CASE REPORT

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Work-Place Homicide by Bow and Arrow

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ABSTRACT: Arrow wounds represent an unusual class of wounds rarely seen by most forensic pathologists. In this paper we present a case of homicide by bow and arrow and the characteristics of such injuries. The essential characteristics of the lesions obtained from conically-tapered field points and from hunting broadhead tips are described and discussed in relation to injuries caused by firearm bullets. In the present case, three arrows struck the victim, and the order in which the injuries were sustained are analyzed. We also discuss the possibilities of localizing the shooter relative to the victim by analysis of the trajectories.

KEYWORDS: forensic science, forensic pathology, homicide, death, bow and arrow, injuries

Injuries by arrows were common previously in history (1), and the bow and arrow in fact date back to the Paleolithic era (2). They still exist as a weapon in tribal fighting (3–5). In developed countries, however, injuries by arrows are rare, and when they do occur, the arrows are most often propelled from crossbows (6–12). Thus arrow wounds are currently unusual, but the increasing popularity of both hunting and target-shooting may lead to a rising number of both intentional and unintentional arrow injuries. In this paper, we present a homicide by bow and arrow.

Case Report

At 6 a.m. on a Monday morning, a 59-year-old foreman was found dead lying in a corridor at work with three arrows in his body. An ambulance was immediately requested. The victim was pronounced dead and the police were contacted. While the police patrol drove to the scene, a 22-year-old man called the police and confessed a homicide by bow and arrow and informed the police where he could be found. He was immediately arrested and showed no signs of drug inebriation.

The Scene

The victim was lying in the division of a corridor. Three arrows had entered the body, and one of these had penetrated into the chest. The angle of this arrow was compatible with the victim bending forward when hit. Another had perforated the body and entered 1 cm into the wall. A third arrow had entered the right forearm. An additional arrow with a three-bladed tip had missed the body, perforated a 1.2 cm plasterboard and reached a depth of 4 cm into a wall of solid pine wood. The angles of these latter three arrows were compatible with the victim lying down in the same position, and with the archer standing in an upright position (Fig. 1). A chair was standing in the corridor 5 m from the victim. On the floor, close to the chair were three arrows with conically-tapered field points (Fig. 2). A bow, a tab, a knife, and a cap were also found at the scene.

The Homicide

According to the assailant, the thought of killing somebody arose while watching video tapes with murders six months prior to the murder. He had owned a hunting bow for about five years and had used it for target shooting. A few weeks before the homicide, the assailant ordered by mail-order 12 hunting tips, and a couple of days before the homicide, he decided to kill the first person to come to his work this specific morning.

Between 2–3 a.m. this morning, the assailant walked to work where he placed a chair in a corridor. He loaded his bow quiver with arrows and an additional three arrows were placed on the floor close to the chair. After this, he positioned himself on the chair and waited.

At 5:55 a.m., the assailant heard a door open. He then raised and aimed roughly at the corner of the corridor where he expected the person to appear, at a distance of about 5 m. As soon as the person became visible in the corridor, the assailant released the first arrow into the victim's chest while the victim rotated slightly towards the assailant. The victim grabbed the arrow with both hands and collapsed. The assailant released an additional three arrows from the same position. He subsequently left the scene through an emergency exit.

Forensic Investigations

The bow was of compound type (PSE Pulsar Game Sport Series, 45–60 lbs, Precision Shooting Equipment Inc., Tucson, AZ) and was tested at the National Laboratory of Forensic Sciences where the velocity of the arrows was determined to be 57–58 m/s with a kinetic energy of 60 Joule regardless of type of tip. Arrows with a conically-tapered tip, known as a field point, penetrated 3 cm into solid pine at a distance of 5 m but did not penetrate an arrow stop (Dead Stop 4000). However, arrows with a hunting tip, known as a broadhead, easily penetrated the arrow stop and another 3 cm into solid pine wood.

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FIG. 1—*The victim lying on the floor, with three arrows protruding from the body and an additional one from the wall. The arrows hitting the body have been indicated with Roman numerals I–III, indicating the probable order in which they were released. Both hands of the victim are in the immediate proximity of the arrow (I) protruding from the chest. The arrows II and III and the arrow in the wall are all parallel to one another and have been fixed in a slightly declining course. A package of coffee is lying on the floor in front of the victim.*

FIG. 2—*The victim seen at the division of the corridor from the position of the assailant. Three arrows with conically-tapered tips, also known as field points, are seen on the floor close to the chair of the assailant. The distance from the chair to the victim is approximately 5 m.*

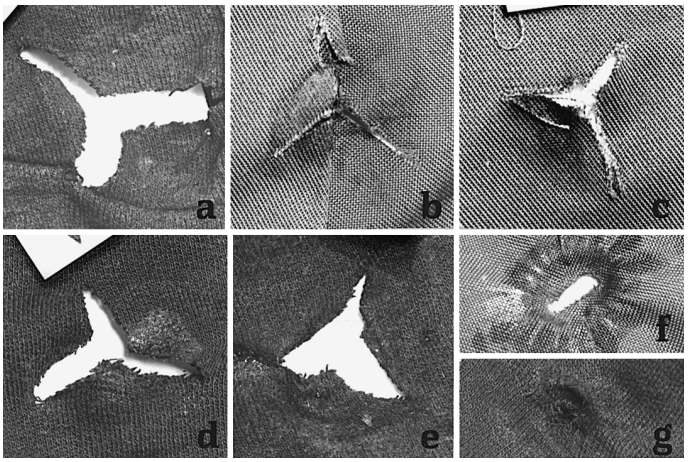

FIG. 3—*Entrance (a, b, d, f, g) and exit (c, e) cuts of arrows with three-bladed tips (I–II) and the conically-tapered tip (III) through the shirt (a, d, e, g) and the jacket (b, c, f). Damage from three-bladed tips (a–e) differs significantly from damage caused by the field point (f, g), each reflecting the geometry of the tip (cf 14). a) Entrance cut of arrow I in the shirt, b) Entrance cut of arrow II in the jacket, c) Exit cut of arrow II in the jacket, d) Entrance cut of arrow II in the shirt, e) Exit cut of arrow II in the shirt, f) Entrance hole of arrow III in the jacket, and g) Entrance hole of arrow III in the shirt.*

The superficial layer of the victim's clothing consisted of a nylon jacket and trousers. Under this was a long-sleeved undershirt and short pants. The victim also wore socks and shoes. The holes in the jacket and the undershirt indicated that two arrows entering the chest and the abdomen had three-bladed cutting tips, whereas the arrow entering the right forearm did not (Fig. 3).

Autopsy

At the autopsy, three arrows (Easton Camo Hunter LITE XX75 2216, Easton, Salt Lake City, UT) were found in the body. The weight of each arrow was 36 g and the outer diameter of the shaft was 0.87 cm. One arrow with a total length of 79.9 cm entered the center of the chest 3 cm above the base of the xiphoid process. This arrow had penetrated 28 cm into the body, through the sternum, the right and left ventricle of the heart, the diaphragm and the left lobe of the liver, and the three-bladed tip was embedded behind the transverse colon without injuring the intestines (Figs. 4A, 5A-D). The tip was a three-bladed pointed metal cutting tip, known as a broadhead, (Thunderhead 125, New Archery Products Corp., Forest Park, IL) with a cutting diameter of 30.2 mm (1 3/16 in.). A small amount of blood was found in the pericardiac sac, which was severely lacerated, and 2100 mL of blood and clot was found in the left pleural cavity.

An identical arrow entered the right side of the abdomen and lower part of the thorax, penetrating the tenth rib, the right lobe of the liver, the diaphragm, the lower lobe of the right lung and the posterior chest wall (Figs. 4B, C, 5E, F). In the right pleural cavity, there was 150 mL of blood and clot, whereas the abdominal cavity contained only minimal amounts of blood. A third arrow (total length 76 cm) with a conically-tapered tip field point) entered the right forearm with tenting of the skin on the opposite side but without injuries to bone structures (Figs. 4D-F). The wound tract showed practically no signs of bleeding. Microscopic investigation of the exit side showed partial destruction of the deeper parts of dermis with dried but otherwise intact epidermis.

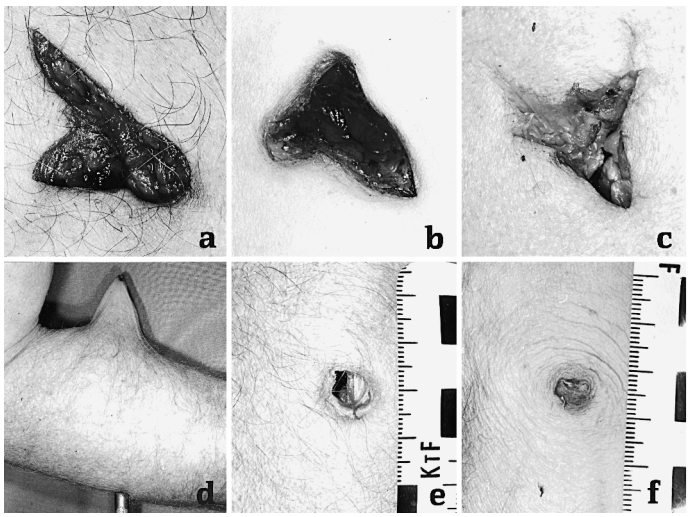

FIG. 4—*Skin lesions from three-bladed tips (a–c) and the field point (d–f). Up in a–c points in cranial direction. a) Entrance wound of arrow I in chest skin. b) Entrance and c) exit wound of arrow II in abdominal skin. d) Field-pointed arrow in situ in the right forearm. The arrow caused tenting of skin at the exit side, without penetration. e) Entrance wound of field point in forearm skin. and f) Desiccated skin mark at the exit side where the tip penetrated into the deeper parts of the dermis. The three-bladed tip produced a triangular entry wound and a similar exit wound. Both entry and exit wounds show retraction of skin edges due to the elasticity of the skin. The asymmetry is caused by the oblique entrance angle. None of these wounds showed discoloration or abrasion of the edges. The field tip created a roughly round skin wound 0.7 cm in diameter, with a slightly asymmetrical rim of abraded heaped-up tissue 0.2 cm wide. Millimeter scale in e and f is valid also for a–c.*

Other relevant postmortem findings were severe coronary atherosclerosis with diffuse myocardial fibrosis and an old myocardial infarction in the apical part of the left ventricular posterior wall. In addition, there was a low degree of liver steatosis and anemic inner organs. Toxicological analysis revealed the presence of 0.2 μg diltiazem per gram peripheral blood, but no presence of alcohol or other drugs.

The cause of death was attributed to the internal injuries caused by the arrow penetrating the chest.

Psychiatric Investigation

According to the forensic psychiatry investigation, the assailant was described as a solitary person living together with his father. He had few friends, no sexual experience and no criminal record. A change in his behavior with, e.g., an obsession to clean his apartment, was seen about six months before the homicide, and he claimed that before the event he had heard voices ordering him to kill somebody. He considered himself a person with a normal mental status, but the psychiatric investigation revealed that he suffered from an unspecified psychotic syndrome with a schizoid personality.

Verdict

The assailant confessed to the homicide and was found guilty of murder in a court of law. He was committed to psychiatric treatment.

Discussion

Arrow injuries were commonly seen during ancient time, and deaths by arrows have been known for as long as human history. Crossbows have been known since the Norman times. With the invention of modern weapons, arrows are rarely utilized in hostile actions nowadays, but may still be seen in tribal fighting (3). Both hand bows and crossbows are, however, becoming more and more popular for sports and hunting, and we must thus learn more about injuries caused by these weapons and sport items.

Handbows are classified into traditional bows and compound bows. The former group originated in prehistory, but are still in use and popular because of their origins, low weight, silence, craft, and artistry, and are often used with what is known as instinctive shooting. Traditional bows subdivide into longbows and recurve bows, the latter mostly seen in archery. Compound bows have been developed during the last decades. Most often their distinctive feature is a wheel at the end of the bow limbs around which an extension of the bow string, or the cable, runs, thereby giving the impression of the bow having three strings. This construction allows the draw to pass the highest draw weight before the bow is fully drawn. Full draw is therefore easier to hold, giving the so called let-off effect which mostly measures 50–65% of peak draw weight, enabling the archer to manage bows with higher bow weight and also wait in full draw for a considerably longer time than with traditional bows. These characteristics have made compound bows the most used by bow hunters. The bow used in this case was a compound bow with a draw weight of 45–60 lbs.

Bow equipment performance measured as arrow penetration depends on a variety of factors, such as bow energy storing capacity, bow effectiveness, arrow length and weight, arrow spine, bow tuning, release technique, the archer's performance, used draw length, target distance, broadhead construction and sharpness of blades, to mention the most important ones. We will not discuss these details further, but emphasize the fact that the effectiveness of handbows in arrow penetration is largely determined by the individual archer's skill and performance. The conditions regarding test-shooting a handbow in crime investigation are thus totally different from those of test-shooting a firearm.

The test shooting done by the National Laboratory of Forensic Sciences was made with finger release and barefingered by a person with no experience in shooting a bow, all factors known to influence the effectiveness of the bow. The penetration depth reported by the laboratory could thus be influenced negatively by an unskilled release technique and by the short test-shooting distance, as it is almost certain that the arrow flight at such a short distance was not yet straight. This would significantly diminish penetration, more so in a hard target like pine wood than in a soft target like a human body. The test at the National Laboratory of Forensic Sciences thereby must be considered as an example of the performance of the bow more than a test of the capacity of the equipment. We therefore recommend that test-shooting handbows in similar cases should be performed by skilled archers and that the test report should include data on draw weight, draw length, release techniques and shooting distance, all of which should be similar to those thought to have been used by the assailant at the scene of the crime. It would also be preferable if demonstration shots were made by the assailant and measured adequately, partly to test his capacity to handle the bow, and partly to test the effect of the (reconstructed) crime situation which may significantly influence bow efficiency and arrow flight, and thereby arrow performance. For instance, a bent or rotated body position by the assailant might

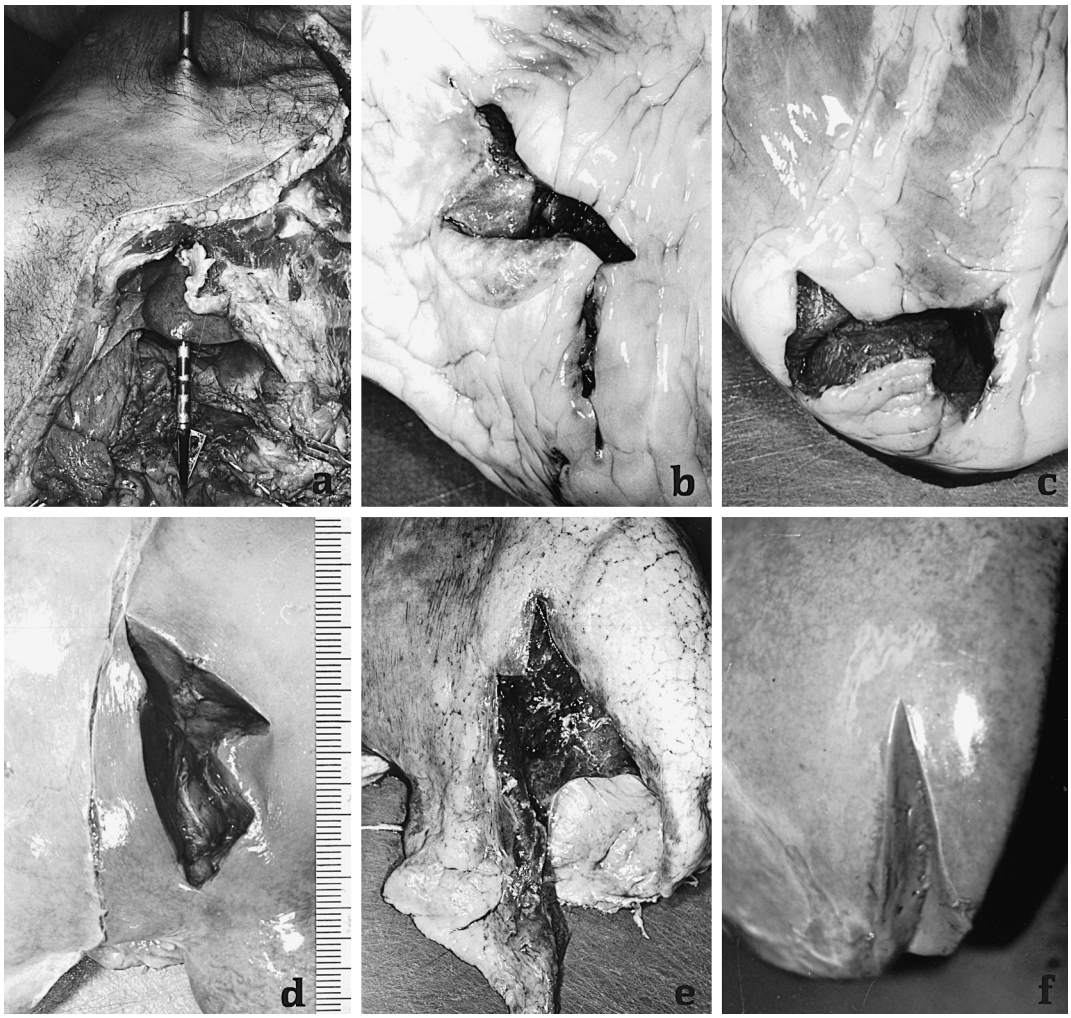

FIG. 5—*Perforating wounds of the chest, the heart and the liver (a–d) caused by arrow I, and of the right lobe of the liver and the right lung (e–f) caused by arrow II. All these injuries are thus caused by arrows with broadheads. a) Arrow (I) with three-bladed tip in situ, penetrating through the sternum, the heart, the diaphragm and the left lobe of the liver, reaching 28 cm into the body. b) Anterior and c) Posterior view of the heart. d) Superior view of the liver after removal of the ligamentum falciforme. e) Posterior view of the lower lobe of the right lung. f) Lateral view of a tangential cut in the right lobe of the liver. Millimeter scale in d is valid also for b and c.*

result in releasing the arrow before a full draw and with a poor release technique.

A bow can be used for hunting or target shooting using different types of tips. The field tip is smoothly pointed and conically-tapered and is used for target shooting, whereas the hunting broadhead tip has cutting razor-sharp edges. In Sweden, bow hunting is forbidden, but bows, arrows and hunting tips can be purchased without restrictions. Razor sharp broadhead hunting tips can cause radiating incised wound with devastating injuries to internal organs and possess the potential to pass completely through the body of a victim or a pray. The penetration ability of a broadhead tipped arrow is thus extensive and bow hunting on large game is practiced around the world. For instance, in North America on bear, elk and moose are hunted, in Europe wild boar and red deer, in Australia buffalo, wild hog and feral camel, and in Africa even the big five are hunted with bow: elephant, rhino, cape buffalo, lion, and leopard. The suitability of this weapon regarding elephant, rhino and cape buffalo is however under debate.

One criterion for the effectiveness of a broadhead tipped arrow in hunting is safe penetration through both lungs at broadside shots, even when hitting the shoulder blade and ribs at entrance. Furthermore, it is desired that the arrow has kinetic energy enough to penetrate and fully pass through the pray's body, thereby ensuring a good blood trail. A great many hunting bows give the arrow penetration power enough to cut large bones like a leg bone or a vertebra on game like bear or deer.

In the present case, circumstantial evidence strongly indicates that the victim had started to bend forward trying to avoid the arrow when hit. It is common knowledge in bow hunting that arrow hits at running or bending deer occasionally diminish penetration depth of the arrow significantly, due to the squeezing effect by bones on the arrow shaft. Thus, if the victim in this case had been motionless when hit, the first arrow might have fully passed through the body of the victim.

Accidental fatal injuries from bows are rare. One explanation for this may be that an extensive active movement in drawing the bow string is required. Another explanation is that the range of good enough accuracy is limited. For instance, most bagged deer in the US are shot at a distance of 18 m or less, and only very few at ranges of 35 m or more. In Sweden, we have to the best of our

knowledge not had any serious accidental injuries from archery. In the US, the most common mechanism of injury during bow hunting is falling down from a tree-stand or during climbing to or from a tree-stand. Three accidental deaths have been reported from the state of Colorado, USA, since 1960. Two of these were caused by an arrow aimed at a deer but deflecting after hitting a branch and killing a hunting companion. The third fatal accident resulted when a man fell down from his horse and landed upon one of his own arrows (13).

Intentional self-inflicted injuries are extremely rare since the bow is impractical and since suicidal person may not have the strength to draw the bow string (6). Recently, however, a case of suicide using a compound bow was presented where the decedent drew the bowstring with his left foot while holding the bow in his hands (14).

As the weapon is almost silent, has an accurate targeting over short distances and as it is not possible to link the missile to the weapon, one would assume that it would frequently be used in homicides. However, the bow is impractical to carry and thus impractical to use as a murder weapon. There are also many requirements upon the skill of the archer and the availability of firearms is usually easy. This may contribute to the fact that homicides with bow and arrow are rare. We have found only one homicide with bow and arrow in the literature, and a compound bow was also used in this case. This was a case of a gun man who was killed with a four-edged hunting arrow entering the right chest yielding rapidly fatal injuries (9). All other homicides with arrows reported in the modern scientific literature have been performed with crossbows (7,10,11,15,16).

Arrow wounds thus represent an unusual class of wounds in forensic practice and reports have usually been anecdotal and related to crossbow injuries. The mechanism of the fatal injury is usually obvious if the projectile still protrudes from the wound. One must, however, be aware of the fact that it is possible that the arrow has been inserted into a preexisting gunshot wound (see 11). As in all penetrating injuries of the body, it is thus recommendable to perform a radiologic investigation before the autopsy.

The two major types of arrow heads, the conically-tapered field point and the broadhead tip, produce distinctive wounds. Shaped like the nose of a firearm bullet, the field point produces a circular to elliptical slit-like skin defect with the potential of being confused with an entrance gunshot wound (11,17). Searches for firearm projectiles, fragments or powder residue are however negative. Further, the archery wound has little if any identifiable abrasion-ring, and the internal wound characteristics are distinctive from high energy release firearm projectiles. In fact, failure to find a bullet during autopsy should alert the forensic pathologist to the possibility that a field tip arrow may have caused the wound (9).

The edged broadhead-tipped arrow, on the other hand, produces an entrance wound usually highly distinctive of archery/crossbow weapons with an unusual radiating incised wound, reflecting the number of blades in the arrow head. The two to six-bladed tips cause cuts in inelastic structures like bone, thereby reproducing the shape of the penetrating edge. In soft structures like the skin and soft tissues, the radiated shape is not fully maintained but is distorted. Instead, a radiating wound with a slight concavity of the edges due to elastic retraction is obtained. The edge of each radius corresponds to the cutting edges, and if the skin is approximated, the length of each radius equals the distance between the cutting edge and the center of the shaft, the cutting diameter, of the broadhead. The skin incision lacks significant marginal abrasion at both entrance and exit. The importance of studying textile damage, especially in obscure cases, has also been pointed out (16).

In the present case, typical injuries of both a field point and broadheads were seen. The characteristics and measures of the wounds matched each arrow tip perfectly. In addition, we describe here the first human case in the literature, to the best of our knowledge, with "bouncing" of a field tip against the skin on the exit side with tenting of the skin. Similar findings are regularly seen when analyzing firearm projectiles, especially bullets with low energy.

In forensic practice, injuries should be assessed with attention to order if multiple injuries are present. In the present case, the assailant started by first releasing an arrow into the chest of the victim, and subsequently releasing another three arrows. This corresponds very well with the postmortem findings. Firstly, the trajectories of the four arrows clearly indicate that the four arrows were released in the order stated by the assailant. Secondly, the amount of hemorrhages also support the assumption that the arrow in the chest was the one first released, and that the arrow hitting the right forearm was the last one released of the three arrows hitting the body. Thirdly, it seems logical that the assailant first released the arrows with broadhead tips, and when he had run out of these, he started releasing field-tipped arrows.

The long and rigid nature of the arrows provides some evidence of the trajectory and may aid in localizing the shooter relative to the victim. It must be remembered, however, that the arrow may divert from its primary direction during its course through the body. Careful dissection of arrow shot deer has revealed that arrows occasionally change direction during penetration with as much as 90° (Georén, unpublished observations). In the present case, however, findings at the scene indicated that the arrow entering the chest of the victim had penetrated as he was bending forward with the assailant in an erect position. The other arrows, on the other hand, had been fired when the victim was incapacitated and lying on the floor, matching the statement of the assailant.

A question that should be addressed by the forensic pathologist is the degree of activity possible after a particular injury has been sustained. Interestingly, in this case, the findings indicate that the victim immediately collapsed after the first arrow had hit him. Probably the only movement he made after being hit by the first arrow was gripping the arrow. The position of the victim when found dead indicated that he never released this grip. Obviously, the time period from the first hit to unconsciousness and death was extremely short, consistent with the fact that the gaping incised injuries of the internal organs caused a very rapid decrease of the cerebral blood pressure. The fact that the victim most certainly was totally surprised by the first arrow and not agitated and already in flight, aided this abrupt course.

As far as we know, the present case is the first Swedish fatality by bow in modern time. This may be a little surprising since arrows do have a potentially fatal capacity and reach a kinetic energy allowing them to easily pass through a human body (cf 18). In addition, bows and arrows are purchased without restrictions and in the last ten years 2000–3000 bows with effectiveness enough for hunting have been purchased in Sweden (Peter Martinelle, personal communication).

Acknowledgment

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