Tool Mark Analysis in Cases of Homicidal Dismemberment

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INTRODUCTION

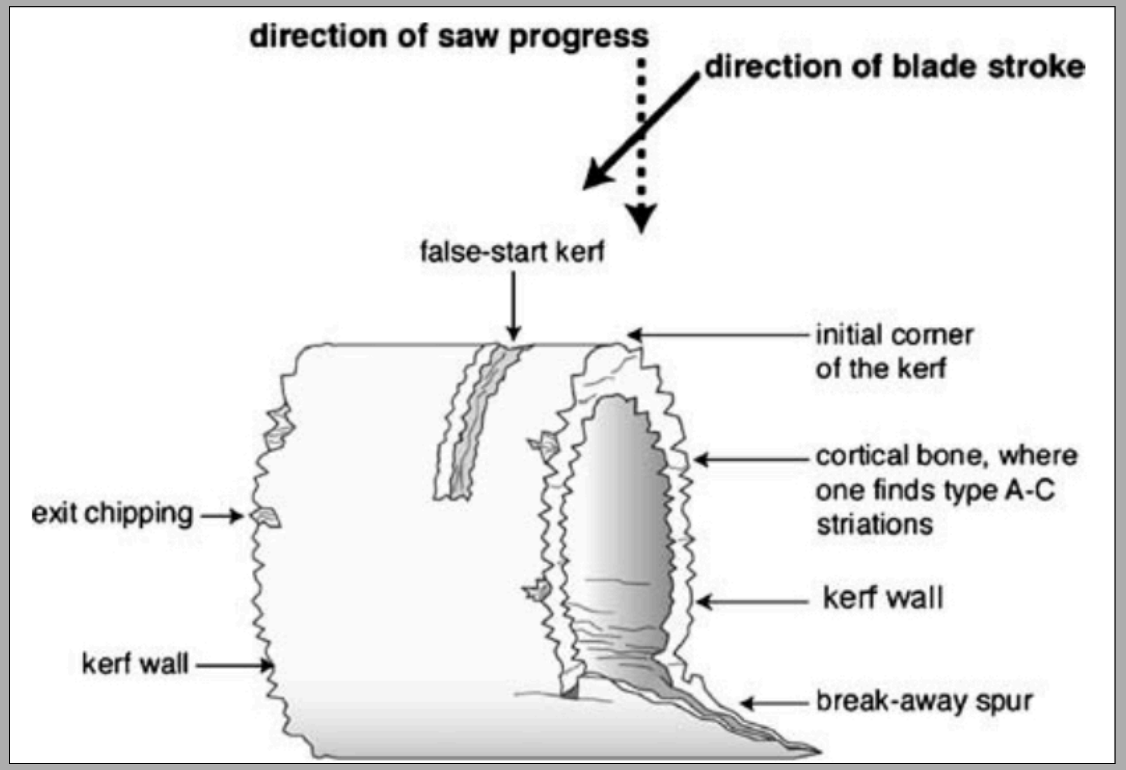

Fig 1: The common features of saw marks on bone.[2]

Dismemberment refers to a voluntary act committed in a criminal manner, and therefore does not include accidental loss of limbs or amputation[1,4,5]. Forensic literature divides dismemberments into four categories:

1. Defensive mutilation – the human remains are dismembered as a means of transportation and/or concealment.
2. Offensive mutilation – the remains are dismembered as a result of impulsive and aggressive acts from the perpetrator against the corpse.
3. Aggressive mutilation – the victim is dismembered as a means to cause their death; this is often carried out via decapitation.
4. Necromantic mutilation – the remains of a murdered or disinterred individual are dismembered so that the perpetrator may collect and retain the body parts for sexual pleasure[1,5].

When conducting analysis of dismembered remains, forensic anthropologists are advised to record the tool type, the anatomical distribution of the cut marks, and direction of the cut marks, as they can provide vital information to investigators of how the crime was committed, and can be compared against witness testimonies[4]. Additionally, dismemberments can be categorized as generalized or localized. Generalized dismemberment is characterized by cut marks dispersed across the body and the body is usually cut into many pieces, whereas localized dismemberment involves the removal of one or several body parts (for example, removal of the head and hands to make identification of the victim more difficult)[2,4].

TOOL MARK ANALYSIS ON BONE

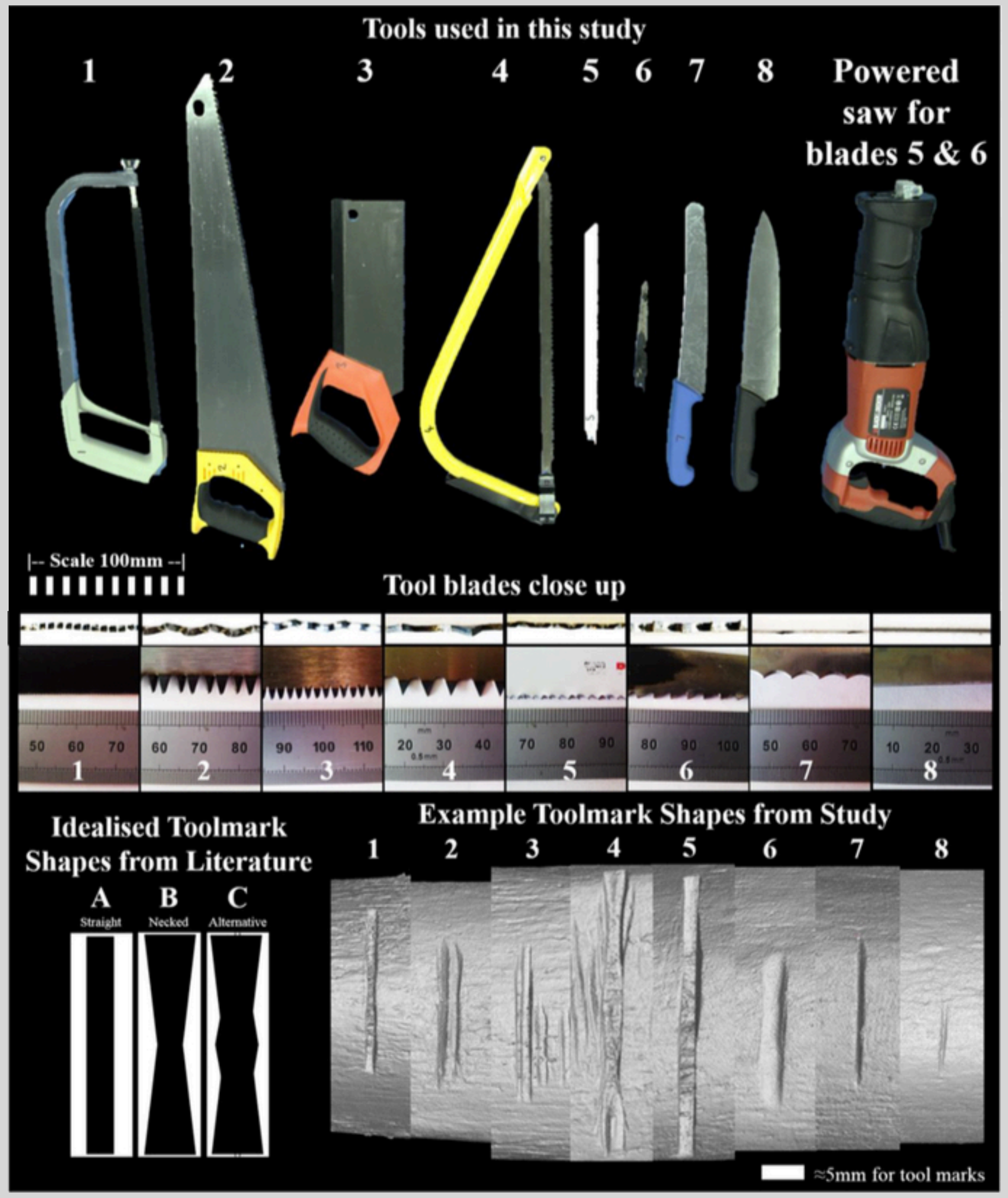

Fig 2: "Toolmark - (A) straight edge shape with near parallel edges seen in toolmarks 2–3,5–8 and typical of raker set blade but also seen with wavy and alternative sets; (B) necked edge shape with a distinct necking in around the center seen with toolmark 1 and typical of wavy set blades; (C) alternative edge shape with both narrow and wide aspects seen in toolmarks 4 and typical of alternating set blades."[3]

Analyzing the tool marks left on bone plays an important role in understanding the shape, angle, and characteristics of a weapon used in a dismemberment[7]. Many studies have been employed to understand the reoccurring characteristics of the incisions left by different tool types and how their appearance differs in fleshed and de-fleshed bones, to allow forensic anthropologists to macroscopically and microscopically recognize their relation to the context in which the individual was killed or their remains were disposed of[8]. Furthermore, weapons are grouped by tool class rather than by individual tool because it can be difficult to determine the individual tool make, unless a characteristic feature has been imprinted on the bone[2].

Saw Trauma

Saws differ by the amount of teeth cut into them and are classified by points per inch or teeth per inch. Saws are set, which means that alternating teeth are bent outwards to different sides in order to widen the kerf width and to prevent the saw blade from bending[2]. A kerf is the slit mark made by a blade and is comprised of a kerf wall and a kerf floor. The kerf wall contains deep furrows and fine striations; the furrows are created during a pull stroke, when all the teeth are aligned, and the striations are created during a push stroke, when each tooth enters lower than the one before it. Counting the number of furrows indicates the number of strokes used to cut the material, whereas counting the striations usually corresponds to 2/3 the number of teeth on the saw. Occasionally, when vertical marks are left from removing a stroke where the saw jammed, the distance between teeth can be calculated. Saw sets are also important to classifying the type of saw used, as distinct sets produce different toolmarks[2]. Saws can be set in the following ways:

1. Alternate – the most common form of setting, the teeth are bent in opposite lateral directions.
2. Raker – every fifth or seventh tooth is specialized to rake material from the kerf floor.
3. Wavy – due to the smaller size of the teeth, they are bent in opposite lateral directions in groups[2].

Knife Trauma

Incisions in bone by knives are often as thick as the knife blade or thinner, and have a characteristic 'V' shape to their cross-sections. Kerf walls produced by knives are generally smooth, although there can often be consecutive matching striations perpendicular to the kerf floor[6,7]. Due to the elasticity of living bone tissue, it can be difficult to deduce the angle of the knife's blade from knife marks alone[7]. When comparing serrated knife blades to non-serrated knife blades, a 'T' shaped cut mark encompassed by concaved cortical bone was produced by non-serrated blades, and a 'Y' shaped cut mark with a right lateral curve at the end of the incision, encompassed by concaved cortical bone was produced by serrated blades. The reason for the different shaped kerfs from serrated and non-serrated blades is because serration creates a single slant of bone above the blade, whereas the bone slants laterally to the blade when the blade is not serrated[8].

Axe Trauma

Similarly to knives, axes (as well as swords and machetes) create a 'V' shaped incision mark, however due to the increased force and kinetic energy produced when swinging the weapon with both hands, a wider incision is made. Additionally, axe incisions are known to produce a large amount of fracturing around the kerf. When the bone is bisected (split into two pieces) from an incision, the resulting fracture is often a curved transverse fracture, which means that the fracture is perpendicular to the shaft. Axe incisions also often produce spiral fractures, indicating that the impact from the axe causes the bone to twist at the point of highest tension, and due to the axe blade wedging into the bone and causing further torsion. Longitudinal fractures can also be created when the axe blade wedges into the bone and causes it to split vertically through the shaft[9].

CASE STUDY

A suspiciously heavy suitcase was located in a canal by canal workers in the West Midlands, UK. The suitcase was CT scanned, revealing the decomposing remains of an adult male, missing his head, arms, and left lower leg. Another suitcase was later found, containing the remaining missing body parts, alongside a saw, a kitchen knife, a hammer, and a chisel. A positive ID was made on the remains, based upon DNA analysis, fingerprints, and tattoos. Samples of bone from the areas of dismemberment were sent off for micro-CT imaging for tool mark analysis. Analysis revealed that there were false starts on the left femur and humerus from the use of a power tool, there were V-shaped, narrow grooves indicative of a knife, there were also U-shaped marks indicative of a saw, and extensive shattering possibly created by a hammer in an effort to separate the limbs from the torso. Furthermore, the cut mark dispersal portrayed the difficulties the perpetrator encountered separating the limbs from the torso during dismemberment. The application of micro-CT tool mark analysis in this forensic case allowed investigators to correlate the incision marks left in the victim's bones to the instruments found alongside the victim's remains, which provided a clearer understanding of the manner in which the perpetrator disposed of the remains. The overwhelming evidence against the perpetrator compelled them to confess, despite remaining silent throughout police interviews[10].

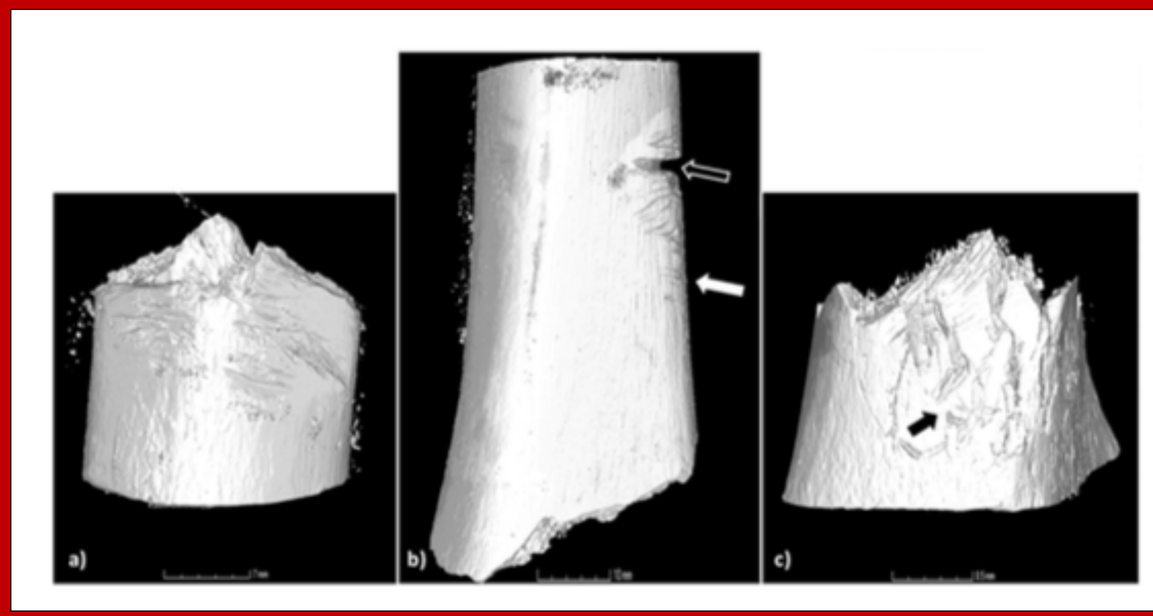

Fig 3: (A) false start incisions on humerus segment found in suitcase; (B) left distal femur with deep U-shaped kerf, indicative of a saw; (C) the arrow shows extensive shattering suggesting the use of a hammer.[10]

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