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CASE REPORT

Complete decapitation of a motorcycle driver due to a roadblock chain

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Abstract An 18-year-old male driving an off-road motorcycle died from complete decapitation when his motorcycle tore a roadblock chain from its attachment. The decapitation injuries of the head and the torso corresponded perfectly, without apparent loss of tissue. The severance plane passed horizontally through the upper cervical region and C4, which sustained a comminuted fracture. The sharply delineated severance edge had a band-like abrasion. The decapitation resulted from the rotational movement of the unstrung chain, which struck and strangled the driver's neck. We were able to explain the movement of the chain and the decapitation mechanism. This case emphasizes the importance of discussing dynamics with experts to clarify a causal mechanism.

Keywords Decapitation · Motorcycle accident · Roadblock chain · Rotational movement · Law of conservation of angular momentum

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Introduction

Cases of complete decapitation caused by traffic accidents have occasionally been reported. In past reports, objects that severed the neck were the tailgate of a truck [1], an iron crossbar on a fence on the side of the road [2, 3], and a barrier stanchion on the side of the road [4]. We saw an unusual case of complete decapitation in which a roadblock chain had been wrapped around the neck of a motorcycle driver. To our knowledge, there are no previous reports of complete decapitation by a chain. The case report and autopsy findings are presented, with an explanation of the mechanics of the movement of the chain.

Case report

An 18-year-old male driving a motorcycle at high speed was driving down a road under construction and hit a roadblock chain. The motorcycle was an off-road type, a Kawasaki KDX250SR. The driver wore an off-road helmet with a chin bar. One-ton concrete blocks located on both sides of the road anchored the roadblock chain stretched between them (Fig. 1). The distance between the blocks was about 5 m, and the total length of the chain was about 9 m. The chain, padlocked to the blocks, was stretched tightly about 60 cm high at the center of the road. The excess chain was lying by the block on the left side of the road. According to an eyewitness, the motorcycle speed was approximately 70–80 km/h, and the collision of the motorcycle with the chain was audible. A decapitated corpse, a head, and a motorcycle were discovered at 22, 25, and 40 m from the entrance of the road, respectively

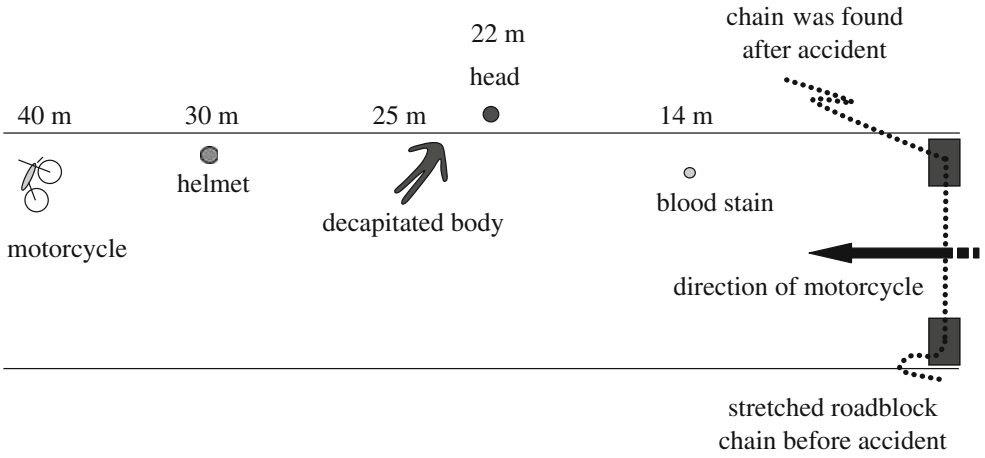

Fig. 1 Illustration of the scene of the accident

(Fig. 1). The motorcycle must have crashed, slid, and scraped against the ground. Damage to the motorcycle under the front fender was caused by the chain while damage to the left side of the motorcycle was caused by the motorcycle falling over and hitting the ground. The padlock securing the chain to the block on the left was broken, and the entire chain was found on the right side of the road. Part of the chain was misshapen from the impact of the motorcycle, and there was a skid mark on the road. A small bloodstain and some tissue fragments were found 30 cm from the left end of the chain, and results of DNA analysis were consistent with their origin from the decapitated corpse. A complete morphological match of both severed planes of each part, the skin, the vertebral fracture, and the airway confirmed their identity.

The driver had no history of mental disorder or drug abuse.

Autopsy findings

The autopsy was performed 17 h postmortem. Autopsy revealed the body of a young Japanese male of medium lean build. The body was 168 cm in length and weighed 50 kg (head included). Postmortem hypostasis on the back was very slight. No petechiae were observed in the palpebral conjunctivae.

The head was completely severed from the trunk and weighed 4.3 kg. The decapitation injuries of the head and the torso corresponded perfectly, without apparent loss of tissue. The severance plane passed horizontally through the upper cervical region, and the edge was sharply delineated (Fig. 2). There were band-like abrasions on the anterior three quarters of the severed edges. The severance plane passed through C4 with a comminuted fracture, and the cervical spine was severed at the level of C4. The epiglottis had been torn off and remained on the head segment, and the airway was severed at the trachea, between the hyoid bone and the thyroid cartilage. Both superior horns of the thyroid cartilage and major horns of the hyoid bone were broken with slight bleeding. Both common carotid arteries were severed, and the adventitia showed slight bleeding. The other cervical vessels, nerves, muscles, and soft tissues were severed horizontally. The entire severance plane had bleeding in the tissue; the torso side of the severance in particular exhibited marked bleeding. There was no blood aspiration in the airway.

Fig. 2 The head side of the severance plane. Severance edge with band-like abrasion and submental lesion

On the head, there were bruises and abrasions on the face and a submental lesion (Fig. 2), without a skull fracture or intracranial injury. There were slight bruises and abrasions on the trunk and extremities. Linear bruises on the back of the trunk extended from the upper right to the lower left, and the upper-right end of the line of bruises approached the severed edge (Fig. 3). Internal findings revealed bilateral third rib fractures at the costovertebral joints and exsanguination of internal organs. The post-mortem blood tested negative for alcohol.

The cause of death was determined to be decapitation.

Discussion

According to previous reports, most complete decapitations result from suicide, such as train–pedestrian fatalities and hanging deaths, while traffic accidents account for most accidental decapitations [5]. Saukko and Knight [1] described a mode of decapitation that occurs in extreme tailgating accidents in which a motorcyclist drives into the back of a truck; the motorcycle passes underneath the truck, but the head of the motorcyclist strikes the tailgate.

In hanging-related decapitations, the severance line is usually located at C1–2 or C2–3 [6–9]. Most of the vertebrae remain intact, but the corresponding intervertebral discs are torn apart by tearing and shearing forces [6]. According to Dedouit et al., both tearing effects of axial traction and shearing and/or crushing effects of radial pressure act on the neck in hanging decapitations [8–10]. In the present case, we believe that the latter effect predominated. There was a fracture of the corpus of C4 in the severance plane and a band-like abrasion around the edges. These findings suggest that a ligature-like object

Fig. 3 The linear bruises distributed in a direction from upper right to lower left on the back

Fig. 4 The off-road motorcycle: the space between the fender and front wheel

wrapped itself around the driver's neck, with a huge blunt force. Meanwhile, circumstantial evidence revealed that the motorcycle was traveling at 70–80 km/h when it struck the roadblock chain and broke the left padlock. We hypothesized that the chain, unstrung by the collision, wrapped around the driver's neck and decapitated him.

The off-road motorcycle involved has a space between the fender and the front wheel designed to ease racing over varied terrain of gravel, mud, and sand (Fig. 4). There were scratches made by the chain under the fender, which was attached at about 70 cm above the ground. The chain slipped under the fender at the collision, and the tension of the chain broke the left-side padlock. The chain was then subjected to two force vectors, a forward strain force exerted by the motorcycle and a backward reaction force (Fig. 5(a)). Under their influence, the chain began a rotational movement, with the fender of the motorcycle acting as the center of rotation (Fig. 5(b)).

The question might arise as to how the chain unstrung behind the motorcycle could catch up to the advancing driver, but the law of conservation of angular momentum can be applied to the motion of the chain. The law states that the angular momentum of an object rotating about some reference point is the measure of the extent to which the object will continue to rotate about that point unless acted upon by an external torque. This law of conservation of angular momentum is explained in the general text of classical dynamics or mechanics on physics and expressed as:

$$M \times V \times L = \mathrm{C}[\mathrm{constant}]$$

where M [kg] is the mass of the object; V [m/s] is the velocity, and L [m] is the distance of the mass to the axis. Conservation of angular momentum also explains many

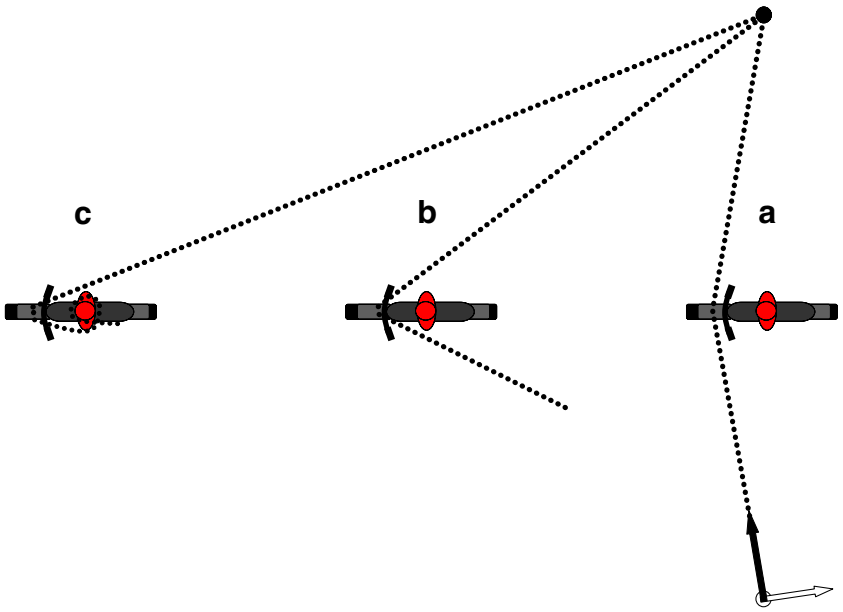

Fig. 5 Schematic description of the movement of the chain after collision with the motorcycle. (*a*) A force resulting from two vectors—a strain force produced by the motorcycle (*black arrow*) and a backward-directed force (*white arrow*)—operated on the point in the chain that was fixed by the padlock. (*b*) The resultant force on the chain caused it to begin to swing around the fender of the motorcycle. As the swinging section of chain shortened, its decreasing radius and weight acted synergistically to increase its velocity. (*c*) The rotating chain finally struck and wrapped itself around the driver's neck

phenomena in sports and nature. For example, a figure skater can spin at a high speed by drawing the arms close to the body. In our case, the more the motorcycle moves forward, the shorter the chain's radius of rotation becomes. Furthermore, because the mass of the rotational object is the weight of the chain, decreasing of the rotational radius also reduces M. Hence, V synergistically increases as M and L decrease (Fig. 5(b)). We believe that the rotational velocity increased enough for the chain to catch up to the advancing rider and his neck (Fig. 5(c)).

We considered another force contributing to the decapitation. Considering the movement of the chain, the chain wrapped itself around the driver's neck from his back. This pathway corresponds with the autopsy findings with band-like abrasions of the severance edges and bruises on the back (Fig. 3). A point 30 cm from the left end of the chain impacted the neck, as revealed by the bloodstain and tissues. Consequently, after the initial blow, a 30 cm length of the left end of the chain continued to rotate around the center of the neck. Because the right end of the chain was attached to the block, as long as the motorcycle was going forward, the chain was under strain from the right. As a result, the chain wrapped around the driver's neck strangled him through the tractive force from each end (Fig. 6).

We have presented an unusual case of a motorcycle driver with complete decapitation caused by the rotational movement of an unstrung chain, which struck and wound around the driver's neck, and we have explained the dynamics of the decapitation. We conclude that the initial blow and subsequent strangling by the chain together effected complete decapitation. Physics analysis and biomechanical approach often make a significant contribution to the decision of the mechanism of the injury [11]. Stacey and Kent [12] describe that an interdisciplinary approach should be utilized to determine how the injury was caused. Forensic pathologists should recognize the importance of basic knowledge of physical laws and work together with physical scientists when necessary.

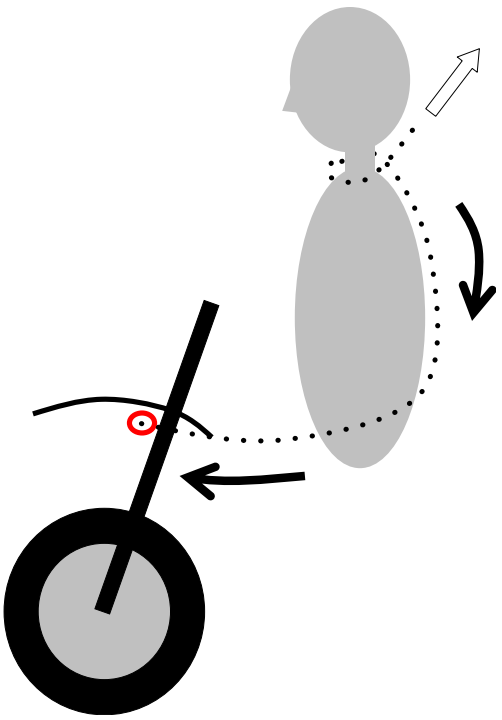

Fig. 6 The driver was strangled by the chain, the ends of which pulled in opposite directions. *Black* and *white arrows* show the respective forces acting on the two ends of the chain

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