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Saw marks in bones: A study of 170 experimental false start lesions

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ABSTRACT

This experimental study examined false starts because these are seldom discussed in the forensic literature and usually concern animal bones rather than human bones. We created 170 experimental false starts (50 on pig femurs and 120 on human femurs) using five different saws (4 with an alternating set of teeth, and one with a wavy set). Teeth per inch (TPI) ranged from 7 to 24. Saws were classified as either rip saws or universal saws. The bone lesions were studied using stereomicroscopy. This study focused on three features that are easily observed with a stereomicroscope: the minimum width of the kerf, the profile of the lesions (concave or convex), and the shape of the edges (narrow-wide pattern, necking in the middle, or straight pattern). These features proved to be useful clues to recognize the class of the saw. Our study found some variability between lesions but also some repetitive features that allow for the classification the handsaws studied according to class. There were also some significant differences in lesions between pig bones and human bones, suggesting that pig femurs (versus human femurs) are not always a good alternative for studying saw marks.

1. Introduction

Saw marks in bones are important to consider in forensic pathology and forensic anthropology, especially in cases of postmortem dismemberment. A saw includes a metallic part with teeth whose back and forth movement is achieved by hand (hand saws) or using power (mechanical or electrical saws). Bonte [1] was probably the first author to state that some characteristics of the saw might be inferred by studying key features of the bone lesion. Andahl [2] and Symes et al. [3–8] were pioneers in this field. They showed that the study of the saw marks in bones could indeed suggest the class features of the saws used. Other authors have confirmed the interest of studying saw marks to assess with some certainty the class of saw that was used [9–15].

The class features concern the design of the saw (crosscut, universal or rip saws) and the features of the teeth (teeth per inch or TPI/points per inch or PPI, angles of the teeth, sizes of the teeth and set type—alternating, raker or wavy sets); they are identical for all tools of the same brand [11,16–18]. Subclass features are produced during the manufacturing process and restricted to a small group of instruments. Individual features (due to the gradual alteration of the tools used to make the saws and/or by the gradual wear of the saws) are unique to a saw [19] and are usually observed on a microscopic scale [16].

This study examined marks left by hand saws (2 universal saws and 3 rip saws). Saws leave different types of lesions on bone: false starts (superficial nicks in the bone due to the fact that the blade bites the bone superficially), complete bone sections (when the bone has been completely severed) and breakaway spurs (projections of bone that indicate the blade exit due to the pressure exerted) or notches (complementary images of spurs on the other side of the cut) [3–8]. Our study specifically examined the lesions left on bone by false starts. The reason for this focus is that we found very few research articles that present findings on false start features and those research articles mostly use animal bones to illustrate their results [9–11,13,15].

The aim of this study was first to determine the variability of the lesions from a controlled series of 170 experimental bone false starts left by 5 different types of saws. The second goal was to try to sort the saws into different classes from the features of the lesions.

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2. Material and methods

2.1. The saws

Five different saws were selected for this study. Saws 1 and 5 were universal saws with isosceles teeth that are rarely studied in the literature (Fig. 1b). Saws 2, 3 and 4 were rip saws (Fig. 1c). The five tools were hand saws with a active pushing stroke. Four of them (saws 1–3 and saw 5) displayed an alternating set, chosen because it is the most common set (whereas saw 4 displayed a wavy set). The fifth had the peculiarity of presenting a concavity inside the blade, every 7 teeth, but it is easily found in plain hardware stores where it is sold for cutting plasterboard and block board (Fig. 2). Three of them were new saws bought in plain hardware stores (saws 1, 4, and 5), whereas saws 2 and 3 were second hand saws. The average height and width of the teeth, along with the distance between two consecutive teeth were measured three times directly on the saws under the stereomicroscope (×20). The average distance between two waves of teeth (wavy set) in the fourth saw was also measured three times under the stereomicroscope (×20). The thickness of the blade was measured three times at the level of the teeth with a digital caliper.

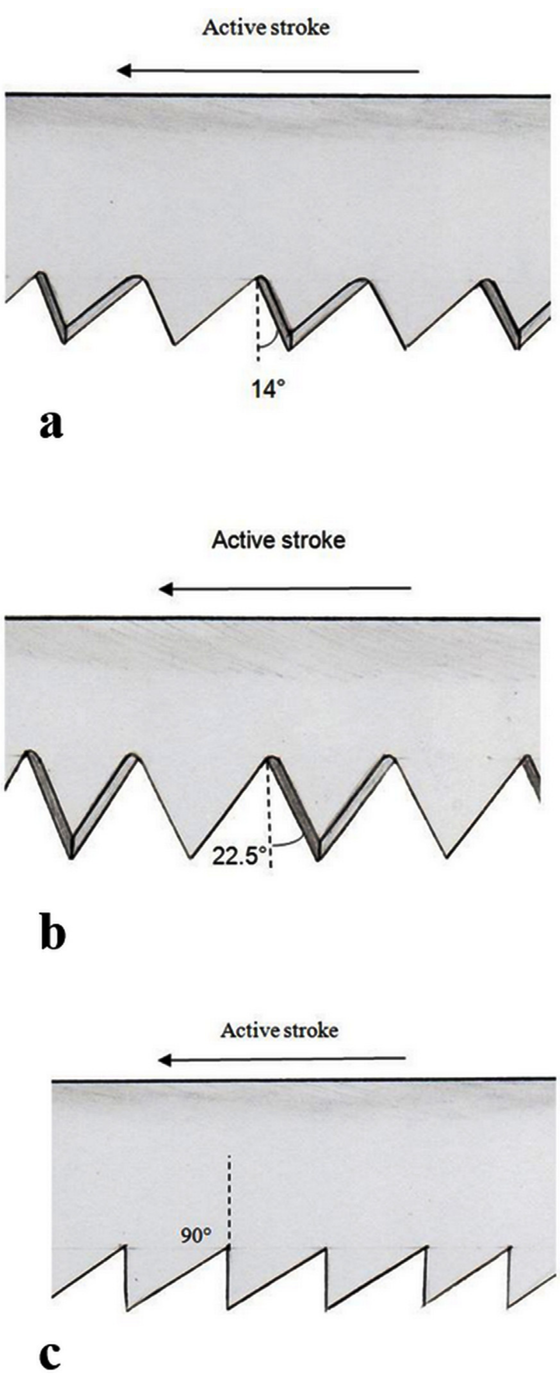

Fig. 1. Various type of teeth.
(a) Crosscut saws. The teeth are tilted backwards (pitch between 14° and 15°). This type of teeth was not study in the current work. (b) Universal saws. The shape of the teeth is isosceles; the teeth are tilted backwards at 22.5°. (c) Rip saws. Teeth are perpendicular set up in front (90°), there is no pitch.

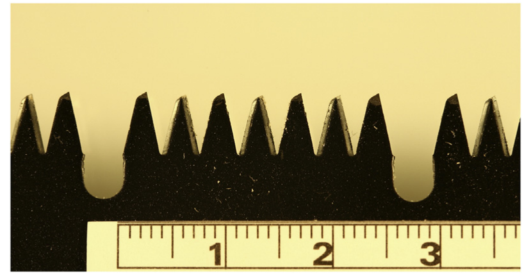

Fig. 2. Peculiar teeth (Saw 5). Concavity in the blade every seven teeth.

Table 1 shows the main characteristics of the five saws and their teeth.

2.2. The bones false starts

Two recently defleshed femoral pig bones were used for the animal series of false start lesions. Pig bones were chosen because the average hardness across the cortex of a pig femur is quite close to that of a human femur (close to 38 kg mm^{-2}) [10]. Nevertheless, there is a difference in the average hardness of the surface of the bone between humans and pigs (39.5 kg mm^{-2} and 26.0 kg·mm^{-2}, respectively) [10]. In other words, the surface hardness of human bones is higher than that of pig bones.

Freshly defleshed human femoral bones were used in the assessment of false start markings. They were sampled from three old (80, 82 and 85 years, respectively) females under a French law that allows for teaching and research.

The animal bone series included 50 experimental false starts (10 for each saw 1 to saw 5). The human bone series included 120 experimental false starts (30 lesions for each saws 1–4). It was impossible to get false start lesions with saw 5 in the human femurs. Both series of lesions (pig bones and animal bones) were achieved by the same person (the senior author).

2.3. Criteria of analysis

Each false start includes two edges, two vertical walls (kerf walls), and a floor (kerf floor). Three particular features were studied: the minimum width of the kerf (measured at the narrowest part of the false start between the two edges of the lesion), the shape of the walls (straight edges, a mix of narrow and wide parts, or necking in the middle of the false start, Fig. 3) and the profile of the lesions (concave or convex, Fig. 4).

The analysis of the lesions was made using a stereomicroscope (SM) (Visiscope SZTL 320, VWR ®) linked to image analysis software (DeltaPixInSight®). The possible magnification of the stereomicroscope ranged from ×10 to ×40. The minimum width of the kerf was easy to assess with the stereomicroscope (at a ×10 magnification) using the image analysis program. This measurement was achieved directly on the bone lesion.