



Case report

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## Bone abrasions due to the dragging force of a moving vehicle: two unusual case reports

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### Abstract

Abrasion injuries such as graze abrasions occur due to dragging of the body over a rough surface along the line of force. Such dragging of a body usually occurs when a person is trapped/pinned underneath a moving object like an automobile. Most of such injuries are superficial in nature or are limited to the soft tissues only. However, when the body is dragged for a considerable distance with considerable force then there might be bony involvement causing abrasion injuries to bone, which may be termed as “bone abrasion”. The authors present 2 cases having a specific pattern of abrasion injuries due to dragging of the broad body surface area by a moving vehicle for a considerable distance with speed and force in a road traffic accident. With evolving science there is a need to acknowledge injuries which may have specific pattern. Abrasion of bone due to a dragging force comprises such an interesting pattern of injuries, which potentially have forensic significance.

**Key words:** forensic science, graze abrasion of bone, vehicular trauma, human body.

### Introduction

The number of injuries caused to vehicular occupants or non-occupants continues to rise, with several having fatal outcomes. Injuries occurring due to vehicular accidents are either body surface injuries or internal organ injuries. The surface injuries are the first injuries visible to any person from a non-expert, such as a bystander or investigating agencies, or an expert, such as a medical doctor. Many of the injuries whether involving the body surface or internal body organs have been well classified in the literature [1]. Classifying the injury is very important because it is helpful for future identification of the injuries and is useful for correlating such injuries with the manner or object by which it occurred.

The author herein attempts to highlight injuries that were found on bones in trauma caused by a vehicle accident. These injuries occurred due to dragging of the body for some considerable distance by a moving vehicle. The authors present two unique cases depicting injuries having a specific pattern of bony injuries due to dragging of the body surface by vehicle for a considerable distance with speed and force in a road traffic accident.

### Case scenario

#### Case no 1

A 17-year-old boy, while travelling on his bicycle, was involved in an accident with a van. He was

struck by the van from behind. He fell and his head collided with the left front wheel of the van. The boy was dragged for around 10 to 20 metres before the van stopped. The incident was witnessed by bystanders who immediately took the victim to hospital. The van driver ran away from the site along with his van fearing public onslaught. The police visited the crime scene and found tyre marks over the road for a length of 15 metres. Similarly, blood stains were visible along the length of the crime scene area. At the hospital the patient was diagnosed to have sustained a head injury. During the period of hospitalization the patient gave a statement to police regarding the manner of his accident. However, he succumbed to his injuries nine days after the accident.

### Autopsy examination

There was a graze lacerated wound over the mid-frontoparietal region with the underlying bone exposed of size 6 cm × 5 cm, with evidence of heaping over the frontal margin. There was evidence of blackening of the skin in and around the injured area. The exposed skull bone showed multiple linear



**Fig. 1.** Graze abrasion of skin and bone was seen directed back to front, with evidence of heaping of skin and bone over the anterior margin

grazed abraded lines with evidence of heaping over the frontal margin involving the skin-covered bone adjacent to it. There was a sagittally placed fissured fracture involving the frontal and parietal bone. Now both of these injuries were adding to each other. It was suggested that it might have been caused by the same impact and by being dragged under the wheel of the van. The blackening in and around the wound would be due to frictional heat generated during the process of dragging victim's head. Graze abrasion of the skin and the bone was seen in the front to back direction with evidence of heaping of skin and bone over the anterior margin (Fig. 1). There was also a graze abrasion over the forehead, the posteromedial aspect of both forearms, and over the left iliac region, which were skin deep.

### Internal examination

There was a comminuted fracture of the frontal bone with multiple linear graze lining over the skull. There was subarachnoid haemorrhaging all over the brain surface. The brain was congested and markedly oedematous. All other internal visceral organs were intact and congested. The cause of death was given as head injury. Toxicological analysis did not reveal any toxicological substances.

### Case no. 2

A 30-year-old male pedestrian was involved in an accident with a truck. He became trapped in the front bumper of the truck and was dragged for around 100–150 metres. At the scene of the crime blood stains and pieces of flesh and body tissue was seen smearing the road up to that distance. At the terminal end, where the body was found, there were tyre marks in a forward and backward direction. Here also, due to fearing the fury of bystanders the truck driver fled. The victim died on the spot.

### Autopsy examination

The deceased had graze abrasion injuries to soft tissues and bone over his chest and right upper limb. The skin in and around the injuries and the corresponding bones were blackened and showed evidence of dermo-epidermal burns. The humerus bone was so abraded that it looked as if it had been planed like

wood by a carpenter, together with blackening of the bone matter (Fig. 2). There was a graze abrasion over the right thigh and knee, which was skin deep.

### Internal examination

Visceral organs were intact and pale, including lungs, heart, liver, and spleen. The brain showed subarachnoid haemorrhage surrounding the entire brain surface area. The cause of death given was shock and haemorrhage due to injuries sustained. Toxicological analysis did not reveal any toxicological substances.

Regarding evidence collection, the blood stains found on site were matched with the blood of the victim, and the tyre marks were identified to be those of the alleged van and truck by the investigating team. However, the van or the truck that was the causative factor of these fatal incidences was not been able to be traced by the investigating team, so they were unable to obtain evidence of traces of any stains on it.

### Discussion

In vehicular accidents involving a pedestrian/bicycle/motorcycle in collision with another vehicle, such as a car or truck, various skin injuries occur. These skin injuries are often termed as “friction abrasions/brush burns/gravel rash/road rash/graze abrasion” [1, 2]. Here, the injuries indicate contact of the body surface with hard and rough surface such as the road. However, such injuries might not be limited to the skin only. When a victim is dragged for a considerable distance with force by any means like a vehicle, it can produce an extensive form of abrasion injuries, which involve the skin, soft tissues, and sometimes the bone. Often the victim dies at the site due to such injuries. However, sometimes they survive and are brought to the hospital in an injured state.

The literature mentions injuries due to dragging of the broad body surface by a tangential force, causing damage to skin, which is known as graze abrasion or friction abrasion or gravel abrasion [1, 2]. Dragging injuries caused to the bone have little mention in the available literature. Several nomenclatures have been given for injuries caused by dragging, such as bone abrasion, grinding abrasion,



**Fig. 2.** Bone abrasion as if polished like wood by a carpenter

dragging injuries, and grinding injuries [3–10]. The term bone abrasion was used by Galloway for injuries caused to bone by dragging of the victim by motor vehicles [4, 5]. However, they believe that in the case of bone abrasion the victim might already be lying on the road and may subsequently have been dragged for a long distance. Such bone abrasion was observed on the dependant portion of the body that was in direct contact with the underlying surface, and it was seen on both the soft tissues and skeletal remains. However, Kendell *et al.* defined such a pattern of injury as grinding abrasion, because they believe that the mechanism of injury was more consistent with grinding trauma [6].

Such injuries can result in death and can involve the skin, underlying soft tissues, and bones. Abrasions on bone are the result of forceful or continued contact with an abrasive substrate. In forensic anthropology we often see bone “abrasions” with remains that have undergone fluvial transport. However, it is very uncommon in cases who survive the accidents before eventually dying.

Broad graze abrasion usually reflects contact with a rough surface. They are commonest over the trunk and limbs and are often confined to one side or the surface of the body. Dragging under any moving object like a vehicle for any distance will usually produce extensive areas of parchenting with overlying circular or oval deficiencies where the skin has been scooped away by friction [2].

Here, in case no. 1 the victim fell from his bicycle in front of the van, which was a light 4-wheeler. The van driver applied the brakes to avoid the accident;

however, the head of the victim became trapped between the road surface and the front wheel. He was dragged over the rough surface of the road, which caused abrasion to the skin to such an extent that it exposed the bone and showed bone abrasion over it. The bone abrasion was seen in the underlying frontal part of skull, which was sagittally placed and directing forward. The victim was alive for a period of 9 days before succumbing to his injuries. So, this makes it very unique. The victim was dragged for a considerably short distance, as reported by the police, through the statements of the bystanders, and also going through the crime scene. In this case, the victim was dragged for only about 10–20 metres.

Similarly, in case no. 2 the involved part was abraded to such a level that it had become flattened and polished. Such a type of flattening and polishing requires a considerable amount of tangential force, which can be achieved by the motion of the entrapped body surface in contact with the road and the vehicle for a considerable period with considerable force for a considerable distance. Also, the skin in and around the injuries and the corresponding bones were blackened, suggestive of dermo-epidermal burns. The humerus bone was so abraded that it looked as if it had been planed like wood by a carpenter, together with blackening of the bone matter. The blackening of skin and underlying bone was due to the heat generated by friction of the body surface with the rough surface of road and the force of dragging at the site of contact. In both the cases the road surface was made up of gravel and coal tar, which is usually ground, flattened, and smoothened by a road roller.

Now, if we look at this abrasion of bone, it is similar to a graze abrasion of skin in the manner and mechanism of causation. However, it is present in a much more severe form and is of more destructive nature than its predecessors. These abrasions of bone, if carefully viewed, can help in ascertaining the direction of the force caused. So, in these cases there was a possibility that the graze abrasion showed particular markings on the bone, which were directional to the dragging force.

Most of the cases reported previously were cases in which the victim was dragged for a very long distance, ranging from 3.4 km to 45 km, with due force and speed [5–11]. Such dragging for a long distance makes the survival of the victim very unlikely and in many cases impossible. However, in the present case

no. 1, the victim was dragged for a short distance by a vehicle that stopped suddenly while trying to save the victim. Also, in case no. 2, the victim was dragged again for a short distance of 100–150 metres. However, in both cases they were not dragged for the very long distances mentioned in previously published literature. The dragging distance was provided by the police who had visited the crime scene, which was also supported by the statements of bystanders present at the time of these incidents.

The possible injury mechanism by a decollement type of trauma was also evaluated. However, the possible decollement-type trauma which could have happened particularly in case no. 1 could not be supported because the dragging distance of the victim was very less, 10–20 metres to be precise. This was supported by the police who visited the crime scene and who found tyre marks on the road possibly due to application of the brakes by the van driver. It is most likely that the van driver had applied brakes to his van, which would have stopped the tyres from rotating. Thus, it was less likely to have caused decollement injuries due to rolling wheels under which the victim was dragged. Due to this factor, it was more likely that the causation of bone abrasion was by dragging of the victim rather than by any other possible mechanism.

However, the car was not able to be traced because the driver fled the crime scene and the van number plate was also not noted by anybody. Also the alleged truck in the second case could not be traced by the investigating agencies. Hence, it was difficult to ascertain the amount of damage the alleged vehicles might have caused due to the above-mentioned victims.

Most of the injuries mentioned in the literature typically occurred on the extremities of the victims involving long bones or on the torso involving the ribs and the spine. The classic pattern of dragging injuries shows a “target-like” appearance. These have central deepening with superficial injuries in the periphery [8, 9]. However, in case no. 1 the involved part was the head and the underlying skull bone. There was graze abrasion of soft tissue and bone causing linear markings on the bony surface directed towards the frontal aspect. There was heaping of the skin over the frontal margin of the wound. Even the markings on the bone showed heaping of bone in the frontal margin.

The severity of the injury depends on many factors, such as the speed, distance, force, substrate material, and skeletal elements involved. These injuries are especially common on elements that have limited soft tissue protection (cranial vault, mandible, ulna [elbow], etc.). Recognizing these injuries, especially in skeletonized remains, may assist in reconstructing the death event when the context is unknown.

Evaluating the striations left by the substrate may provide information regarding bone orientation in relation to the substrate when force was applied. Thus, from a forensic point of view, directionality may be inferred by evaluating such injuries. Also, it will be of some value to determine the period and amount of force applied over the body by the suspect vehicle or object.

Bone abrasion can easily be observed in cases of dead bodies that are found in non-decomposed condition and in living victims. However, when the bodies become decomposed or skeletonized then such abrasion of bone can become very important to ascertain the manner and method of occurrence. Even in cases of mass disaster, like air crashes, railway accidents, or any other manmade disaster, the presence of such injuries can be of significant forensic importance. Hence, the present case reports where discussed for their rarity and uniqueness of occurrence in the event of dragging of victims by a moving vehicle.

## Conclusions

The appearance of such injuries is characteristic such that they do not constitute a major diagnostic problem in the differentiation of their cause and mechanism. However, the evaluation of circumstances of an accident is very important to have a fair opinion regarding the facts and the actual causation of such injuries and their relation with the alleged accidents. For this, evidence collected at the site of the accident, results of car/vehicle inspections (traces on the hood, wheels, and the chassis), technical reconstructions, and computer simulations of the sequence can be of great help. However, in both of the presented cases this aspect was incomplete due to the inability of the investigating agencies to trace the alleged vehicles that caused the fatal accidents. So, unfortunately inspection of the vehicle,

i.e. collection of trace evidence from it, could not be performed. Similarly, the dragging distances of the victims by the alleged vehicles given by the investigating agencies were approximate assessments from the evidence at the crime scenes and the narrations given by the bystanders at the times of the incidents. However, they were unable to perform technical analysis or computer simulation of the sequence due to a lack of experts in this area in our region, which could have added a certain value to the outcome of the investigation in the presented cases. Thus, the opinion in such cases can become highly speculative in nature due to a lack of further technical analysis and other related assessment. This area of limitation needs to be improved in the future in such types of injuries and fatalities, so as to have a reasonable final conclusion.

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