

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/locate/jflm

Case review

Neck injury patterns resulting from the use of petrol and electric chainsaws in suicides. Report on two cases

Carlo Moreschi ^a, Ugo Da Broi ^{a,*}, Sirio Cividino ^b, Rino Gubiani ^b, Gianfranco Pergher ^b^a Department of Medical and Biological Sciences, Section of Forensic Medicine, University of Udine, Italy^b Department of Agricultural and Environmental Sciences, Section of Agricultural Engineering, University of Udine, Italy

ARTICLE INFO

Article history:

Received 16 December 2013

Received in revised form

5 February 2014

Accepted 15 April 2014

Available online 29 April 2014

Keywords:

Suicide

Neck injuries

Petrol chainsaw

Electric chainsaw

ABSTRACT

Suicides due to neck injuries caused by chainsaws are uncommon events. The cutting elements of petrol and electric chainsaws produce different features in lethal neck injuries. The accurate evaluation of the death scene, of the power and mechanical characteristics of the chainsaw and of wound morphology are all essential in distinguishing a case of suicide.

© 2014 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.

1. Neck injuries in chainsaw suicides

Suicides committed using a chainsaw are uncommon and highly damaging events.^{1–6}

The victims, frequently suffering from mental disorders, apply the cutting attachment to the back or side of the neck, to the lower part of the head or to the throat, while more unusual suicides involve the lethal self-mutilation of arms, thorax or abdomen.^{1–8}

The application of the guide bar to the neck or lower part of the head produces deep, lethal wounds involving the tegumental areas, muscle, bone, nerves and spinal cord, which cause a rapid demise due to exsanguination and collapse due to the interruption of spinal sympathetic fibres.^{1,9,10}

Analysis of the death scene and related circumstances may sometimes be inconclusive, with forensic investigators having initial difficulty in differentiating between suicide and homicide events.⁹

In the event of a chainsaw-related death it is essential that the following steps are taken in order to determine whether a suicide or homicide has been committed: an accurate reconstruction of the event, the scrupulous investigation of the death scene, the

reconstruction of the victim's psychiatric history or the prior experience of handling chainsaws or similar tools, and the execution of appropriate autopsy examinations.

Furthermore, a comparison of the macroscopic morphology of the neck and head wounds with the power and mechanical characteristics of the chainsaw found near the corpse should confirm whether that tool was in fact used and to differentiate between the use of a petrol or electric chainsaw.

Schiwy-Bochat et al. and Reuhl et al. described the typical morphology of neck injuries caused by the use of chainsaw consisting of one main lesion involving the skin and the underlying anatomical planes caused by rough and deep cutting into and removal of the tissues, which may produce contused and irregular skin flaps at the initial point of contact and penetration of the surface tissues by the chain teeth.^{3,9}

The main cut is generally straight but may present some tags in the side walls which are extensively contused.^{3,9,11}

Wound morphology is determined by the shape of the saw teeth whose perpendicular cutting surfaces are designed to cut and remove wood (see Fig. 1).¹

As a result, the wounded tissue is cut, bruised, chewed and coarsely removed while the margins of the wound may often be contaminated with foreign oily substances, sawdust or wood chips, bark, grease, bacteria or fungal microspores normally lodging on the chain and teeth.^{9,11}

The teeth's chewing effect produces an accumulation of coarser, heavier fragments of tissue below the cutting attachment while

* Corresponding author. Sezione Dipartimentale di Medicina Legale, Università degli Studi di Udine, Piazzale Santa Maria della Misericordia 11, 33100 Udine, Italy. Tel.: +39 0432 554363; fax: +39 0432 554364.

E-mail address: ugo.dabroi@uniud.it (U. Da Broi).

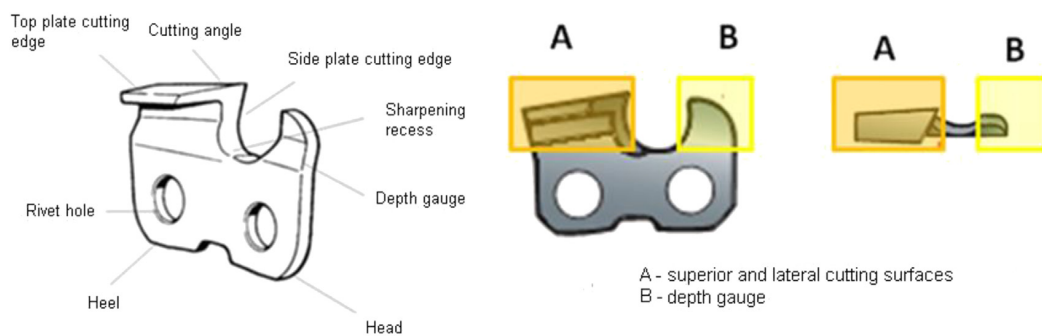


Fig. 1. Saw chain element.

smaller, lighter fragments of tissue and blood are normally launched ahead from the tip of the bar.¹²

Schiwy-Bochat et al. reported that the saw teeth normally slip off the skin on initial contact with surface tissues but, after increasing manual pressure, the saw penetrates the deeper tissues causing lethal wounds to the deep vessels and nerves of the neck as far as the cervical spine bones.³

When the chain hits bone, in the absence of sufficient manual pressure applied by the operator, the dangerous phenomenon known as “kickback” may occur, with the guide bar bouncing back and causing small, secondary, smooth-edged, parallel wounds above the deep primary wound, which may also be enlarged.^{9,10,15,16}

The wounds caused by kickback may be morphologically different from tentative wounds caused by multiple applications of the bar and may be distant from the main wound and generally less deep.

The main wound caused by a chainsaw might, in some cases, appear to have been caused by a homicidal attack with a chopping device or an axe because its edges may in some areas present a raised flap. However, the edges of a wound caused by a chainsaw are generally more irregular, bruised and ragged when compared with those caused by a steel blade.⁹

Autoptic macroscopic and histological confirmation of the vitality of the margins of the main wound are mandatory, in order to exclude the presence of post-mortem cross-cutting wounds on the corpse, inflicted after the subject had been killed by means of a chainsaw or other tools or weapons.

Moreover the evaluation of the blood level of carbon monoxide and aromatic compounds from unburned lubrication oil absorbed through the alveolo-capillary membrane, may confirm that the subject breathed exhaust fumes from the chainsaw immediately before death.¹⁸

Tournel et al. reported that the mechanical vibrations produced by a chainsaw may also cause lesions when the tool is used on the human body.¹⁰

The severity of these wounds is a consequence of the amplitude, frequency and duration of the vibrations and the density of the part of the body in question.

The greater the density, the greater the transmission of mechanical waves and their fragmentation effects, especially in bone.

Tournel et al. reported that lesions of the cervical area due to vibrations may appear at frequencies near 50–60 Hz, while in the case of frequencies approaching 100 kHz the vibration energy is transmitted in the form of destructive waves so that the damage to the cervical vertebrae or the basal bones of the skull presents as multiple fractures or crumbling.^{2,10}

In the case of vibrations above 100 kHz the destructive compressive waves will increase and give rise to a macerated appearance in the deepest internal areas of the lateral walls of the wound and will involve bone, cartilage (periarticular, thyroid, hyoid, tracheal rings), ligaments, tendons, and soft tissues such as muscles, blood vessels and nerves.¹⁰

The angle of incidence between the longitudinal axis of the neck and the longitudinal axis of the guide bar is generally less than 90°, since the handgrip of the chainsaw is held down and the bar is held up, while the angle of incidence between the longitudinal axis of the neck and the transverse axis of the bar can be more or less than 90°, because the bar is generally held against the neck with a rotation of its transverse axis, depending on how the chainsaw is held by the subject.

The duration of the manual pressure applied to the throttle trigger switch is generally no longer than a few seconds due to reaction to the perceived pain and the loss of consciousness induced by neurovascular lesions, so that a complete suicidal decapitation in reality never occurs because the chain does not keep running when the trigger is released and because the chainsaw generally falls from the hands of the victim.

Overall the depth and the seriousness of the injuries caused by a chainsaw are influenced by a combination of the variables such as the intensity and duration of the force applied to the guide bar held against the neck, the size, weight and power of the chainsaw used, chain velocity, chain acceleration and deceleration time, vibrations delivered, the sharpness of the cutting elements, and the pitch and depth gauge settings.

The width of a wound also varies according to the lateral oscillation of the saw because the subject does not have full manual control over the tool and because of the vibrations generated by the engine.¹¹

Those who stand while applying the chainsaw to the neck, may take a few steps before losing consciousness and falling to the floor while the saw comes to a standstill and is retrieved at a certain distance from the corpse with the engine either still running or off.

The presence of footprints in blood on the floor, with the chainsaw lying some metres away from the corpse, might suggest homicide rather than suicide (the victim having apparently been pursued by an attacker wielding the chainsaw).^{9,11}

Various authors have described and differentiated the typical morphological features of wounds to the neck or basal areas of the skull produced by petrol and electric chainsaws observed during post-mortem examination.^{9,10}

Reuhl et al. reported the features of conspicuous neck wounds caused by petrol chainsaws as consisting of deep, gaping injuries, measuring several centimetres in width and several centimetres in length, with the edges mostly torn and ragged.⁹

Table 1
Chainsaw classification.

Power support	Guide bar length (centimetres)	Chain speed (metres/sec)	Mass (kilograms)
Petrol chainsaw	25–100 cm	16–28 m/s	3–16 kg
	>100 cm	>28 m/s	
Electric chainsaw (mains)	25–45 cm	6–12 m/s	4–8 kg
Electric chainsaw (battery)	25 cm	3–5 m/s	3–5 kg

Reuhl et al. also remarked that the majority of the edges present the typical features of severely lacerated and contused wounds with transverse fissures and notches also involving the deep bony structures.⁹

The high power and the consequent high velocity of the chain running on the guide bar as well as the high intensity of vibrations and the wider gauge and longer pitch of a petrol chainsaw are responsible for generating more damage to the anatomical structures of the neck if compared with those produced by an electric chainsaw.

In a petrol chainsaw the rapid acceleration of the chain, activated by the trigger switches, produces an immediate capacity to injure while the progressive deceleration after releasing pressure on the switch, only serves to prolong the damaging effects.⁹

Neck wounds caused by an electric chainsaw are similar to those caused by a petrol chainsaw but the morphology of the tissue lesions, both superficial and deep, is more regular and less cut up, bruised and chewed. This occurs because the cutting and chewing effects of an electric chainsaw, which is less powerful than a petrol version, are correspondingly less aggressive and do not result in wounds as broad and irregular as those caused by a petrol chainsaw.¹⁰

The action of the vibration energy waves and the lateral oscillation of the cutting attachment are not so evident when using an electric chainsaw, so the width of the main wound produced is not so great, neither at the surface nor at depth, without producing a significantly contused and macerated appearance at the bottom of the wound and at the deepest internal areas of its lateral walls.

Consequently less crumbling and fracturing is detectable in the deep bony structures of the neck or basal areas of the head (cervical vertebrae, mandible, occipital bone), and the cut is more uniform and regular.

Furthermore, in an electric chainsaw the slower acceleration of the chain activated by the trigger switches and the immediate chain deceleration after releasing the same switches produces less devastating and less rapid damage when cutting starts and less prolonged effects after it stops.

2. Technical specifications and functioning of chainsaws

Chainsaws are cutting tools frequently employed in forestry, agricultural and gardening work and are primarily used for tree



Fig. 2. Petrol chainsaw.



Fig. 3. Electric chainsaw.

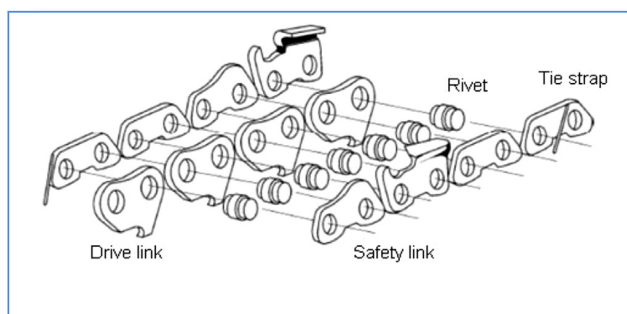


Fig. 4. Enlarged view of saw chain elements.

falling, for limbing and bucking, cross-cutting trunks, cutting firewood and pruning.

Chainsaws are classified, according to the power source which drives the chain, as petrol chainsaws, electric chainsaws or electric battery chainsaws.

The specific engine or motor driving the chainsaw determines the power and size of the tool and the speed of the chain (see Table 1, Figs. 2 and 3). Professional chainsaws have high-powered engines while chainsaws for hobby and Do It Yourself applications have less powerful petrol engines and electric motors.^{13–15}

The cutting action of a saw chain on wood is produced by two perpendicular cutting surfaces (side and top plates) which constitute the cutting teeth (the chain has both left and right symmetrical cutters) which work together with a third ramped surface, the depth gauge (see Figs. 1, 4–6). The chain links are therefore designed not merely to cut the wood but to operate with a dual cutting and removing action.¹⁴

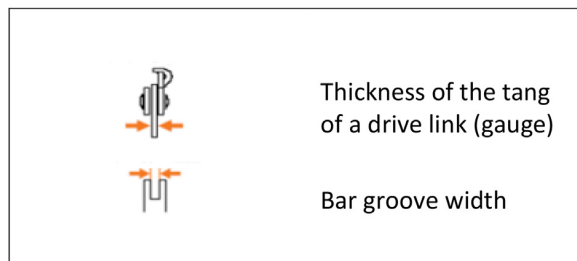


Fig. 5. The connection between the tang of a drive link and the related bar groove makes up a single element of the chain.

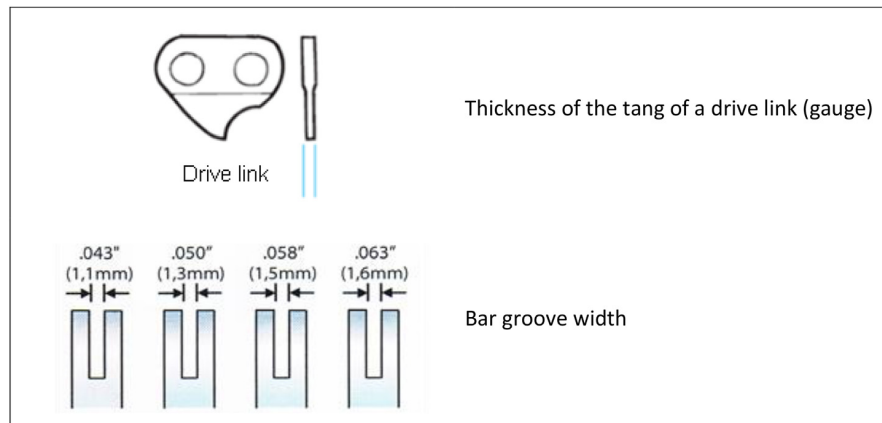


Fig. 6. Saw chain gauge – Standard values 0.043" (1,1 mm), 0.050" (1,3 mm), 0.058" (1,5 mm), 0.063" (1,6 mm).

Essentially the teeth cut and remove the material in the form of wood chips, which are normally 5 mm/10 mm if the chain is sharp (assuming the appearance of pulverized wood if the chain elements are not sharpened), while the depth gauge determines how deep a bite the cutters make (see Figs. 1, 4–6).

"Kickback" may occur if the tool is used incorrectly and the tip of the guide bar comes into contact with the material being cut, which results in the bar being thrust upwards in an uncontrolled arc. Kickback generally occurs when the tip or upper quadrant of the bar meets a highly resistant material and shifts violently away from the primary cutting line.^{15,17}

Gauge and pitch are two important structural parameters, which determine the width and length of the chain links and the consequent cutting and wood-removing ability of the chainsaw.

Gauge is the thickness of the "tang", which is the part of the "drive link" (the central element connecting two adjoining links of the outer chain) that rides inside the bar groove where a sprocket system draws the chain (see Figs. 1, 4–6).¹⁵

Electric chainsaws have small gauge values normally equal to 0.5 inches (1.3 mm), while petrol chainsaws have higher values equal to 0.58 inches (1.5 mm).¹⁴

These different gauge values reflect the specific uses to which petrol or electric chainsaws are put: electric chainsaws are designed to cut trees with small diameters or to limb and buck trunks, while petrol chainsaws are designed to fell trees of a medium or large diameter and require a larger gauge in order to work on the wood more aggressively (see Figs. 1, 4–6).¹⁶

Chain pitch is the value determined by measuring the distance between the centres of three adjacent rivets and dividing by two. Pitch size is described as an imperial or metric fraction of an inch (see Table 2, Figs. 1, 4 and 7). Obviously the longer the pitch, the longer the cutting teeth, which in turn produces more aggressive effects on the wood (see Figs. 1, 4 and 7).

Table 2

Pitch values of the chain measured in millimetres and inches.

Distance between three adjacent rivets (mm)	Pitch (mm)	Pitch (inches)
12.80 mm	6.40 mm	1/4"–0.25"
16.70 mm	8.35 mm	0.325"
19.20 mm	9.60 mm	3/8"–0.375"
20.60 mm	10.30 mm	0.404"
38.00 mm	19.00 mm	3/4"–0.75"

Two characteristics of chainsaws are the processes by which the chain accelerates and is arrested, both controlled by trigger switches, which must be pushed and gripped during acceleration and released to halt the chain.

Electric and petrol engines cause the saw chain to accelerate and decelerate in different ways in response to the pressing or release of the trigger switches.¹⁵

Electric chainsaws incorporate a potentiometer which is turned on or off by pushing or releasing the throttle triggers: when the triggers are pushed, acceleration is progressive and the chain initially starts cutting and removing the material slowly. When the triggers are released, the chain stops immediately.

Petrol chainsaws accelerate as soon as the triggers are pressed but, rather than stopping immediately when the triggers are released, deceleration lasts a few seconds, so that the saw chain continues cutting and removing material for a short time.

These design features of petrol and electric chainsaws mean that they operate in different ways according to their dimensions, weight, power, chain velocity, chain acceleration/deceleration time, vibration and the cutting/removing ability of the chain teeth on the wood which is, in turn, specifically influenced by the gauge and pitch of the constituent parts of the chain (see Tables 3 and 4).

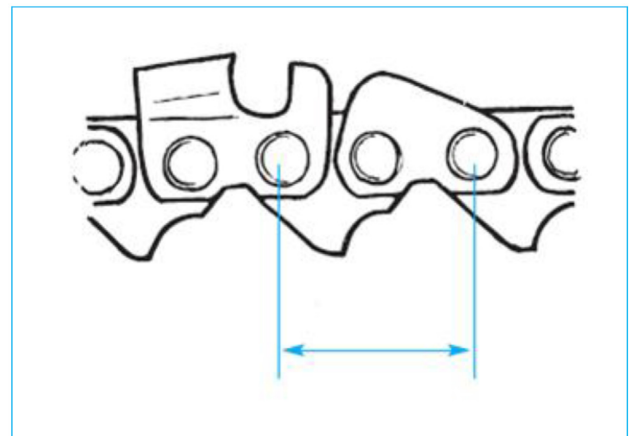


Fig. 7. Saw chain pitch: distance between the centres of three adjacent rivets divided by two.

Table 3
Main differences between petrol and electric chainsaws.

Engine	Bar length	Chain pitch	Gauge	Number of chain components
Petrol	35 cm (14")	0.325"	1.5 mm (0.058")	50
Electric	35 cm (14")	3/8" mini	1.1 mm (0.043")	50

3. Description of two chainsaw suicides

Data from the death scene and post-mortem investigations of two cases of suicide have recently been recorded in our departmental register of post-mortems. The two victims employed different types of chainsaw, one petrol-driven, the other electric with different functional and mechanical characteristics (see Table 5).

The first case involved a 58-year-old man, who had no psychiatric record, although he claimed to have had suicidal tendencies in the past.

The corpse of the man was found inside a private garage, on the floor near a butcher's workbench (used to cut up pig carcasses).

A large amount of blood was found on the bench and floor but there were no footprints in the blood on the floor. Many fragments of tissue and blood were found spattered on a window and a wall some metres from the corpse. The petrol chainsaw was lying on the floor about one metre away from the left hand of the corpse.

At post-mortem examination a large wound was observed on the right and posterior side of his neck which involved the neck muscles, jugular, vertebral and carotid vessels and the cervical vertebrae (the bone was almost severed between the second and third cervical vertebra) with nearly complete cervical spinal cord transection. The wound, 20 cm long, 4 cm wide and 3 cm deep (the cut crossed the longitudinal axis of the neck at an angle of less than 45°, with its apex towards the head) was gaping open with contused and mostly torn and ragged macerated edges (see Fig. 8).

In accordance with the data reported by Reuhl et al. the rims of the wound were severely contused and lacerated, with transverse and notched fissures involving the muscles (especially the sternocleidomastoid muscle), blood vessels and the deep bony structures which were not cleanly cut and were partly fragmented.⁹

The cause of death was identified as haemorrhagic shock with impaired control of sympathetic vascular modulation (nearly complete cervical spinal cord transection).

The morphology of the stains found on the floor, the inspection of the death scene and the autoptic data suggested that:

- no one else was present in the private garage at the moment of the event.
- the event occurred inside a private garage where the subject was seated on a chair, lay the left side of his face and neck onto a butcher's workbench and applied a petrol chainsaw to the right upper side of the neck, below the ear, and then fell to the floor dead.
- the position of the neck on the workbench permitted the application of the chainsaw bar on the right side of the neck.

Table 5
Functional and mechanical characteristics of the chainsaws employed in two observed suicides.

Engine	Chain speed	Guide bar length	Power	Power supply	Noise	Weight
	Metres/sec	Centimetres	Kilowatts		DeciBels	Kilograms
Petrol chainsaw suicide	20 m/s	35	2.7	Two-stroke engine	113	4.7
Electric chainsaw suicide	11 m/s	35	1.8	Electric engine 220 V	104	4.4

Table 4
Main acceleration values (toward x, y, z cartesian spatial axis) of petrol and electric chainsaws quantified at the handgrip (UNI ISO 7505: 1989).

Engine	Acceleration x spatial axis (Mean)	Acceleration y spatial axis (Mean)	Acceleration z spatial axis (Mean)	Acceleration vectorial sum (Mean)
Petrol	7.2 m/s ²	4.5 m/s ²	11.8 m/s ²	14.6 m/s ²
Electric	3 m/s ²	2.4 m/s ²	1.9 m/s ²	4.3 m/s ²

- demise occurred rapidly due to the high and disruptive power of the petrol chainsaw used.
- the subject committed suicide.

The second case involved a 23 year-old man, who suffered from depressive psychosis and had twice attempted suicide in the past, once by hanging and the other time by using a knife on his neck.

The corpse of the man was found supine in a corridor at home. A large amount of blood was found on the floor where the subject collapsed.

Several blood stained footprints were found on the floor, which showed that the victim had taken steps away from an initial point before returning more or less to the same point, where he fell.

The electric chainsaw was found on the floor near the corpse. The chainsaw had been unplugged from the mains by the rescuers.

At autopsy a double cut was observed on the right side and back of the neck involving the ear, neck muscles, jugular and vertebral vessels, while two deep, parallel, curved cuts (3.5 cm and 2 cm long, both 1 cm wide) were identified on the right side of the occipital bone around the occipital foramen, with other tiny fractures branching off, suggesting that the subject applied the chainsaw to the neck twice.

The autoptic evidence is supported by the analysis of the crime scene which suggests that demise was not immediate, with the victim able to take a few steps between the two applications of the chainsaw.

Various haemorrhagic and contusive lesions of the upper spinal cord and cerebellum were found, involving mainly the right-hand regions of the cerebellar lobes, right-hand tonsillae and inferior peduncles. The wound was 10 cm long, 3 cm wide and 2 cm deep (the cut crossed the longitudinal axis of the neck at an angle of less than 30°, with its apex towards the head) and was more regular, less bruised and chewed up, both superficially and at depth. The width of the wound produced was not as great as in the preceding case, and in the edges, bottom, and deepest internal areas of its lateral walls did not present a significantly contused or macerated appearance (see Fig. 9).

In accordance with the data reported by Tournel et al. the edges of the wound, both at the surface and at depth, were more regular and less cut up, bruised and chewed. This resulted from the more moderate cutting and chewing effects of the electric chainsaw as well as the less severe vibration energy waves and lateral bar oscillation, which do not produce the same degree of damage as a the more powerful petrol chainsaw.¹⁰

Consequently the main wound produced was not so wide, either at the surface or at depth.



Fig. 8. Deep, gaping lesion, caused by petrol chainsaw, measuring up to several centimetres in width and length, with contused and macerated edges mostly torn and ragged.

Less marked crumbling and fracturing were also present, with a more uniform and regular cut in the deep bony structures of the neck and occipital areas of the head.

The cause of death was identified as haemorrhagic shock with impaired control of sympathetic vascular modulation (haemorrhagic contused lesions of upper spinal cord and cerebellum).

The comparison of the soles of the victim's feet with all footprints found on the floor, the inspection of the death scene and the autoscopic data (a double al wound on the right side and back of the neck) suggested that:

- a) the footprints found were compatible with the soles of the subject's feet.



Fig. 9. Lesion, caused by electric chainsaw, which is more regular, less bruised and chewed, both superficially and at depth. The width of the wound produced is not so great, without significantly contused and macerated edges, at the bottom of the wound and at the deepest points of the side walls.

- b) the chainsaw was applied while the victim took a few steps from and back to approximately the same point on the floor.
- c) the event occurred in a corridor at home where the man, bare-footed, applied an electric chainsaw bar to the right side of his upper neck and through the middle of the ear, took several steps, returned to the point of departure, applied the chainsaw bar a second time and fell to the floor. He left several blood stained footprints which initially raised some doubts as to whether it represented a suicide or an assault.
- d) the first cut was not deep or immediately lethal and allowed the subject to take several steps while the second of the wound caused the death.
- e) the double wound on the right side and back of the neck was self-inflicted.
- f) demise did not occur so rapidly due to the lower power of the electric chainsaw used.
- g) the subject committed suicide.

4. Discussion

The two suicides described above revealed, in agreement with other published reports, different crime scene dynamics and different wound morphologies at autopsy, which enabled us to differentiate the application of a petrol or electric chainsaw.

The first case involved a man found dead inside a private garage on the floor in a large amount of blood under a butcher's workbench. Many fragments of tissue and blood were found sprayed on a window and a wall located a few metres from the corpse. A petrol chainsaw was found on the floor near the corpse.

At post-mortem examination a large wound was observed on the right and posterior side of his neck involving the neck muscles, jugular, vertebral and carotid vessels, cervical vertebrae and cervical spinal cord.

The rims of the wound were severely contused and lacerated and the underlying tissues were not cleanly cut and were partly fragmented.

The death was clearly a suicide because the man, seated on a chair, lay the left side of his face and neck onto the bench and applied a petrol chainsaw to the right upper side of the neck. Death occurred rapidly due to the high and disruptive power of the petrol chainsaw employed.

The second case involved a man found dead in a corridor at home. A large amount of blood was found near the corpse on the floor where several blood stained footprints showed steps moving away from and then returning to the same point, near which an electric chainsaw, unplugged from the mains, was found.

At post-mortem examination a double cut was found on the right side and back of the neck involving the neck muscles, jugular and vertebral vessels and the right side of the occipital bone (two full-thickness parallel cuts), the cerebellum and cervical spinal cord.

The rims of the wound were more regular, less bruised and chewed up, both superficially and at depth, without presenting a significantly contused or macerated appearance.

The death was a suicide: the man applied the electric chainsaw to the right side of his upper neck, took several steps, returned to the point of departure and performed a second lethal application of the chainsaw.

The comparison of all the morphological features of the neck and head injuries with the mechanical and operational characteristics of the associated chainsaw must always be done in order to

ascertain whether the tool was in fact used in the suicide and to exclude the use of other tools or weapons and to distinguish a suicide from murder.

The intensity of the ruinous effects of the chainsaw on anatomical tissues is crucially dictated by the power of petrol and electric chainsaws. Essentially a petrol chainsaw produces more power and generates a higher chain speed, more intense vibrations and greater lateral oscillation than an electric chainsaw. A petrol chainsaw will achieve its top chain speed very soon after starting but takes a longer time to stop, while an electric chainsaw takes longer to reach its top speed but a shorter time to stop: this means that a petrol chainsaw immediately and aggressively attacks the anatomical tissues after the trigger switch has been activated and keeps doing so even after its release. All the mechanical and power characteristics listed above mean that a petrol chainsaw is able to produce lesions of greater width and depth, with more contused and macerated edges, mostly torn and ragged and less regular, bruised and chewed than those produced by an electric chainsaw.

Hence the application of a petrol chainsaw to the neck may produce greater lethal effects more rapidly than an electric chainsaw.

Finally the following crucial data should be taken into account, as noted by Fernie et al., in order to differentiate suicide by chainsaw from murder:

- the reconstruction of the deceased's mental state and the evidence of previous suicide attempts.
- the occupation, background and experience of the deceased which may have given easy access to and skill with chainsaws.
- the physical strength to hold, lift and apply such a heavy, vibrating tool to the neck.
- the presence of tentative wounds on the neck or other parts of the body.
- the absence of defence wounds on the forearms.
- the presence of abrasions or wounds caused by the chainsaw falling when the victim, on losing consciousness, released the chainsaw.
- the correspondence of the blood and tissue spatter pattern with the position of the blade on the neck when the victim was holding the chainsaw.
- the correspondence of the oil discharge pattern with the position of the lubricant drainpipe of the chainsaw when the victim was holding the tool.¹⁹

Ethical approval

None declared.

Funding

None.

Conflict of interest

None declared.

References

1. Campman SC, Springer FA, Henrikson DM. The chain saw: an uncommon means of committing suicide. *J Forensic Sci* 2000;**45**(2):471–3.
2. Segerberg-Kottinen M. Suicide by the use of a chainsaw. *J Forensic Sci* 1984;**29**(4):1249–52.
3. Schiwy-Bochat KH. Wound pattern in fatal suicidal chainsaw injury. *Rechtsmedizin* 1992;**2**:71–3.
4. Betz P, Eisenmenger W. Unusual suicides with electric saws. *Forensic Sci Int* 1995;**75**:173–9.
5. Clark SP, Delahunt B, Thompson KJ, Fernando TLU. Suicide by band saw. *Am J Forensic Med Pathol* 1989;**10**(4):332–3.
6. Rainov NG, Burkner WL. An unusual suicide attempt using a circular saw. *Int J Legal Med* 1994;**106**:223–4.
7. Catalano G, Morejon M, Alberts VA, Catalano MC. Report of a case of male genital self-mutilation and review of the literature, with special emphasis on the effects of the media. *J Sex Marital Ther* 1996;**22**:35–46.
8. Bonte W. Self mutilation and private accident insurance. *J Forensic Sci* 1983;**28**:70–82.
9. Rehul J, Bratzke H. Death caused by a chain saw - homicide, suicide or accident? *Forensic Sci Int* 1999;**105**:45–59.
10. Tournel G, Dedouit F, Balgairies A, Houssaye C, De Angeli B, Becart-Robert A, et al. Unusual suicide with a chainsaw. *J Forensic Sci* 2008;**53**(5):1174–7.
11. Koehler SA, Luckasevic TM, Rozin L, Shakir A, Ladham S, Omalu B, et al. Death by chainsaw: fatal kickback injuries to the neck. *J Forensic Sci* 2004;**49**(2):345–50.
12. Randall B. Blood and tissue spatter associated with chainsaw dismemberment. *J Forensic Sci* 2009;**54**(6):1310–4.
13. Health and Safety Executive – UK Government. *Chainsaws at work*. 1st ed. London: HSE Editor; 2006.
14. Kestel BR. *Chainsaw operator's manual: the safe use of chainsaws*, 6th ed. Collingwood-Victoria: CSIRO Editor; 2005.
15. Butler J, Hetzel GH. *Safety with chainsaws*. 1st ed. Blacksburg: Virginia Cooperative Extension Editor; 1966.
16. Harstela P. Work postures and strain of workers in nordic forest work: a selective review. *Int J Ind Ergon* 1990;**5**(3):219–26.
17. Taber D. Chain saw kickback causes severe injuries. *Agric Impact* 1988;**15**(1):8.
18. Hagberg M, Kolmodin-Hedman B, Lindahl R, Nilsson CA, Norstrom A. Irritative complaints, carboxyhemoglobin increase and minor ventilatory function changes due to exposure to chain-saw exhaust. *Eur J Respir Dis* 1985;**66**(4):240–7.
19. Fernie CGM, Gibson I, Newton F. Chainsaw deaths: accident, suicide or murder? *J Clin Forensic Med* 1994;**1**:109–12.