behind the cut ($F_{1,16} = 161.6$, $\rho \leq 0.001$). This means that the length of tissue spatter distribution behind the cut is determined by the cast off velocity at point **1** (as the chain begins to turn round the sprocket) and the discharge chute and not by the joint size.

Length of tissue spatter distribution in front of the cut

For the electric Challenge chainsaw the results showed that the length of the tissue spatter distribution in front of the cut does not depend on the cross sectional area ($R^2 = 0.27$), Figure 7.

If only joint cross-sectional areas greater than 300 mm^2 were considered (cuts A and B) then the petrol chainsaw also gave a tissue spatter distribution length in front of the cut that was independent of cross-sectional area ($R^2 = 0.32$), Figure 7. The tissue spatter distribution length of the petrol Stihl chainsaw was shorter for cuts with small cross sectional areas. This may be due to the larger proportion of bone compares to muscle in this section of the joint. More muscle produces a larger proportion of large particles.

In front of the cut for cross-sectional joint areas less than 300 mm^2 similar tissue spatter distribution lengths were seen for both the electric Challenge and petrol Stihl chainsaws, Figure 7.

For large cross-sectional areas, > 300 mm^2, the log of the length of the tissue spatter distribution was significantly different between the two chainsaws ($F_{1,10} = 83.8$, $\rho \leq 0.001$). This could be due to the difference in velocity of the chain between the petrol Stihl and electric Challenge chains. The velocity of the Challenge electric chainsaw was 10 ms^{-1} and the petrol Stihl chainsaw was 20 ms^{-1}. The faster chain speed of the petrol Stihl chainsaw threw the tissue further.

Particle size analysis

The variation of particle size in front of the cut showed little or no dependence on distance for either chainsaw, Figures 8 and 9 respectively. Comparing the particle size of the two chainsaws the only statistical difference in particle size between the two chainsaws was on the right-hand side of the cut between 0 and 50 cm (ANOVA $F_{1,4} = 8.6$, $\rho \leq 0.05$). In this instance the electric Challenge chainsaw produced a larger average particle size than the Stihl petrol chainsaw. This was unexpected. The petrol Stihl chain, with a semi chisel cutter tears and rips the joint. In contrast, the Challenge chain type, a micro chisel, gives a cut two-thirds of the width of the semi chisel cutters. However, the analysis of individual particle sizes showed that the petrol Stihl chainsaw produced a greater range of particle size. Hence, whilst the average particle size for the petrol Stihl chainsaw was smaller or the same as for the electric Challenge chainsaw, the variation in particle size was greater.

The electric and petrol chainsaw used in this work had the same length of bar, 35 cm, but different chains speeds, cutters and discharge chutes. The results presented in this paper show that it is possible to distinguish between chainsaws, but not whether the difference is due to the power source, chain speed, cutter type or discharge chute design.

Conclusions

The work presented in this paper studied the use of chainsaws to cut through pig joints The results confirmed that of Randall [8] that standard, readily available, petrol and electric chainsaws are efficient, quick and can easily cut through a pork joint.

An analysis of the results demonstrated that the chainsaws do produce an identifiable and consistent tissue spatter distribution. This tissue spatter distribution consists of i) a line of tissue in front of the cut, ii) tissue particles to either side of the line in front of the cut and iii) a line of tissue behind the cut. This distribution was seen for both chainsaws and all cross-sectional areas.

The results also demonstrated that the different chainsaws did show differences in the tissue spatter distribution.

The average particle size for the petrol Stihl chainsaw was smaller or the same as for the electric Challenge chainsaw. The variation in particle size was greater for the petrol chainsaw.

Behind the cut it was found that the length of the tissue spatter distribution was dependent on chainsaw type but independent of joint size.

In front of the cut, for joints with a cross-sectional area of greater than 300 mm^2, the length of the tissue spatter distribution was dependent on chainsaw type. It was independent of cross sectional area of the joint. For small joints with a cross-sectional area less than 300 cm^2 the length of the tissue spatter distribution in front of the joint did depend on joint size.

Ethical approval

All applicable international, national and institutional guidelines for the care and use of animals were followed.

References

1. Quatrehomme G. A strange case of dismemberment. In: Brickley M, Ferilini R, editors. Forensic anthropology: Case studies from Europe. Springfield, Il: Charles C Thomas, 2007;99-119.

2. Holmes D. Psychology and dismemberment. In: Black S, Rutty G, Hainsworth S, Thomson G, editors. Criminal dismemberment: forensic and investigative analysis. CRC Press London, UK, 2017;27-40.

3. Symes, S.A. Morphology of saw marks in human bone: Identification of class characteristics. PhD thesis University of Tennessee, 1992.

4. Dogan K, Demirci S, Denziz L. Erkol Z. Decapitation and dismemberment of the corpse: a matricide case. J For Sci 2010 55(2):542-545.

5. Konopka T, Bolechala F, Strona M, An unusual case of corpse dismemberment. Am J. forensic Med. Pathol. 2006 (27): 163-165.

6. Filho AT, Machado MPS, Dismemberment in Brazil: from early colonization to present days. In: Ross AH, Cunha E, Editors. Dismemberments Perspectives in forensic anthropology and legal medicine. Academic Press, London, United Kingdom. 2019; 43-63.

7. Madea, F. Driever, F. Leichenzerstückelung durch Kettensäge. Arch Kriminol. 2000 205, p75-81. Translated from German by E Woodland, Cadaver Dismemberment by Chainsaw.

8. Randall B. Blood and tissue spatter associated with chainsaw dismemberment. Technical note in J For Sci 2009 54(6): 1310-1314.

9. Reichs K. Postmortem dismemberment; Recovery, Analysis and Interpretation. In: Reichs K. (editor) Forensic osteology – Advances in the Identification of Human Remains. 2nd ed. Springfield, Il: Charles C Thomas. 1998;353-388.

10. Black S, Appendix II: Known cases of criminal dismemberment in the United Kingdom since 1985. In: Black S, Rutty G, Hainsworth S, Thomson G, editors. Criminal dismemberment: forensic and investigative analysis. CRC Press London, UK, 2017;199-202.

11. Maples W, Browning M. Deadmen do tell tales. New York, Doubleday. 1995.

12. Duhig C, Martinsen N. Many layers of taphonomy: dismemberment and other body processing. In: Brickley M, Ferilini R, editors. Forensic anthropology: Case studies from Europe. Springfield, Il: Charles C Thomas, 2007;86-98.

13. Symes, S.A. Rainwater, C.W., Cabo, L.L., Chapman, E.N., Wolff, I., Knife and saw toolmark analysis in bone: A manual designed for the examination of criminal mutilation and dismemberment. National Institute of Justice Grant. Available from https://www.ncjrs.gov/pdffiles1/nij/grants/232864.pdf (Accessed 14/06/2019)

14. Sanabria-Medina, C., Osorio Restrepo, H. Dismemberment of victims in Columbia: A presepctive from practice. In: Ross AH, Cunha E, Editors. Dismemberments

Perspectives in forensic anthropology and legal medicine. Academic Press, London, United Kingdom. 2019; 7-42.

15. Amadesi A, Mazzarelli D, Oneto C, Capella A, Gentilomo A, Cattaneo C. Dismemberment and toolmark analysis of bone: A microscopic analysis of the walls of cut marks. In: Ross AH, Cunha E, Editors. Dismemberments Perspectives in forensic anthropology and legal medicine. Academic Press, London, United Kingdom. 2019; 43-63;115-132.

16. Ross AH, Radisch D, Toolmark identification on bone: Best Practice. In: Ross AH, Cunha E, Editors. Dismemberments Perspectives in forensic anthropology and legal medicine. Academic Press, London, United Kingdom. 2019; 165-182.

17. Symes S, Berryman H, Smith O. Saw marks in bone: introduction and examination of residual kerf contours. In: Reichs K. (editor) Forensic osteology – Advances in the Identification of Human Remains. 2nd ed. Springfield, Il: Charles C Thomas. 1998;389-409.

18. Moreschi C, Da Broi U, Cividino S, Gubiani R, Pergher G. Neck injury patterns resulting from the use of petrol and electric chainsaws in suicides. Report on two cases. J For Leg Med 2014;25:14-20.

19. Hainsworth H, Identification marks – saws. In: Black S, Rutty G, Hainsworth S, Thomson G, editors. Criminal dismemberment: forensic and investigative analysis. CRC Press London, UK, 2017;152-154.

20. Brunet B, Doucet C, Venisse N, Hauet T, Hébrard W, Papet Y, Mauco G, Mura P. Validation of large white pigs as a model for the study of cannabinoids metabolism: Application to the study of THC distribution in tissues. F Sci Int 2006;161:169-174.

21. Saville P, Hainsworth S, Rutty G. Cutting crime; the analysis of the ”uniqueness” of saw cut marks on bone. Int J Leg Med 2007;12:349-357.

22. Kneubuehl BP, Coupland RM, Rothschild MA, Thali MJ, Wound ballistics – basics and application. Publ. Springer, Germany, 2011.

23. Rickman JM, Shackel J, A novel hypothesis for the formation of conoidal projectile wounds in sandwich bones, Int. J. Legal Medicine 2009;133 (2):501-519.

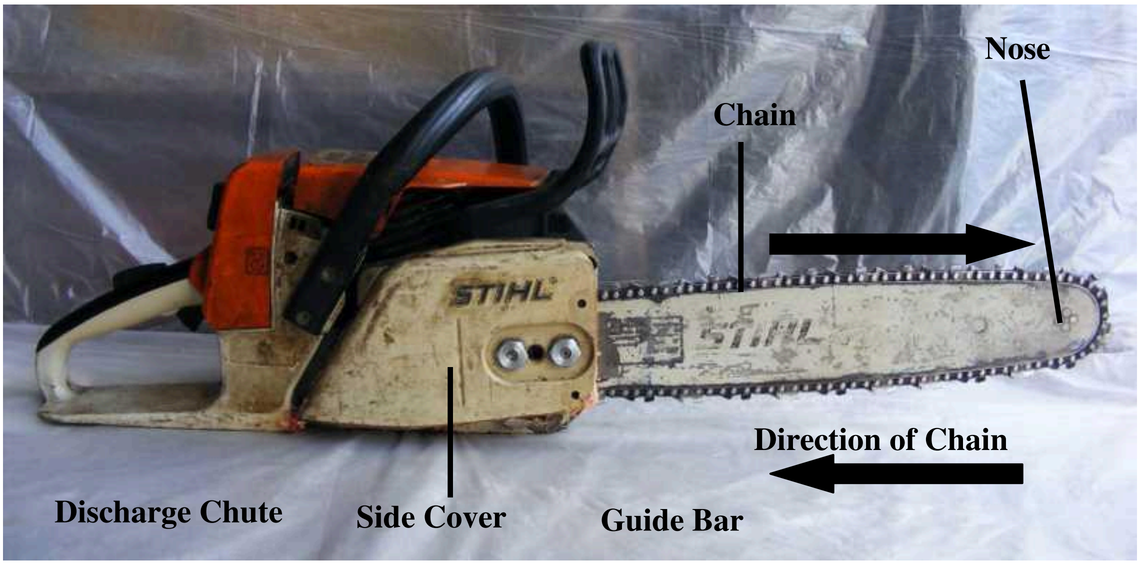

Figure 1. Exterior of a petrol chainsaw (a Stihl).

Figure 2. Position of the chainsaw operator for cutting.

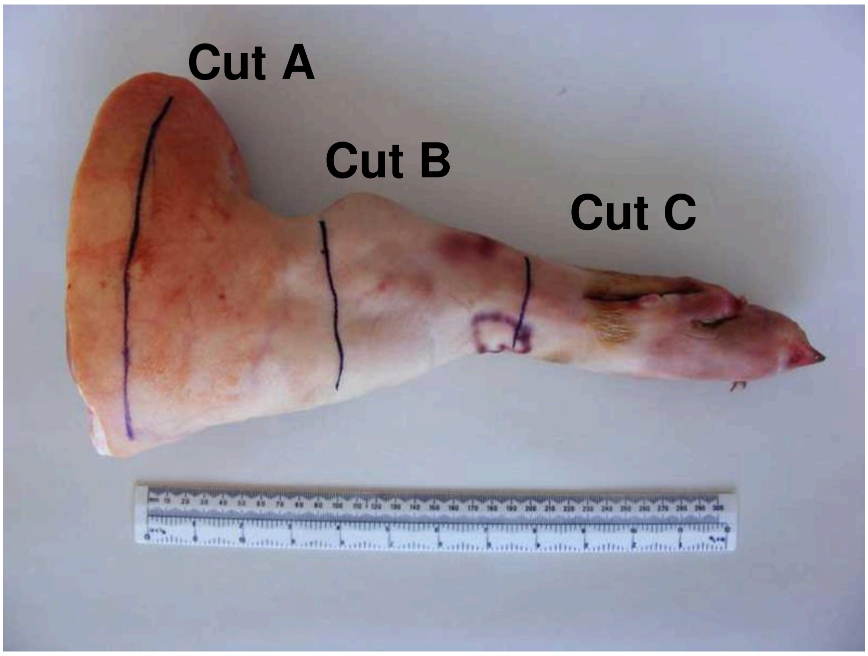

Figure 3. Pig joint showing cuts A, B and C.

Orientation of chainsaw (not to scale).

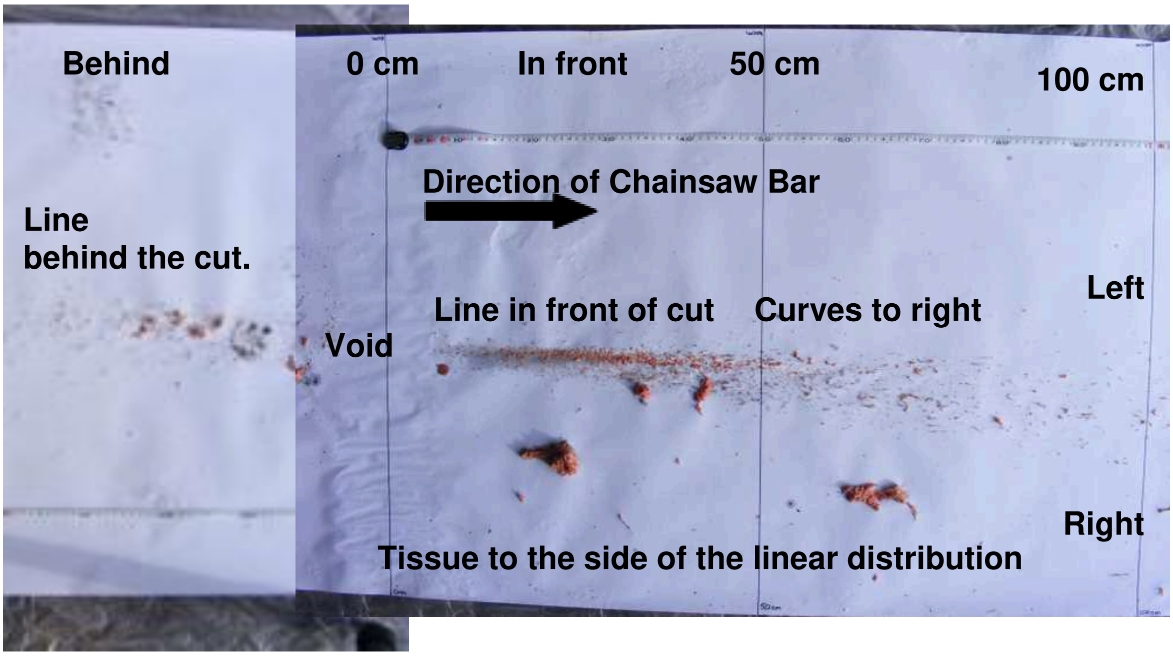

Figure 4. Stihl tissue spatter distribution behind and up to 100 cm in front of Cut A.

Figure 5. Tissue particle 60 - 70 cm behind the impact site. From B cut by petrol Stihl chainsaw.

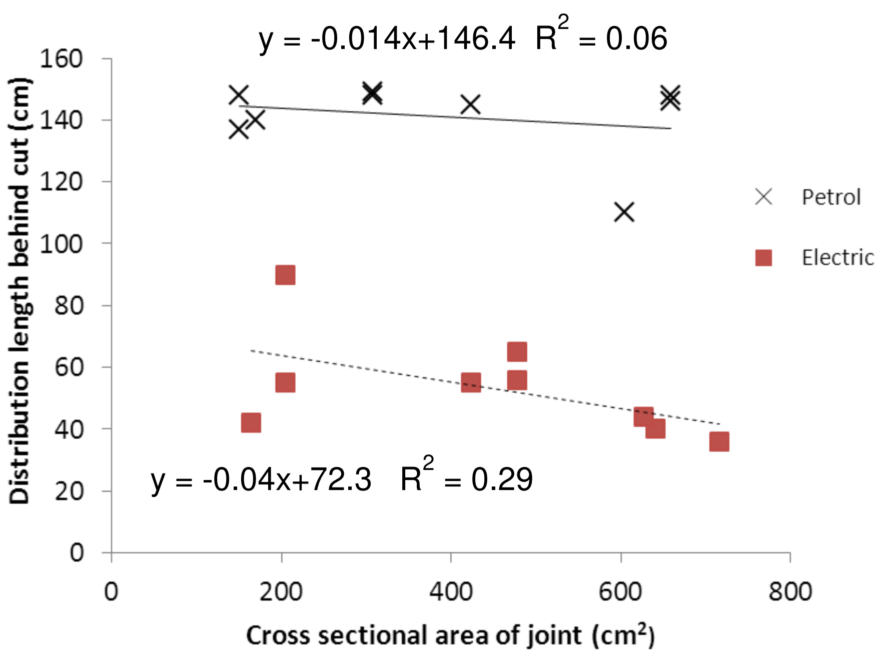

Figure 6. Length of tissue spatter distribution behind the cut. R^2 is the correlation coefficient.

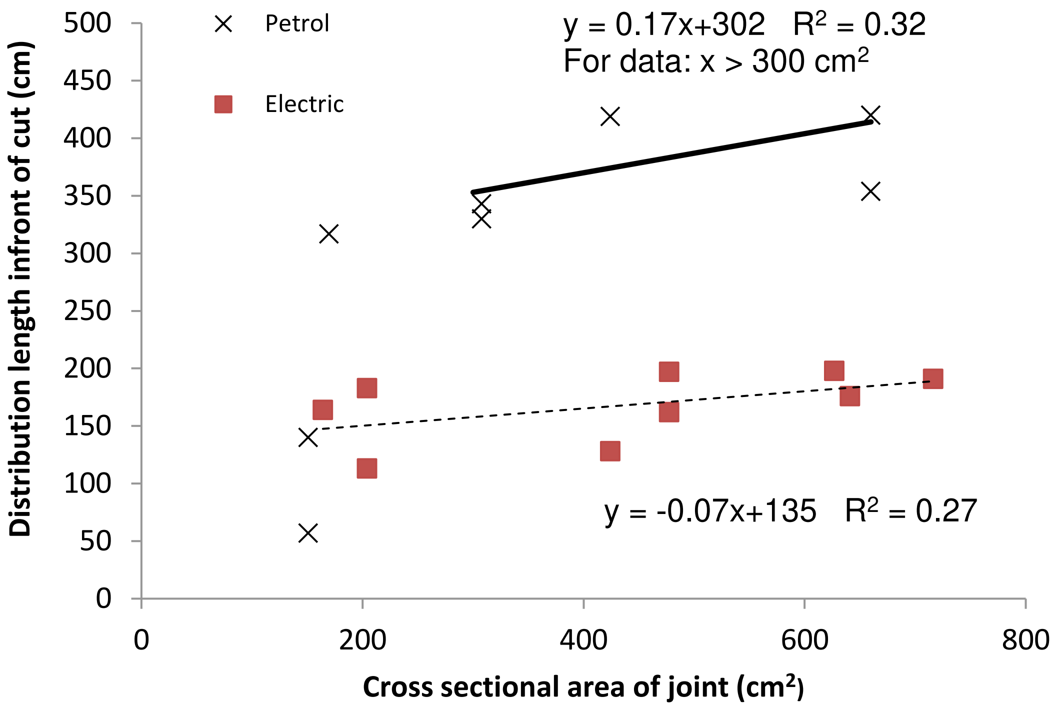

Figure 7. Length of tissue spatter distribution in front of the cut.

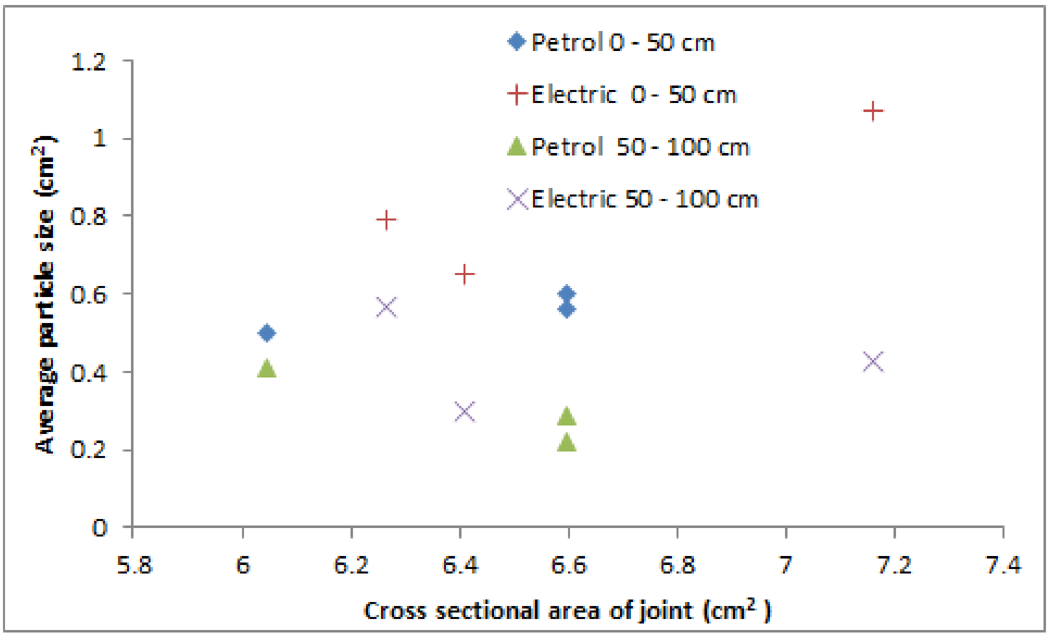

Figure 8. Average particle size to left of cut.

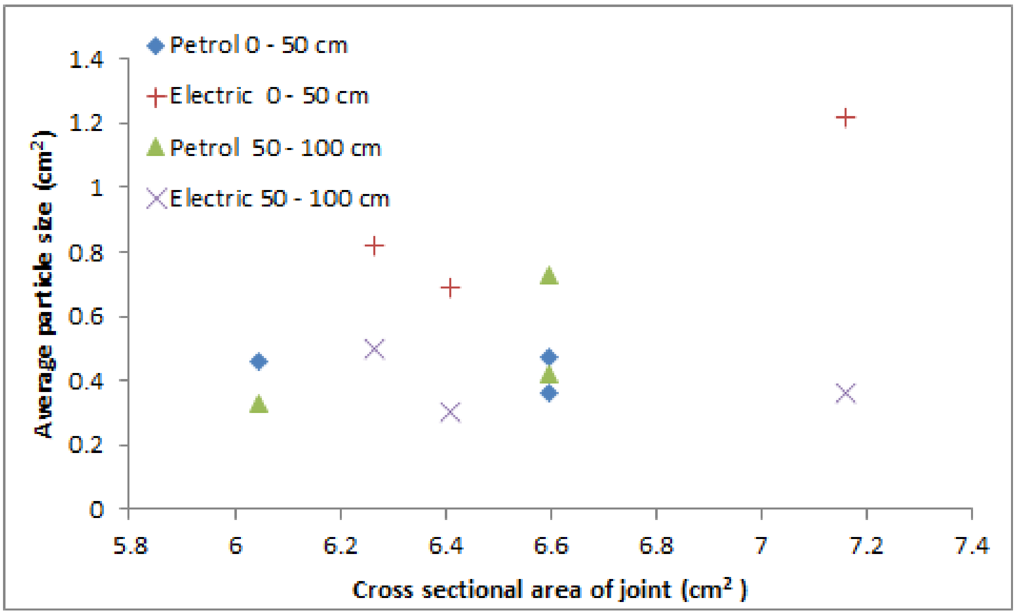

Figure 9. Average particle size to right of cut.

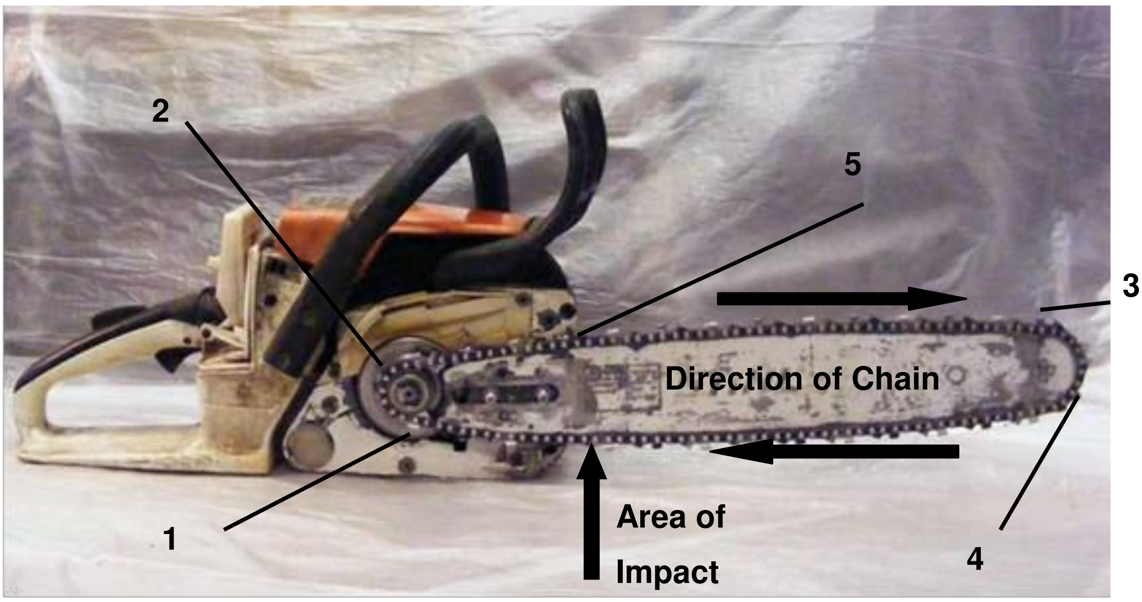

Figure 10. Cast-off points of chainsaw. The cast off is in the direction of the arrows.

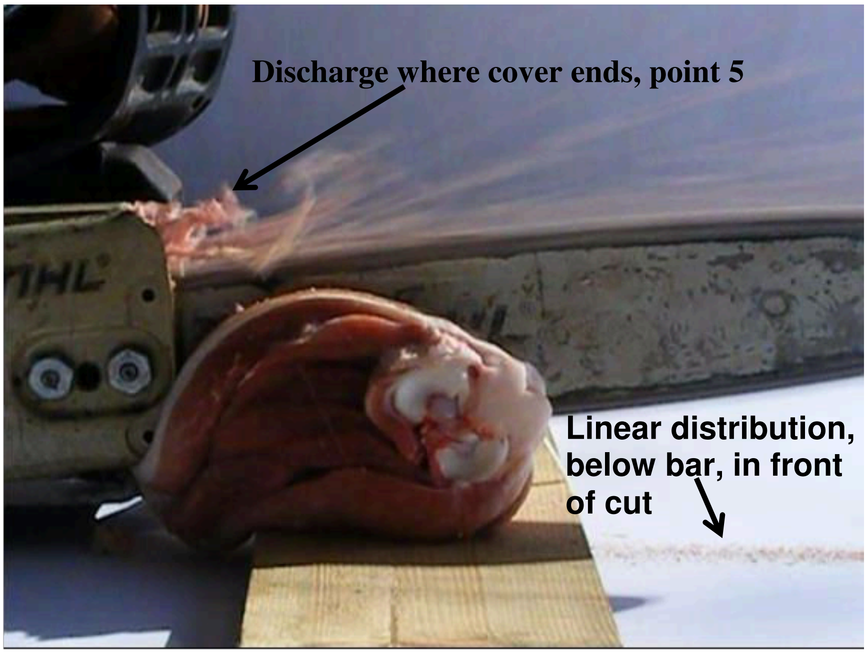

Figure 11. Cast off from the cover and linear tissue spatter distribution in front of the cut from the petrol Stihl chainsaw.

Post-mortem dismemberment using chainsaws

Knock, Clare

2019-08-25

Knock C, George A. (2021) Post-mortem dismemberment using chainsaws. Australian Journal of Forensic Sciences, Volume 53, Issue 1, January 2021, pp. 50-61

https://doi.org/10.1080/00450618.2019.1655094