Case Report

Unusual Fatal Bitemporal Crushing Head injury By Industrial Baler Machine

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Abstract

A peculiar case of crushing head injury is presented, which was caused by compression of the head by a machine known as "Industrial Baler", which is used for compressing and packing scrap. Most cases of head injury are caused by "acceleration-deceleration" or "direct impact" forces, and crushing head injuries are relatively fewer in frequency of occurrence. Also, amongst the cases of crushing head injury, most cases involve both dynamic and static forces acting on the head. This case is peculiar in the sense that only "pure-static" forces were involved. The pattern of scalp and vault injuries also was unusual as although caused by compression by a blunt flat object having a large surface area, the appearance was that of injuries caused by impact by a heavy, cutting (chopping) edged object. In jobs that require working with any sort of industrial machinery, there is a potential risk of injuries or death of workers handling them in the event of an accident so workers need to ensure that they operate the machine in only the correct manner and do not bring their bodies in close proximity to heavy machinery,

Key Words: Bitemporal compression; Crushing head injury; Baler machine

Introduction:

A baler is a machine which compresses various waste materials and shapes them into bundles called "bales". Balers may be vertical balers or horizontal balers. A vertical baler has a broad surface area flat metal block called as "platen" that moves up and down and compresses the scrap material. After the material has been compressed by the machine and is ready, the worker ties it with straps or wires in order to keep it in place after ejecting it from the machine. Lack of adequate care and safety precautions while handling such industrial machinery can result in fatal injuries.

In this case, apparently, an improper method of operating a vertical baler machine resulted in fatal compression of the head and spot death of the victim.

Case History:

The victim was a worker in a small scale unit dealing with pressing of scrap in baling press machines and packaging it for recycling.

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There were no eyewitnesses who actually observed how the victim actually got trapped within the machine and had his head crushed. However, another person who worked as a driver of a rickshaw transporting material to and from the packaging unit gave testimony that when he reached the site, he observed that the press-machine was "on" and "in motion", and that the victim's head had got crushed.

His hand was seen caught in the machine; and there was nobody else in the unit at that time and as such the victim had been alone at the time the incident happened. It was also observed that the victim had not been wearing any safety headgear in the form of a helmet. From the position of the body as seen in the photograph, the following sequence of events is reconstructed by the authors.

The right upper limb of the victim got trapped in between the platen (the horizontal slab of metal that moves up and down and causes compression of the scrap material) and the body of the baler machine; and as he was unable to free his upper limb, his head was compressed in between the platen and the bale of scrap that was placed within the baler machine. The bale of scrap had been compressed and was tied with cords and ready for ejection from the machine.

At this time, the victim would have opened the front door of the baler machine to make way for the bale to be ejected from the

machine, and would have proceeded to the back side of the machine. At this time, the platen would have been in the "down" position, over the top of the bale, and would have had to be lifted up in order to eject the bale.

For this purpose, the victim would have leaned from the back side of the machine over the top of the platen onto the front side, in such a way that his body was within the baler machine; and he would have put on the switch which was located on the front side of the machine, with the intention of pushing the bale out from the back to the front side, when the platen would move up.

At this time, the platen would have begun to move upwards, but the sleeve of the victim would have got caught in between the platen and the back of the body of the baler machine. Even as the platen would have continued to move upwards, the victim would have tried to free his shirt, but his upper limb would have got trapped and as a result, he would have been further unable to free himself.

As the switch of the machine would continue to be "on", the platen would have competed its upward motion and then started to move downwards, during which time, the head of the victim would have got compressed in between the platen and the un-ejected bale, resulting in instant death, as the injuries were necessary fatal in nature and grossly incompatible with life.

Autopsy Findings:

The platen compressed the head in the transverse plane, resulting in circumferential laceration of the scalp in the transverse plane along the "hat-line" and separation of the entire skull vault as one unit, with scalp hair remaining intact on the detached skull cap. The edges of the skull bones along the line of separation (i.e. along the "hat-line") showed relatively clean splitting of both tables, exposing the diploe.

The inner aspect of the separated skull cap showed separation (diastasis) of the frontal bone from the two parietal bones and side to side compression of the parietal bones, as evidenced by buckling inward of the lateral parts of the parietal bones, with multiple linear fractures running in the antero posterior direction along the line of bend. However, the sagittal suture did not show any diastasis.

The exposed base of the skull showed transverse lines of fractures running across the base of the anterior and middle cranial fossae, from temporal to temporal direction, again indicating a side to side compression of the head. Remnants of crushed brain matter along with torn and crushed dura were visible within the exposed base of the skull.

Some of the brain matter was pulped and extruded out at the scene of accident, and was visible over the top of the bale in the baler machine, along with copious blood staining the bale and some of it was produced separately by the police in a plastic bag.

The right upper limb showed an extensive pressure abrasion suggestive of compressive force, over the entire length of the right arm over its entire circumference. The right axilla showed an extensive open contused laceration involving the proximal antero medial aspect of the right arm, the anterior aspect of the right deltoid area of the shoulder, the entire axilla and infra axillary area.

There was exposure of the underlying muscles namely the anterior part of the deltoid muscle, the lateral most part of the right pectoralis major muscle, the right biceps brachii, lateral part of the right latissimus dorsii, and upper part of the right serratus anterior muscles.

The exposed muscles showed bruising; and the skin surrounding the open laceration showed extensive contusions. The injury over the upper limb was consistent with the fact that the limb was trapped in the machine between the moving platen and the rear side of the body of the machine, resulting in compression of the arm between the platen and the body of the machine and also overstretching and tearing of the axilla owing to motion of the platen.

Discussion:

Most cranio-cerebral injuries are caused by mechanisms of acceleration and/or deceleration. Traumatic injuries following progressive compression to the head are certainly unusual. [1, 7] A crush injury occurs when a body part is subjected a degree of sustained force or pressure, usually after being trapped between two heavy objects or hard surfaces. [1] Crush injuries are produced by static or quasi-static applied forces, which are defined as those that occur over a longer period of time (>200 ms) and are applied over a large area (as opposed to a point).

These static forces squeeze or slowly deform an object, like the cranium, until it is crushed beneath the load. [2] Multiple fractures through the cranial base are the most commonly described pattern in adult crush injuries. The fractures associated with crush injuries occur both at the site of contact of the crushing object and remotely, because the force is transmitted throughout the cranial base. [2] With an extensive striking surface, the skull bone tends

to break into irregular fragments. If the skull is supported when a blow is struck, the tendency is always to cause greater damage. [3]

As such, a crushing force applied to the head would normally be expected to produce a generalized deformation of the skull and as such cause comminuted fracturing of the entire skull vault with the skull vault appearing as multiple fragments of bone. In addition there would be multiple fissure fractures expected to involve the sides of the skull.

Takeshi et al [4] have reported seven cases of crushing head injury out of which one patient had sustained crushing of the head by a press machine and the said patient expired after 4 days. Multiple temporal and parietal bone fractures have been observed in the said patient. [4] However, in the instant case, the unusual pattern of injury was that the skull cap was circumferentially detached from the base of the skull with no fragmentation of the bones of the skull cap into multiple pieces.

The two parietal bones showed a good degree of plasticity on being subjected to the continuous sustained compression between the platen and the bale, as demonstrated by the fact that there was buckling inwards of the lower halves of the two parietal bones with longitudinal fissure fractures of the two table along the line of bend. Unusually, although the skull cap had got compressed by the platen, the sagittal suture did not show any diastasis.

Also, though the coronal suture did show diastasis and separation of the frontal bone from the two parietal bones, there were no comminuted fractures of the frontal bone itself. No radiography of the cadaver could be carried out owing to logistic impediments.

However, there appeared to be no facial fractures as was judged from the absence of crepitation or abnormal mobility in the areas of the facial bones. The bilateral critical pressure applied to the skull produces a fracture that often runs in the same direction as the applied force. [1, 3, 8] In this case, the base of the skull showed transverse fractures across the base of the anterior and middle cranial fossae, indicative of the fact that the compression was bi-temporal in direction.

The bilateral application of static forces on the head can occur in any region, however in most cases, it often occurs in the bi-temporal region. [1] The exposed edges of the skull bone along the line of separation of the skull base from the skull vault was relatively cleanly cut with much less fragmentation of the bones unlike expected, and as such resembled an injury which would have been caused by an impact with a heavy, cutting edged object, probably akin to the blade of a guillotine if it were to strike across the head.

Crush injuries are usually described in the context of industrial accidents. However, various other case reports have described compressive head injuries in various other scenarios. Crush injuries in natural disasters, such as earthquakes, have been described, but these situations are uncommon in clinical practice. More often in neurosurgical practice, static or quasi-static loading injuries occur in children when the patient's head is crushed beneath a moving vehicle or when a heavy object has been pulled down accidentally and has pinned the child's head. [2]

Purely static force, as was generated by Russell and Schiller in their experimental study, is rarely seen clinically, as the victims either fall a few feet to the ground before being run over by a vehicle or being hit by a falling object. [5] As such, in the majority of patients seen in clinical practice, injuries are biomechanically mixed, including a dynamic component and a static component. [2, 5] However, even in those compression injuries which have both static and dynamic forces involved, the static loading is considered to be a greater factor in causing injuries, than the dynamic force.

For example, when a person is knocked to the ground by a falling object the crushing weight of the object is considered to be a greater factor in the injury than the dynamic force involved in falling to the ground. The short distance of the falls is not likely to have been of sufficient force to generate severe injuries, in cases where the victims fall from a standing or squatting position rather than from a height. [5]

However, in the instant case, “purely static” forces were involved and there was no involvement of any dynamic component.

Echizenya et al [6] have reported two cases of bi-temporal compression head injury caused by static loading mechanism in which low velocity, low acceleration, high energy forces were involved as in the present case. In one case, the head of a coal miner was trapped in between an excavator and a prop due to a “cave-in” in a coal mine, resulting in gradual compression of both temporal regions. In the other case, the head of a lumber mill worker was caught between a log and an operating machine. Both cases were non-fatal. [6]

Tortosa et al [7] also have reviewed clinical and radiological features in a series of patients who had sustained a special type of cranial crush injury produced by the bilateral application of rather static forces to the temporal

region. They reported a case of a 10 year old boy whose head got trapped in a packing machine but was not fatal and the victim did not lose consciousness.

Other cases described by them include case of head being trapped in packing machine, head crushed by automatic door, head rolled over by sewer pipe, head trapped between two marble blocks, head run over by automobile wheel, head crushed by wooden beam, head trapped under wooden post, head trapped between pallet truck & wall. [7]

Russell and Schiller [8] have carried out clinical and experimental observations on crushing injuries to the skull in which, bi-temporal compression of the head was experimentally shown to produce a bilateral narrowing and antero-posterior elongation of the skull. This has not been observed in the instant case.

Clinical cases described by them included case of head being caught between hutches, head crushed by fall of rock in mine, head crushed between railway carriages, head crushed between backing lorry and wall, head crushed between two motor vehicles, head crushed under the axle of a motor vehicle, head crushed under an overturned lorry, head crushed under oil drums, head crushed under several 100-lb. Shells and head crushed under gun-wheel. In these cases, transverse fracture of the base of the skull was observed, running in the direction of the compression.

With sufficient pressure the base of the skull was actually broken in two, the parts articulating on a transverse hinge. [8] Such transverse fracturing of the base of the skull has been observed in the instant case too, as mentioned above, though “hinge-like” movement was not observed.

Conclusions:

In jobs that require working with any sort of industrial machinery, there is a potential risk of injuries or death of workers handling them in the event of an accident. Hence, it is necessary to ensure that more than one person should operate the machine at any given time. Also, it is necessary to ensure that workers are provided with safety gear including helmets to minimize the risk of injuries.

Most importantly, workers need to ensure that they operate the machine in only the correct manner and do not bring their bodies in close proximity to heavy machinery, as in such cases, presence or absence of safety equipment and headgear would be of little use in preventing injuries and death, in cases where the bodies or parts of bodies get entrapped within heavy machinery.

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Fig. 2: Extensive Open Contused Laceration of the Right Axilla

Fig. 3: Exposed Base of Skull and Separated Skull Vault Along With Extruded Brain Remnants

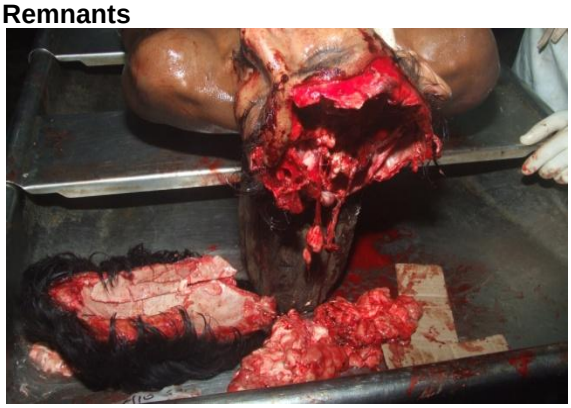

Fig. 4: Separated Skull Cap

Fig. 5: Scene of Accident Showing the Body trapped in Situ in Baler Machine

Fig. 6: Scene of Accident Showing the Body trapped in Situ in Baler Machine

Fig. 1: Victim's body with an Overview of the Head Injury