

Skull Injuries Caused by Blows With Glass Bottles

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SUMMARY

The medicolegal literature provides many reports on the morphological appearance of stab injuries caused by pieces of broken glass (e.g., glass splinters). The review presented here focuses on the particular aspect of blow injuries to the head and skull inflicted by glass bottles. Findings from an experimental biomechanical study conducted by the authors as well as 10 case reports are presented and discussed in detail. In order to characterize typical findings and provide valuable guidelines for practical casework, cases of blows to the head with glass bottles that were not followed by any serious injuries are compared to such cases in which the blows resulted in fatal outcome. Com-

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binations of lacerations and incised wounds were encountered in most cases. Interestingly, lacerations were of major severity as opposed to the incised wounds. The latter were, as a rule, only superficial. Differences in bottle shape, weight, and filling conditions did not account for any differences of the resulting injuries and the breaking behavior of the bottles, respectively. Strikingly, even in the cases in which death was attributable to the blow with the glass bottle, the actual cause of death was not related to mechanical damage of bony structures or to brain injury (e.g., comminuted skull fractures or severe cerebral contusions). Here, rather exsanguination from the inflicted lacerations was found to be responsible for fatal outcome. Skull fractures resulting from blows to the head with glass bottles can be considered rare events. Regarding biomechanically relevant factors that are determined by the bottle itself, the minor elasticity of glass, as compared to bone, the filling condition, and the location of impact have to be considered as important. Additional factors related to the victim's head, such as the quantity of hair, the thickness of the scalp, the configuration and thickness of the skull, and the elasticity of bone, also must be taken into account. Considering the high frequency of assaults against the head using glass bottles, it would be most helpful for forensic practical casework to gain more detailed and sophisticated knowledge on the subject (e.g., about biomechanical principles of skull injuries caused by blows with glass bottles). However, the case reports presented here, complemented by experimental biomechanical data, will contribute to the understanding and assessment of analogous cases in practical forensic casework.

Key Words: Blow; glass bottles; skull injuries; lethal hemorrhage.

1. INTRODUCTION

The German medicolegal literature provides many reports on the morphological appearance of stab injuries caused by pieces of broken glass, for example, glass splinters (1–8). Special emphasis is placed on morphological criteria, which may be used to differentiate between self-inflicted or accidentally sustained lesions caused by pieces of broken glass on the one hand and stab wounds caused by knives or other sharp force instruments on the other (9,10). More recent medicolegal literature has also reported falls into architectural glass surfaces, glass plates (11) as well as lethal stab wounds caused by smashed bottlenecks (12).

Blow injuries to the head caused by glass bottles may be observed in daily clinical routine from time to time, but there are almost no data available on cases with fatal outcome in which bottles were used as a deadly tool (13,14).

Even in the setting of large neurosurgical departments, severe injuries of the skull and brain caused by blows with glass bottles are rarely observed.

The following review presents a number of cases of blow injuries that were caused by glass bottles. In order to characterize typical findings and provide valuable guidelines for practical casework, cases of blows to the head with glass bottles that were not followed by any serious injuries are compared to cases in which the blows resulted in fatal outcome. Based on these case reports, which are complimented by experimental biomechanical data, crucial medicolegal issues and further considerations regarding the identification of skull injuries that were caused by blows with glass bottles are discussed.

2. CASE REPORTS

2.1. Case 1

During a dispute between three teenagers, the two offenders covered the victim with a blanket and subsequently beat the victim's head with three bottles of different filling levels (an empty liquor bottle, one half-filled, and one completely filled wine bottle, respectively). The assailants had taken the neck of the bottles in their hands and directed the blows to the victim's parietal and occipital region, so that the bellies of the bottles hit the victim's head. Following impact on the head, each bottle broke into pieces. The victim did not sustain any injuries at all (15).

2.2. Case 2

Two teenagers joined a heavily drunk 30-year-old alcoholic with the intention of robbing him. Initially, they drank alcohol with him on a park bench. When the man fell asleep on the bench as a result of his drunkenness, the teenagers beat an empty wine bottle on his vertex. Because the wine bottle broke, the teenagers repeatedly beat the man with another half-filled bottle. This bottle also broke into pieces. Finally, the victim woke up, raising his head asking "How now?" The offenders desisted from the man and took refuge immediately. Medical examination of the victim revealed a swelling and contusion of the scalp. However, severe injuries of the skull and brain were excluded (15).

2.3. Case 3

In a brawl between several inebriated individuals, a 21-year-old sailor was hit on the head with a half-filled wine bottle. The blow with the neck-held

bottle was done from the front onto the forehead and vertex area. On impinging the head, the bottle burst immediately. The victim sustained only incised injuries of the forehead and of the midface that were related to the broken bottle neck (15).

2.4. Case 4

A 56-year-old man became the victim of a holdup murder. Following excessive consumption of alcoholic beverages, the man was knocked down by several offenders using a beer bottle, a vodka bottle, and a pitcher. The victim sustained lacerations and incised wounds of the scalp. Glass splinters were observed sticking out of several of the wounds. The cranial bone and the brain had remained uninjured. It was concluded that the victim had initially been knocked down by the blows to the skull. Subsequently, the perpetrators killed the man by manual strangulation while he was lying on the ground (15).

2.5. Case 5

During a physical assault that appeared to be sexually motivated, a 59-year-old female sustained three blunt lacerations of the head with concomitant avulsion of the scalp. The wounds were localized over the hind part of the skull and splinters deriving from a glass bottle were found inside one of the injuries. Numerous superficial scratches and incised wounds of the skin attributable to pieces of broken glass were also found on other parts of the body (e.g., the buttocks). The wounds were suspected to have been caused by the body being dragged through the glass splinters. Avital incisions on the exterior genital region provided morphological evidence for a sexually motivated background. At autopsy, the thickness of the cranial bone was found to range from 3 to 7 mm. Injuries to the skull or brain were not observed. Neck compression was determined as the cause of death. Nevertheless, marked loss of blood from the lacerations of the scalp was stated to have contributed to fatal outcome (15).

2.6. Case 6

During a domestic argument that occurred after excessive consumption of alcohol, a 35-year-old male was hit by his wife with an empty beer bottle. The bottle burst into pieces, causing a severely bleeding laceration of the man's scalp. Subsequently, the man refused to be taken to the hospital by his wife and continued arguing. At that point, his wife left their apartment. Approximately 30 minutes later, a relative found the man dead in a puddle of blood in the bathroom. At autopsy, a superficial laceration (incomplete transection of

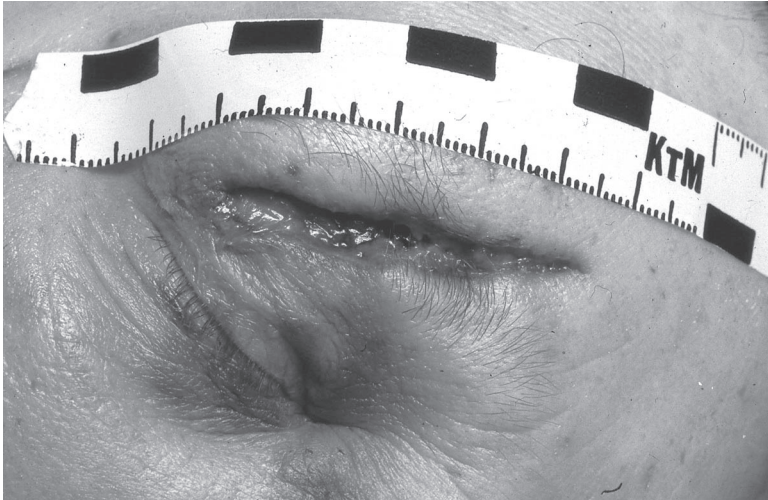


Fig. 1. Incised wound above the eyebrow after a blow to the head with a glass bottle (case 7).

the scalp) was noted, but the skull was intact. No intracranial bleedings or cerebral contusions were seen. Livor mortis was sparse and the internal organs were pale, indicating massive blood loss. Exsanguination was stated as the cause of death with the scalp laceration being the only identifiable source of hemorrhage. Postmortem blood alcohol concentration was 316 mg/dL.

2.7. Case 7

An 80-year-old woman clashed with her daughter-in-law who was placing lemonade bottles into a refrigerator. The daughter-in-law started beating the woman on the head with several bottles, breaking all the bottles. The victim suffered numerous lacerations of the scalp and a number of small superficial incised wounds of the skin caused by glass splinters (Figs. 1, 2A,B). However, a fracture of the 1-cm-thick cranial bone could not be encountered, nor were there any intracranial hematomas or contusions of the brain. Exsanguination from the incised wounds of the scalp was determined as the cause of death. As a result of the blows, hematomas of the back of both hands, scratches and dehiscence incised wounds of the skin on both arms (Fig. 3) and legs that were caused by the broken bottlenecks were noted (15).

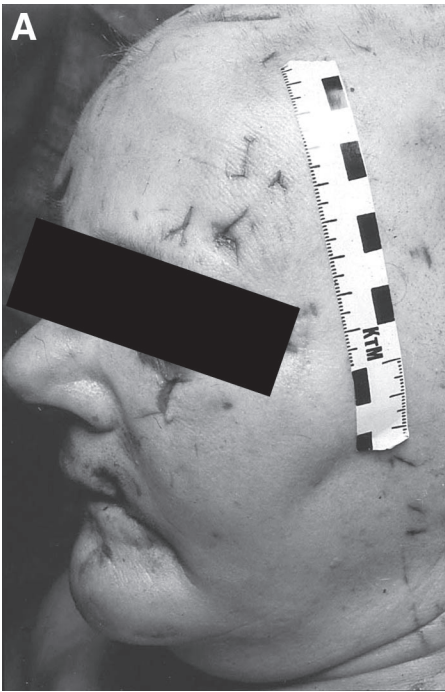


Fig. 2. (A,B) Numerous lacerations of the scalp and a number of small superficial incised wounds of the skin caused by glass splinters from blows to the head with glass bottles (case 7).

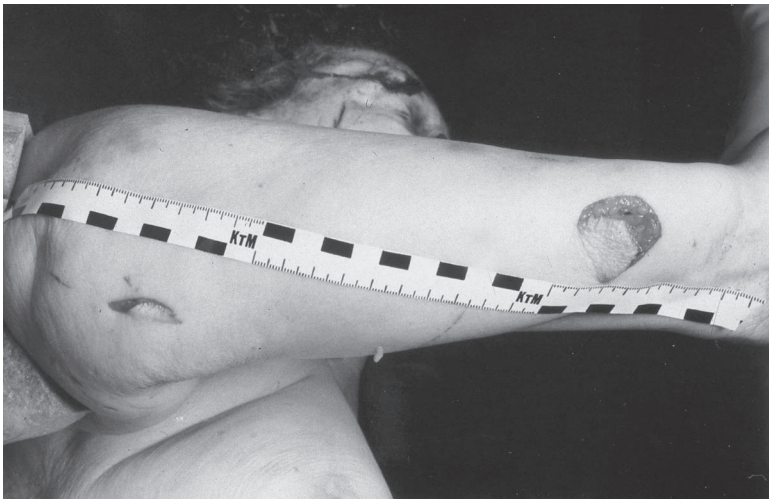


Fig. 3. Dehiscent incised wounds of the skin on both arms, caused by the broken bottle neck(s) (case 7).

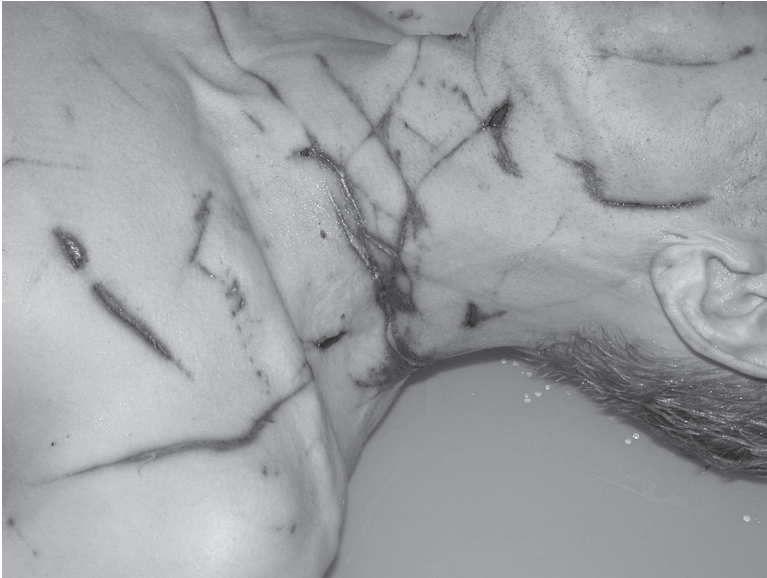


Fig. 4. Several incised wounds as well as stab wounds of the neck and thorax that were attributed to an assault by a knife and to glass splinters from the broken bottle (case 8).

2.8. Case 8

During homosexual intercourse, a 52-year-old man (the eventual victim) demanded further bizarre sexual activities from his partner, who refused. Thereupon, the man tried to hit his partner's head with a beer bottle. The partner escaped this assault and subsequently repeatedly hit the victim's head with a beer bottle. The bottle burst into pieces but the victim did not lose consciousness. During the fight that followed, the victim sustained several stab wounds. At autopsy, exsanguination caused by several stab wounds and incised wounds of the thorax and the neck (Fig. 4) was determined as cause of death. The incised wounds were attributable to assaults with a knife derived from glass splinters, too. In addition to the incised wounds that were caused by the glass splinters, lacerations of the scalp that were attributed to the blow with the beer bottle were observed (Fig. 5). These injuries comprised large-sized hematomas with several short and angled lacerations, as well as streaky impressions of the tabula externa accompanied by subarachnoidal hemorrhage.



Fig. 5. Lacerations of the scalp of the forehead resulting from blows to the head with a beer bottle. Incised wounds caused by glass splinters and hematomas with several short and angled lacerations were accompanied by streaky impressions of the tabula externa (not shown) (case 8).

2.9. Case 9

In the course of an argument between two homosexuals, the assailant repeatedly beat the 47-year-old victim's head with a beer bottle. The victim sustained several sharp-force injuries and died. At autopsy, cause of death was determined as exsanguination resulting from multiple stab wounds and incised wounds located on thorax and neck. The deceased's blood alcohol concentration was 289 mg/dL and his urine alcohol concentration was 382 mg/dL. The sharp-force injuries, as well as 13 lacerations of the skin of the face and the scalp (Figs. 6A,B, 7), two depressed fractures of the left parietal bone, a slight subdural hematoma, and cerebral contusions were attributed to repeated blows with the beer bottle.

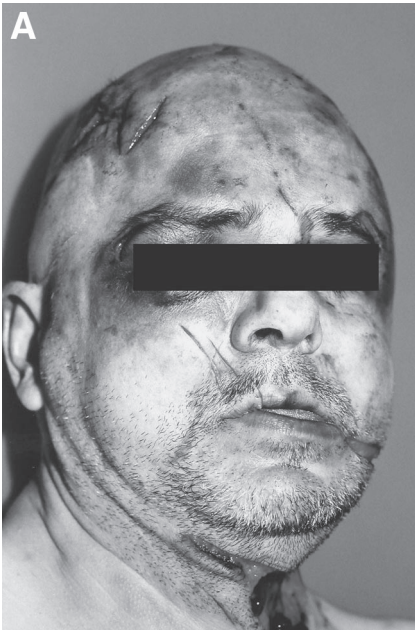


Fig. 6. (A) Injuries after repeated blows with a bottle. (B) Note large incised wound on the left side of the neck with transection of large vessels that caused fatal blood loss (case 9).

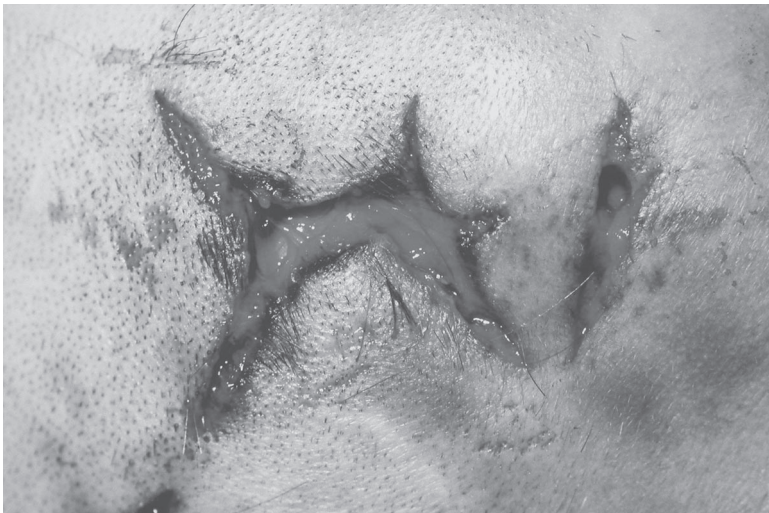


Fig. 7. Characteristic X-shaped laceration of the scalp after a blow to the head with a glass bottle (case 9).

2.10. Case 10

A 16-year-old girl was found dead in her room by her foster mother. The deceased was lying in a prone position on the floor between a sofa and a writing table. Substantial blood stains, most probably caused by being dragged, were noted on the floor in the vicinity of the body. Blood splatters and flocci of the victim were found on a baseboard. Police investigations and autopsy revealed that one assailant had inflicted the following injuries: four deep stab wounds to the victim's face, two stab wounds to her chest with penetration of the right lower lobe of the lung, one abdominal stab wound without wounding the internal organs, and multiple defense wounds of both arms. It was speculated that a second assailant had inflicted several heavy blows with a full bottle of water, which caused severe contusions on the right side of the forehead, the chin, the left midfacial area, and a spider's web fracture of the frontal bone. Assessing the contribution of the single injuries to the occurrence of death, the severity was quantified using the injury severity score (ISS [16]). According to this, the stab wounds unequivocally were the leading cause of death. In this case, the bottle remained intact and was found on a table next to the victim.

A summary of the individual case characteristics is presented in Table 1.

3. EXPERIMENTAL BIOMECHANICAL INVESTIGATIONS

Case 1 was the subject matter of an expert opinion report on request of the prosecution authorities. To provide a scientific basis, several biomechanical investigations and experiments were performed. Postmortem blow tests with three different types of bottles (sparkling wine, wine, and liquor bottles with volumes of 0.7–0.8 L) in different filling conditions were performed. Altogether, 20 bottles were held on the bottle neck and the body of the bottle was beaten on the vertex area of corpses with a medium intensity. Without any exception, all bottles broke at the time of impact. Detailed postmortem examination did not reveal any injuries of the cranial bones and no damage to the brain.

These experiments lead to the conclusion that blows to the head by wine, liquor, or sparkling wine bottles in the described way are not suitable to cause any serious injuries of the skull and/or the brain. The breaking of the bottles following impact on the skull, may apparently be explained by "inner tensions" and inhomogeneity of the bottle material (glass). The energy to break a glass bottle is in general assumed to be lower than the energy required to break a normal stable cranial bone without any pathological changes (15).

Table 1
Individual Characteristics of 10 Cases of Blow Injuries Caused by Glass Bottles

Case	Age	Gender	Type of bottle/ filling condition ^a	Bottle broken	Autopsy findings	Cause of death
Case 1	18	Male	Liquor, wine/half emptied and full	Yes	No injuries	Individual survived
Case 2	30	Male	Wine/half emptied and full	Yes	Swelling and contusion of the scalp	Individual survived
Case 3	21	Male	Wine/half emptied	Yes	Incised wounds on front of the head and midface area	Individual survived
Case 4	43	Male	Vodka, beer, glass jar	Yes	Lacerations	Neck compression
Case 5	56	Female	Liquor	Yes	Lacerations	Neck compression, exsanguination
Case 6	35	Male	Beer	Yes	One superficial laceration of the scalp	Exsanguination
Case 7	80	Female	Lemonade	Yes	Lacerations	Exsanguination
Case 8	52	Male	Beer	Yes	Large sized hematomas with several short and angled lacerations, streaky impressions of the tabula externa, subarachnoidal hemorrhage	Exsanguination
Case 9	47	Male	Beer	Yes	13 lacerations of the scalp, two depressed fractures of the left parietal bone, subdural hematoma, cerebral contusions	Exsanguination
Case 10	16	Female	Water/full	No	Severe contusions of the forehead, chin and left midfacial area, spider's web fracture of the frontal bone, subarachnoidal hemorrhage	Exsanguination

^a Only given if data were available.

4. DISCUSSION

In synopsis, the cases presented here have considerable similarities. In all cases, the head was the main target of the assault. In one case (case 4), the offenders probably had planned both where to place the blow (occipital area) and with how much intensity the blow needed to be applied to assure that the victim was incapable to act. Moreover, combinations of lacerations and incised wounds were encountered in most of the cases. Interestingly, lacerations were of more severity than incised wounds. The latter were, as a rule, only superficial. Thus, the incised wounds observed in the cases discussed here can be thoroughly considered as coincidental sequelae of glass splinters. However, no injuries were observed in only one case (case 1), in which the victim had been covered with a blanket by the perpetrators prior to the assault. The total absence of injuries might be attributable to the fact that the covering of the head with the blanket absorbed the energy of the blow impact and thus protected the victim's head from sustaining any injuries.

Regarding the observed breaking of the bottles in all cases except for one, it must be noted that the differences in shape, weight, and filling conditions of the bottles did obviously not account for any differences of the resulting injuries and the breaking behavior of the bottles, respectively. Interestingly, as far as it can be concluded from our experiments, the filling level of glass bottles does not seem to have any impact on either the severity of the resulting injuries or the bottle's breaking behavior.

Despite different thickness of cranial bones, it is interesting that the elasticity of the affected cranial bones is obviously sufficient enough to absorb the energy of the blow impact. Strikingly, even in the cases where fatal outcome was in some way attributable to the blow with the glass bottle, the actual cause of death was not in any circumstances related to mechanical damage of bone or brain (e.g., comminuted skull fractures or severe cerebral contusions). Interestingly, lacerations were ascertained to be of more major severity than incised wounds that were, as a rule, only superficial. Here, rather exsanguination from the inflicted lacerations was found to be responsible for fatal outcome.

It should be mentioned that, in contrast to the findings just presented, Zimmer et al. reported on 11 fatalities presenting with severe injuries that were attributed to blows with glass bottles (17). In seven cases, these authors observed injuries of the skull that turned out to be solely caused by blows with glass bottles, and resulted in fatal outcome. The authors speculated that fractures of the skull might be expected if the bottles do not break and transfer the complete energy of the blow to the skull. However, the authors did not pro-

vide further detailed data to confirm this hypothesis based on the findings in their case material.

Furthermore, Weyrich reported on a fatal terraced depressed fracture of the skull caused by a blow with a glass beer mug (18).

As a result of the small number of cases presented, general conclusions regarding skull injuries caused by blows with glass bottles should be drawn with considerable caution. Nevertheless, the observed pathological and biomechanical features allow the following considerations. Despite different shapes and filling conditions of the bottles, the morphological appearance of the injuries resulting from blows with different bottles resembles each other very much. Concerning the probability of an occurrence of skull fractures in cases of blows with glass bottles it should be emphasized that skull fractures were observed only in 2 of the 10 cases presented here. Under experimental conditions, no skull fractures could be produced in 20 postmortem experiments with corpses. Taken together, in an overall number of 30 cases (authentic cases plus experimental setting), skull fractures were only present in 2 cases. Therefore, skull fractures resulting from blows to the head with glass bottles can be considered rare events. Factors influencing the probability that a fracture occurs are depending on the bottle used, characteristics of the victim's head, and, finally, variable constellations determined by the individual mode of assault.

Regarding biomechanically relevant factors that are determined by the bottle itself, the minor elasticity of glass, as compared to bone, the filling condition, and the location of impact have to be considered as important. One is tempted to speculate whether the observed absence of pond fractures is attributable to the fact that the bottle's belly and not the edge of the bottles bottom hit the head in the cases presented here.

Additional factors related to the victim's head, such as the quantity of hair, thickness of the scalp, configuration and thickness of the skull, and elasticity of bone have to be taken into account, too. Finally, one case reported by Prokop and Radam (13) seems to indicate that age seems to be another very important factor that must be considered as well. These authors describe an extensive system of bending fractures of the left parietal bone extending to the left temporal bone in a 73-year-old alcoholic who was killed by a blow with a wine bottle.

The final outcome and sequelae of a blow to the head with a glass bottle also depend on constellational factors determined by the mode of commitment like covering of the head (case 1) or the mobility of the cervical spine and head, respectively, at the moment of impact (case 10). Rare cases in which

depressed fractures of the skull following a blow with a glass bottle can be observed are in particular those in which the victim was lying on the ground with the head fixed when being hit by the bottle.

Considering the high frequency of assaults against the head using glass bottles, it would be most helpful for forensic practical casework to gain more detailed and sophisticated knowledge on the subject (e.g., about biomechanical principles of skull injuries caused by blows with glass bottles). Such data are already partially available regarding drinking glasses (19). However, the case reports presented here, complemented by the given experimental biomechanical data, will contribute to the understanding and assessment of analogous cases in practical forensic casework.

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