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TECHNICAL NOTE

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A Preliminary Assessment of the Identification of Saw Marks on Burned Bone*

ABSTRACT: This study assesses the degree of modification to the saw mark characteristics of dismembered skeletal remains when exposed to a controlled outdoor fire of limited duration. The sample consists of 36 adult pig hind limbs which were dismembered fleshed. Six handsaws and six power saws were used, with three limbs dismembered and burned for each of the saw types. Results indicate that fire exposure affects the visibility and identifiability of saw mark striae. With the handsaws, the bow saw, hacksaw, and keyhole saw were consistently recognizable. In the power saw group, the saw marks of the jigsaw, reciprocating saw, and chainsaw remained identifiable. Although the bone ends exhibited thermal alterations, the false starts were well preserved with minimal damage. Given the parameters of this study, it is possible to identify the class of saw based on the diagnostic characteristics present on the cremated bones.

KEYWORDS: forensic science, forensic anthropology, dismemberment, saw marks, cremation, animal bone, class characteristics

In the investigation of violent deaths, identification of the implement which caused the injury is an important aspect of analysis (1). Forensic investigators are focused on the diagnostic signatures produced by instruments on a bone's cut surfaces (2). In addition to revealing the behavioral preferences of a perpetrator, the value of saw marks in forensic science involves the ability to identify the class characteristics of saws which are of great utility in reducing the possible number of suspect tools utilized in a case of criminal dismemberment (3,4). Symes' (1992) research demonstrated that patterned striations on the cut surface of a bone could be related to the class of saw responsible for the observed markings (2). The systematic analysis of saw marks is able to proceed based on the ability of bone to retain characteristic features of saw marks, documented to such a degree that class determination of the features and the potential for individualization enable a forensic investigator to correlate the evidence with a specific weapon utilized in a criminal dismemberment.

Previous research has shown that it is possible to identify the type of saw utilized based on the morphology of saw marks in skeletal remains (4). There has also been documentation of the process by which bone responds to burning, both macroscopically and microscopically (5). The effects of burning on saw mark class characteristics, however, have gone largely unexamined within the discipline of forensic anthropology.

The exposure of bone to intense heat causes it to warp, shrink, discolor, and fragment, which will influence the analysis of age, sex, ancestry, stature, and trauma (5). An illegal cremation is the act of deliberately destroying the remains of an individual in order to potentially obliterate evidence of the cause or manner of death as well as inhibit the possibility of identification of the victim (6–8). Bass (1984) argues that although the soft tissue of the body may be burned away, fragments of the skeleton will remain and can be identified. High temperatures, a constant source of oxygen, and a long duration of exposure to fire are needed in the complete destruction of human remains, factors which are typically fulfilled in the steady-state environment of a crematorium and occasionally in forensic contexts (9–13). Additional factors affect the influence of fire on human remains, including whether accelerants are used, the material used to start and maintain the fire, whether the remains are fleshed, and the environment in which the remains are burned (i.e., the atmospheric and weather conditions) (6,14–16).

Exposure to heat can distort the signatures of sharp force trauma, blunt force trauma, and gunshot trauma (17). Some types of trauma may retain certain features; however, the literature does not adequately establish the specific features retained or the amount of diagnostic features lost due to heat-induced fractures. Recent research, however, has focused on identifying the characteristics of implements of trauma that are retained in bone exposed to fire (6,18). Pope and Smith (2004) examined the survivability of perimortem traumatic injury in burned cranial bone and found that the characteristics of tool marks and sharp force trauma were identifiable after fire exposure. Similarly, de Gruchy and Rogers (2002) also investigated the effect of fire exposure on the diagnostic features of chop marks made by cleavers. These authors found the trauma inflicted by the cleaver made the bone prone to fragmentation near the chop mark; however, a potential weapon could still be identified, despite the damage caused by burning (6).

This research assesses the degree of modification to the saw mark characteristics of dismembered skeletal remains when exposed to a controlled outdoor fire of limited duration. The research objectives are: (i) to confirm whether saw type affects the morphology of saw marks on cremated bone; (ii) to assess the changes in saw mark characteristics after burning; and (iii) to examine the burned bone macroscopically and microscopically for the degree of saw mark feature preservation. The objectives relate to enabling a forensic anthropologist to lend their expertise to the tool mark examiner in recognizing the presence of saw mark characteristics in cremated skeletal remains and differentiating those characteristics from heat-related fractures.

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TABLE 1—*Listing of all saws used in this study with information regarding manufacturer, size, and set. All measurements are in inches.*

Saw Type	Manufacturer	Teeth per Inch	Points per Inch	Blade Length/Diameter	Set
Handsaws					
Crosscut universal	Mastercraft	7	8	22	Alternating
Crosscut aggressive	Mastercraft	7	8	14	Alternating
Back saw (manual miter)	Mastercraft	12	13	12	Alternating
Bow saw	Mastercraft	4	5	12	Alternating
Hacksaw	Mastercraft	24	25	12	Alternating
Keyhole	Mastercraft	7	8	7	Wavy
Power saws					
Circular saw	Craftsman	3	4	7.25	Alternating
Miter saw	Craftsman	3	4	10	Alternating
Table saw	Craftsman	6	7	10	Alternating
Jigsaw	Bosch 50E	10	11	4	Alternating
Chainsaw	Remington Powercutter (electric)	15	16	18	Alternating
Reciprocating saw	Craftsman	18	19	12	Alternating

Methods

The sample utilized in this study consisted of adult domestic pigs (*Sus scrofa*) that were obtained from a local pork distribution plant (Woodward Meat Purveyors, Oakville, ON, Canada). The selection focused on sampling the hind limbs (more specifically the femora) because Reichs (1998) indicates that femora are the most common sites of dismemberment and generally, such detachment occurs in the proximal third (19). The limbs were semi-fleshed with the skin and some muscle removed, but 2 cm of muscle and connective tissue remained in order to facilitate efficient dismemberment and subsequent burning. Thirty-six hind limbs were used, with an additional 12 pig femora comprising a control sample.

From the sample of 36 hind limbs, a total of three were used for each saw type identified in the study. Following Symes (1992), the saws selected for this study were those commonly available to the public. The types of saws used are broadly categorized into handsaws, consisting of the crosscut universal saw, crosscut aggressive saw, manual miter saw, bow saw, hacksaw, and keyhole saw; and power saws consisting of the table saw, miter saw, circular saw, jigsaw, reciprocating saw, and chainsaw (Table 1).

The type of dismemberment employed in this study focused on the generalized removal (bisection) of the limbs, because in relation to human dismemberment cases the cutting of these parts eases the transportation and disposal of the body (19,20). Each saw blade was used to completely cut through each limb, as well as make one false start on the bone. Both ends of the cut bone were subject to analysis, following Reichs (1998).

The macroscopic and microscopic analysis of a control sample of 12 hind limbs was conducted prior to the burning and dismemberment of the remaining sample to ensure that the researcher had sufficient familiarity with saw mark characteristics and could identify how fire damage could affect the presentation of the striae.

The guidelines of saw mark analysis for this research followed those provided by Symes (1992: 9) and documented the "saw size, set, shape, and power" in order to arrive at a class identification. The first step in saw mark analysis utilized in this study was to describe the observed cuts on the limbs, identified by Symes and colleagues (1998: 393) as an examination of "superficial false start scratches, false start kerfs, or completely sectioned bone cuts."

The second step was the determination of the tool type, which includes visual examination of the cut cross sections of the limbs and the false starts (19). The kerf floor (i.e., false start) provides information about the size and set of the saw blade and teeth (3,4). The shape of the saw blade and teeth are assessed from the kerf walls, based on the striae cross-section (3,4). The next step in the analysis was to determine the energy source of the saw cuts, either human or mechanically powered. The cuts produced by human power are variable in characteristics whereas power saws eliminate human variation, adding increased consistency in the saw cut (3,4). The final step in the analysis was to examine the direction of the saw cuts to assess the position of the body at the time of dismemberment, through a documentation of blade progress and blade stroke (4).

In this study, a microscopic examination of the saw marks on the limbs was conducted with a Digital Blue QX5 Smithsonian Computer Microscope, which enhanced the morphological features of the marks. The bone ends were observed under magnifications of 10× and 60×, which provided the most detail of the saw mark striae. The false starts were similarly analyzed with their anterior surface facing the microscope under magnifications of 10× and 60×.

The use of outdoor fires has been incorporated into archeological studies of cremation, and they were used here to approximate some of the conditions of a forensic cremation of limited duration and without complete thermal destruction of the bones (6,15,21). The limbs were burned at the Oakville Fire Department Training Facility (ON, Canada) and the fires were set up along the ground, consisting of hardwood (maple) and softwood (spruce). Separate fires were created for each group of limbs dismembered by the saw types. The limbs dismembered with the handsaws were burned first and the power saw samples were burned a week and a half later.

The duration of the fire was set for a maximum of 3 h and the limbs were randomly placed within the fire, to mimic the behavior of a perpetrator, but were not agitated while being burned so as not to induce severe fragmentation. It is acknowledged that a perpetrator may induce fragmentation of human remains to further the destruction of evidence; however, the objectives of this research focused on assessing the modification of saw mark characteristics exposed to fire, not on recreating all of the conditions of an illegal cremation. Furthermore, the dynamics of the fire in the context of this research did not involve allowing the fire to proceed from ignition to decay; rather, the limbs were removed before this process occurred (i.e., when the flames were widespread). Therefore, the limbs were not exposed to the fire for such a duration that they could be considerably influenced by the prolonged effects of heat.

The limbs were removed from the fire every 5–10 min to evaluate the bone quality and ensure that it was not compromised. The temperature of each separate fire was recorded when the limbs started to become charred and the fire appeared to be strong, using a thermocouple provided and calibrated by the Oakville Fire

Department. Although the temperature was taken only once, the reading itself does not represent the temperature for the entire duration of the fire, as the temperature would likely fluctuate. When the limbs had to be removed from the fire, barbecue tongs were used to carefully lift the limbs out. After recovery from the fire, the fragmented remains were placed in boxes according to the saw type utilized.

Although the maximum duration of the fire was set at 3 h, criteria were developed to evaluate whether the limbs should be removed from the fire or be allowed to continue to burn. The criteria focused on the degree of thermal alteration to the class characteristics that would not result in the complete destruction of the bone ends, in order to assess the modification induced to the residual saw mark features. Thermal alterations such as fragmentation, warping, discoloration, and shrinkage are capable of affecting the analysis and thus criteria had to be developed to ensure that such effects did not proceed unchecked. The criteria aided in the prevention of severe bone fragmentation; however, after the limbs were removed from the fire, the debris was sifted through by hand to locate bone fragments. In this study, if a portion of bone was white, it was considered calcined; however, the bones did not remain in the fire for such an amount of time that the entire bone surface became calcined (5).

The limbs were removed from the fire if they fulfilled one of the following conditions:

1 If there was a significant amount of cracking or fragmentation which threatened the quality of the bone either by traversing the cut ends of the limbs, potentially splitting the ends of the bone where the saw marks were inflicted, or threatening to split the shaft of the bone itself.
2 If the bone exhibited deformation, warping, or twisting that would affect the cut ends of the bone or the surface details of the false starts to such a degree that those aspects would not be capable of being analyzed.
3 If the bone reached the color range of gray, blue, and white, in order to prevent complete calcination of the limb and subsequent fragmentation due to the fragility of the bone.
4 If the temperature of the fire exceeded 800°C, shrinkage was considered to be playing an active part in the destruction of the bone. Heat-induced alterations such as fragmentation and deformation were reevaluated in the context of the influence of shrinkage, which may increase the fire damage observed on the bones.

Each limb was evaluated based on its own condition and if one half of the dismembered limb exhibited the above criteria and needed to be removed, it did not require that the other half be removed as well if its bone quality was not an immediate concern. Although the focus of the analysis was the cut bone ends, by removing the sectioned limbs at different times, there is an acknowledged reduction in comparing each half with the other.

The next set of criteria involved the class identification of the saw marks and the saw type used in the dismemberment. The first subset of criteria focused on documenting the presence or absence of specific class characteristics derived from the saw mark striae of the kerf floor and walls. Provided that the striae were present, a second subset of criteria was used in the identification of the class characteristics leading to the identification of the saw type, following the methods of Symes (1992). The saw mark criteria were evaluated along a gradient of how identifiable the class characteristics were from clearly identifiable, possibly identifiable, and not identifiable (or unclear) (Table 2).

TABLE 2—*Saw mark criteria used in class identification.*

Kerf floor
Blade and tooth size
Rough or smooth floor
Small or large teeth
Striae fine or large
Many or few points/inch
Blade and tooth set
Width of kerf
Width of blade (kerf/1.5)
Kerf walls
Blade and tooth shape
Striae curved or straight
Fixed radius curvature
Rigid circular blade
Semi-circular striae
Concave breakaway spur
Uniform throughout cut
Non-fixed radius curvature
Straight rigid blade
Linear lines parallel
Non-parallel (change in direction)
Straight non-rigid blade
Striae slightly curved (blade bends)
Source of energy
Handsaw
Uneven kerf walls
More striae
Power saw
Smooth, polished kerf walls
Straighter, uniform

Results

The set of criteria used for the removal of the limbs from the fire aided in preserving the quality of the bone ends. The most common criterion met in the removal of the limbs was cracking, fragmentation, or fracturing of the cut end of the bone. The most common types of heat-related fractures observed on the limbs were longitudinal, curved transverse, and straight transverse.

Among the handsaws and power saws, the characteristics of the tool type (the kerf floor, the kerf walls, and the energy source) were recorded as present on all of the limbs (both proximal and distal fragments). The second stage of analysis involved evaluating the class characteristics of the saws to determine whether the characteristics were sufficient for the identification of saw type. As there were no differences in the retention of the saw mark characteristics between the two limb fragments, both were examined. The results are summarized in Tables 3 and 4.

With the crosscut universal (Fig. 1*a*), crosscut aggressive (Fig. 1*b*), and manual miter (Fig. 1*c*) handsaws the saw mark striae were less recognizable in the gray and white color range. In calcined areas of bone, the striae were sometimes difficult to discern and were less diagnostic of saw class. In contrast, the characteristic striae of the bow saw (Fig. 1*d*), hacksaw (Fig. 1*e*), and keyhole saw (Fig. 1*f*) were identifiable in varying degrees throughout the burning process.

With the table saw (Fig. 2*a*), miter saw (Fig. 2*b*), and circular saw (Fig. 2*c*), the portions of calcined bone retained very little or none of the diagnostic striae patterns. As well, if the bone dismembered with a circular saw was fragmented (on either the lateral or medial side, depending on where the saw cut the bone), the diagnostic striae pattern was not observed. The

TABLE 3—*Characteristic features of the handsaws: control and burned samples.*

	Control Group		Burned Group	
	Striae Features	False Start	Striae Features	False Start
Universal	Deep striae Fine and coarse Irregular spacing	Convex shape Kerf floor prominent	Fine and coarse Fewer observable striae More pronounced pattern of fine striae bordered by deeper striae	Black color No alterations to kerf floor, still prominent
Aggressive	Striae not as deep Fine striae Irregular spacing	Convex shape Edges sharper Smoother kerf floor	Fine striae clear on charred bones Less prominent on dark/light gray, white color	Black color Convex shape, edges well-defined Smoother kerf floor No changes in shape
Miter	Prominent fine striae Spacing more regular	Convex shape Longer and sharper	Prominent fine striae Fewer coarse striae Less visible, faint on gray/white colored bones	Black color No changes in shape Convex, longer and sharper contour
Bow	Striae irregular, coarse (raised) Fine striae clustered, surrounded by coarser striae Fewer striae on surface	More superficial cuts Rougher margins Uneven kerf floor	Fine striae clustered with surrounding coarse striae Coarser striae prone to slight distortions Striae less visible, gray/white colored bones	Black color Features unaffected Superficial damage visible Rougher margins, uneven kerf floor
Hacksaw	Very fine striae Regular spacing	Straighter Well-defined margins Narrow and fine kerf floor	Fineness of striae not as distinct Even spacing Coarser striae more pronounced, prone to distortions Striae faint on gray/white colored bones	Black color Unaffected by fire Straight shape, well-defined margins Narrow kerf floor
Keyhole	Striae irregular, coarse (raised) Wavy cutmarks Overlapping of striae Striae prominence varies	Shape narrows at midline Ends in forked formation Not as deep	Wavy cutmarks visible Coarser striae prone to distortions Fine striae observable Gray/white colored bone, striae less visible	Black color Unaffected by fire Shape still narrow at midline, with forked ends

TABLE 4—*Characteristic features of the power saws: control and burned samples.*

	Control Group		Burned Group	
	Striae Features	False Start	Striae Features	False Start
Table	Striae fine, multiple Evenly spaced	Long and rectangular Well-defined margins Kerf floor beveled upwards (prism)	Striae uniform and multiple Difficult to observe on gray/white colored bone	Black color Unaffected by fire Contour long and rectangular Kerf floor beveled
Miter	Striae fine Evenly spaced Lack definition, vary in prominence	Floor contour beveled Shape not as elongated as table saw Box-like shape Sharp margins	Fineness of striae recognizable, pattern difficult to discern Gray/white colored bone, barely visible striae	Black color Unaffected by fire Elongated shape, beveled kerf floor Box-like, sharp margins
Circular	Striae curved, bend into bone Uniform throughout cut	Uniform, semi-circular shape Fine striae on kerf floor	Striae curved, bend into bone Uniformity of pattern clear Gray/white colored bone pattern not always recognizable	Black color Unaffected by fire Semi-circular shape Fine striae on kerf floor
Jigsaw	Striae fine, multiple Ridged striae, evenly spaced	Well-defined, forked margins Narrow kerf floor contour	Striae pattern enhanced by slight burning Ridged and undulating pattern distinctive regardless of fire damage and bone color	Black color Unaffected by fire Well-defined margins, sharp kerf floor Narrow contour
Reciprocating	Ridged striae, irregular in spacing and thickness Overlapping of striae	Superficial damage Kerf floor not smooth Flat, exhibits ridges	Fine striae and ridged pattern consistently visible Overlapping of striae Loss of detail on light gray/white colored bone	Black color Unaffected by fire Kerf floor rough, with ridges
Chainsaw	Lack fineness Surface of cut irregular	Kerf floor convex, ridged line in middle Flat and wide	Irregularity of striae consistently identifiable Portions of pattern remained Less clear on gray/white colored bone Coarser striae prone to distortions	Black color Unaffected by fire Wide shape, convex floor contour Ridged line in middle

characteristic striae of the jigsaw (Fig. 2*d*), reciprocating saw (Fig. 2*e*), and chainsaw (Fig. 2*f*) were consistently observed on all of the bone fragments, regardless of fire exposure and bone color. The striae pattern of the chainsaw was difficult to discern in general, as quite often only portions of the pattern were visible on the initial or terminal aspects of the saw cut. What was

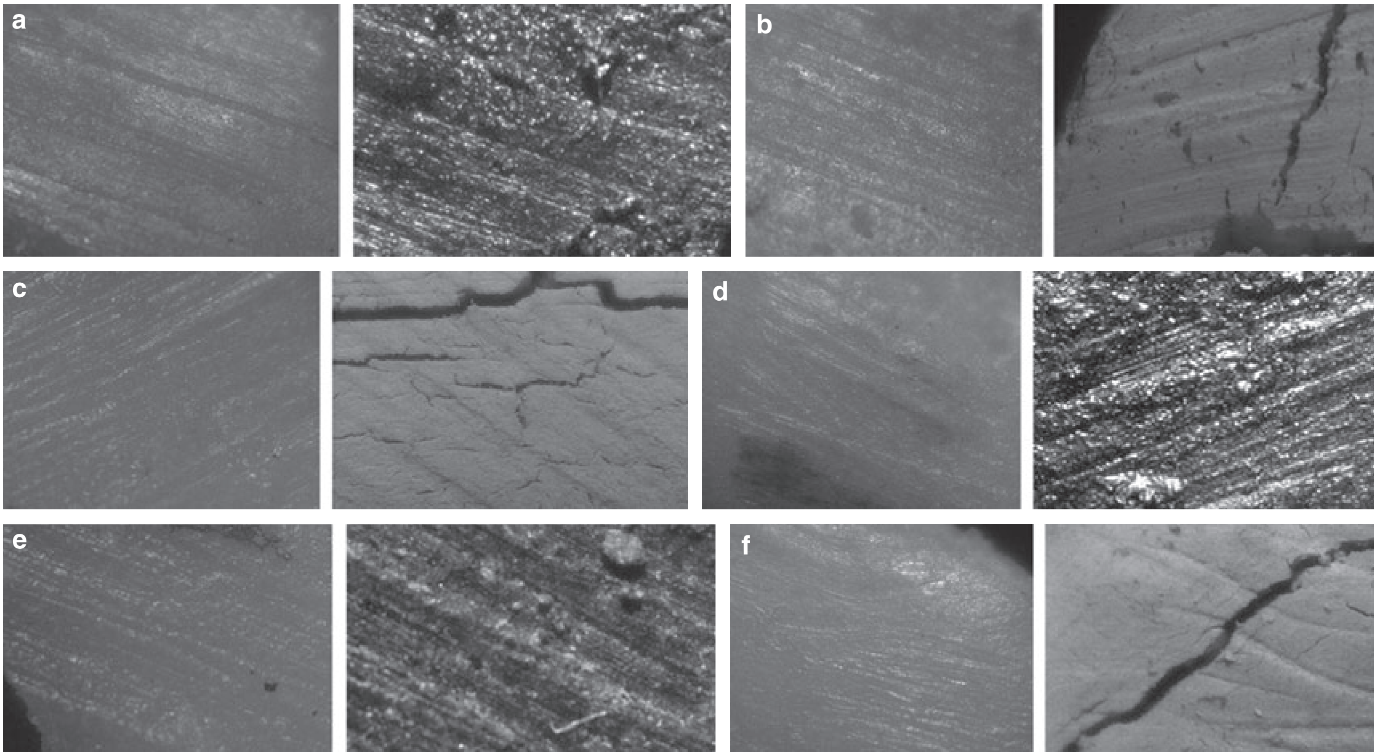

FIG. 1—*(a) (left) Control universal saw striae pattern (60×). (right) Burned universal saw striae pattern (60×). (b) (left) Control aggressive saw striae pattern (60×). (right) Burned aggressive saw striae pattern (60×). (c) (left) Control manual miter saw striae pattern (60×). (right) Burned manual miter saw striae pattern (60×). (d) (left) Control bow saw striae pattern (60×). (right) Burned bow saw striae pattern (60×). (e) (left) Control hacksaw striae pattern (60×). (right) Burned hacksaw striae pattern (60×). (f) (left) Control keyhole saw striae pattern (60×). (right) Burned keyhole saw striae pattern (60×).*

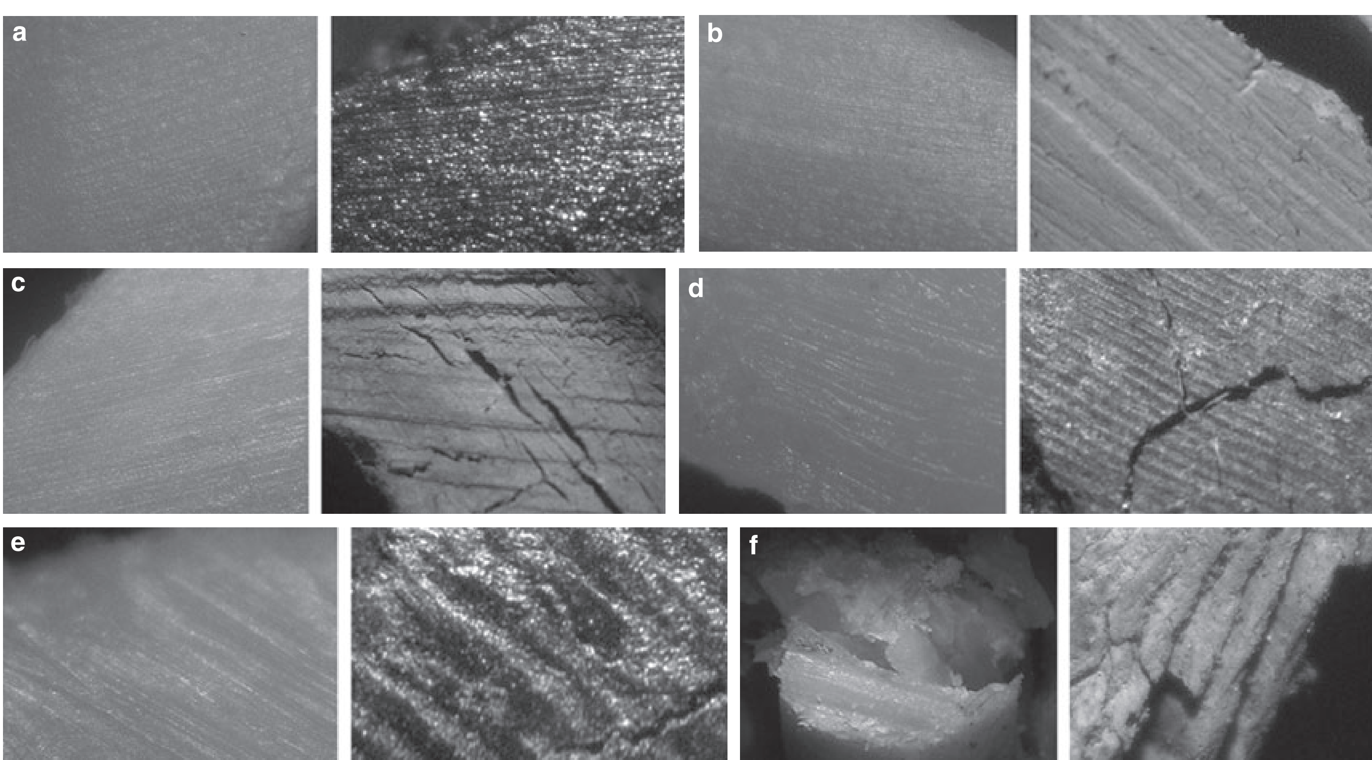

FIG. 2—*(a) (left) Control table saw striae pattern (60×). (right) Burned table saw striae pattern (60×). (b) (left) Control miter saw striae pattern (60×). (right) Burned miter saw striae pattern (60×). (c) (left) Control circular saw striae pattern (60×). (right) Burned circular saw striae pattern (60×). (d) (left) Control jigsaw striae pattern (60×). (right) Burned jigsaw striae pattern (60×). (e) (left) Control reciprocating saw striae pattern (60×). (right) Burned reciprocating saw striae pattern (60×). (f) (left) Control chainsaw striae pattern (10×). (right) Burned chainsaw striae pattern (60×).*

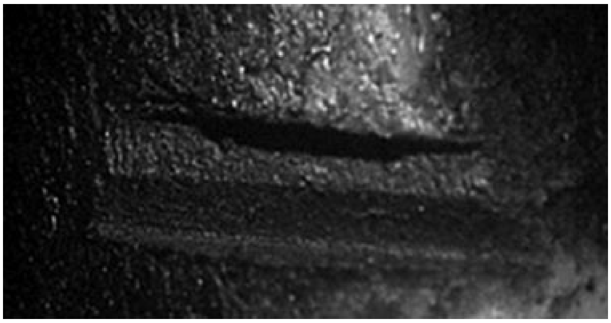

FIG. 3—*Burned table saw false start (10×).*

more characteristic was the damage visible on the bones themselves, as none of the other bones cut with either the power saws or handsaws exhibited the extent of heat-related damage as the chainsaw samples.

The false starts of the handsaws and power saws were all unaffected by fire exposure and did not exhibit thermal damage aside from charring and blackening (Fig. 3). The characteristics of the kerf floor were still discernible.

Discussion

The area of the bone where the false start was present did not progress through the same series of soft tissue changes and subsequent changes in bone color as did the sawed ends of the limb fragments. The tissue surrounding the false starts reacted to heat in such a way that the underlying bone was protected to some degree (22). Exposure to fire did not burn the soft tissue completely from the bone, although the tissue did contract and retreat around the exposed areas of the false starts. The exposure of the false starts to heat resulted in organic pyrolysis and carbonization of the surrounding soft tissue, which produced a blackened color on the area of bone where the false start was located. The reaction of the false start to fire exposure may be analogous to that of incised wounds (sharp force injury of the skin) whereby upon burning, a rapid retraction or shrinkage of the surrounding soft tissue would prematurely expose the underlying bone (18). The initial damage inflicted on the bone through the introduction of a false start did not disturb the structural integrity of the bone. For example, the action of the saw on the limbs exposed the underlying bone ends, removing any protection that would have been conferred by the presence of soft tissue. Consequently, the sections of exposed bone were more prone to thermal alterations and were more quickly altered by heat due to the absence of soft tissue. Pope and Smith (2004) similarly comment that sharp force trauma injuries which are open when burned will exhibit accelerated color changes to the exposed bone. Without soft tissue protecting the bone ends, the stages of organic and inorganic changes proceeded more completely, beyond the stage of organic pyrolysis and carbonization to the early stages of calcination.

The saw mark striae on the bone ends are more prone to alterations due to heat, and whether the striae pattern is pronounced, visible, or faint depends on the bone's response to fire. In addition, not all aspects of the sawed end of the bone will react to burning in the same manner. Certain portions of bone retained evidence of saw mark characteristics whereas other portions did not exhibit diagnostic features of a particular saw. Whether the bone was in the stage of organic pyrolysis and carbonization or the early stages of calcination did affect the identifiability of the saw mark striae. Bone ends exhibiting a black or gray color retained characteristic features of saw marks more consistently than white portions of the bone. During this stage of thermal damage, the organic component of the bone is not degraded as it is with calcined bone and it may be more similar to unburned bone in this respect. It was not unique to the calcination stage that all features of the saw marks are obliterated. The striae which reflect the saw mark are manifested in varying ways on the bone, depending not only on the characteristics of the saw but the ability of the bone to receive the saw mark and the skill or intention of the individual utilizing the saw.

The identifiability of the saw mark striae was retained throughout the burning process despite burning damage; however, the handsaws and power saws exhibited differing degrees of preservation of saw mark characteristics. With the power saws, the ability to identify diagnostic features of the striae is difficult unless the striae are produced by a saw with a characteristic morphology of the blade and teeth (such as the reciprocating saw, jigsaw, and chainsaw). The identifiability of the saw mark striae of the handsaws depends on the sawing action, because this affects the degree to which the striae are preserved and retain diagnostic features. Furthermore, the degree to which the particular handsaw grips the material as it enters and moves through the bone affects the amount of residual characteristics that remain. The degree of experience and training of the observer necessarily influences the ability to accurately identify diagnostic features of saw mark striae.

If the bones were exposed to fire for a longer duration and if the temperature was above 400°C, the results of the research would be different. The ability to recognize diagnostic features of saw marks may be increasingly difficult, since exposure to fire has the potential to obliterate saw mark striae completely or make the striae pattern less visible or identifiable. Fragmentation or fractures on the cross-section of the bone will affect the investigator's ability to deduce the striae pattern produced by a particular saw. Agitation or increased pressure resulting from high temperatures of a fire is capable of greatly reducing bone fragments to small or unrecognizable remnants, which subsequently reduces the ability to identify the bones themselves (15). The retention of diagnostic portions of a saw mark depends on a suite of variables, such as the orientation of the bone in the fire, the manner in which the particular bony element reacts to heat, the duration of exposure, and external atmospheric conditions which affect the temperature of the fire (6,14,16). Drawing from the research of de Gruchy and Rogers (2002), chop marks can be seen as similar to false starts in that the bone is not completely bisected, and when exposed to fire, there is a layer of soft tissue protecting the injury. It is expected that despite prolonged fire exposure and increased thermal alterations, the false start will remain identifiable and the particular class of saw may be detectable.

Conclusions

The results indicate that cremated bones exhibit a degree of preservation of saw mark characteristics, which depends on the saw utilized to dismember the remains and the variables of the fire itself, such as the position of the bone in the fire, the atmospheric conditions, and the fluctuating temperatures.

There were certain saws that produced striae patterns which remained recognizable and identifiable despite the heat-induced effects of fire. For example, the characteristic striae of the bow saw, hacksaw, and keyhole saw were preserved. In addition, the jigsaw, reciprocating saw, and chainsaw produced striae patterns that remained identifiable. In general, whether the saw was hand powered or mechanically powered did have an influence on the preservation of the saw's particular characteristics; however, neither the handsaws nor power saws as a general category outperformed the other.

This research created a situation where some of the variables involved in a criminal dismemberment and forensic cremation were known. The documentation of the temperature of the outdoor fires, the presence and type of heat-related fractures, and the condition of the burned remains as indicated by the various color and tissue changes present, function in a collaborative manner to provide the conditions by which the saw marks manifested on the bones. If a similar forensic case were found, the results of this research could be a standard to compare circumstances of postmortem dismemberment and burning.

The controlled factors surrounding the burning of the dismembered limbs were a recognized limitation. In addition, the selected saws in this study do not represent the wide variety of saw and blade combinations that exist among tools. There is variability between saws of different classes as well as within classes. For example, the diameter of a circular saw blade may vary depending on the manufacturer's specifications.

Further study will illustrate the reproducibility and success rates of identifying saw marks on burned bone, enabling its use in courtroom testimony by an expert witness. Future research should focus on burning dismembered limbs in a truly blind manner (i.e., the researcher is not familiar with the saw types and entire sample of limbs), incorporating accelerants, and burning with intervention (i.e., agitation). The initial assessment of the potential for evaluating diagnostic features of saw marks on burned bone is promising, and further research will demonstrate the applicability of identifying the characteristics for the forensic science community.

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