"A TWO YEAR STUDY OF CRANIO-CEREBRAL INJURIES BY MECHANICAL VIOLENCE, WITH SPECIAL REFERENCE TO TRAFFIC ACCIDENTS IN AND AROUND MADURAI CITY (JANUARY 2004 – DECEMBER 2005)"

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CERTIFICATE

This is to certify that this dissertation entitled **"A TWO YEAR STUDY OF CRANIO-CEREBRAL INJURIES BY MECHANICAL VIOLENCE, WITH SPECIAL REFERENCE TO TRAFFIC ACCIDENTS IN AND AROUND MADURAI CITY (JANUARY 2004 –DECEMBER 2005)"** has been prepared by **Dr. M. SREENIVASAN** under my overall supervision, in partial fulfilment of the regulations for the award of Degree of **DOCTOR OF MEDICINE** in **FORENSIC MEDICINE** of TamilNadu Dr. M.G.R. Medical University, Chennai.

I certify regarding the authenticity of the work done to prepare this dissertation.

Date:

Place: Madurai

Dr. K. MEIYAZHAGAN

DECLARATION

I hereby declare that this dissertation entitled **"A TWO YEAR STUDY OF CRANIO-CEREBRAL INJURIES BY MECHANICAL VIOLENCE, WITH SPECIAL REFERENCE TO TRAFFIC ACCIDENTS IN AND AROUND MADURAI CITY (JANUARY 2004 – DECEMBER 2005)"** has been prepared by me under the overall guidance and supervision of **Dr. K. MEIYAZHAGAN M.D.,** Professor and H.O.D. in partial fulfilment of the regulations for the award of Degree of **DOCTOR OF MEDICINE** in **FORENSIC MEDICINE** of TamilNadu Dr. M.G.R. Medical University, Chennai.

I further declare that I have not submitted this dissertation previously for the award of any degree or diploma to any other University.

Date:

Place: Madurai **DR. M. SREENIVASAN**

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Date:

Place: Madurai

CONTENTS

INTRODUCTION

To-morrow, and to-morrow, and to-morrow,

Creeps in this petty pace from day to-day,

To the last syllable of the recorded time.

Shakespeare, Macbeth V, 5.

See one promontory, one mountain, one sea,

One river, and see all.

Socrates, Burton, “Anatomy of Melancholy”.

Cranio-cerebral injuries has assumed paramount importance in recent times due to mechanization and industrialization. These injuries have shown an alarming rise in the recent times owing to fast modernization as a result of adaptation of man to machine and motor. Despite supreme measures in the form of sophisticated protective gadgets usage, tremendous advances in public education, the subject continues to be a major cause of mortality and morbidity. Head injury occur every 15 seconds and patient dies from head injury every 12 minutes in a day and, these injuries and account for a significant portion of health care costs today. Head is the most prominent of the exposed parts of the body by virtue of its position and is very vulnerable to trauma.

The mechanism, diagnosis and the management of head injury poses a definite challenge to the medical profession. Improvement in the economic standard of the people has resulted in substance and alcohol abuse, which has only complicated the subject, not only for the doctors, but also for the law enforcing agencies. The high incidences of morbidity and mortality due to head injuries obviates one to understand the underlying mechanisms, physiological changes, rationale of management and the sequelae of such injuries. Its importance lies not only in the physician's point of view, but also in their medico-legal implications like that of survival time, acts of volition, reconstruction of the events, the liability and compensation settlements.

Inspite of the tremendous advance made it is still not possible to evaluate all the lesions encountered. A trivial injury, apparently a normal presentation may unravel as a severe injury on the autopsy table. To quote, "no injury to the head is too trivial or severe to be despaired of". Head hosting the vital structures is an enigma, aptly stated by Goldsmith in "The Deserted Village", as

And still they gaz'd, and still the wonder grew

That one small head could carry all it knew.

This study is a sincere attempt to dissect and deduce, in a step-wise approach, the possible causes and mechanisms of the trauma to the head.

AIMS AND OBJECTIVES

1. To analyze and study the post-mortem features of head injuries cases.
2. To study the mode of trauma and the type of agent causing trauma.
3. To study the incidence of age and sex of victims involved in accidents.
4. To analyze the relationship of seasonal variations and road traffic accidents with respect to time, day and quarter of the year.
5. To study the pattern of scalp and skull injuries.
6. To study the types of different intracranial haemorrhages.
7. To study the gross features of brain damage.
8. To analyze the association of head injuries and other bodily injuries contributing towards the cause of death.
9. To analyze the cause of death.
10. To analyze the survival time and modes of intervention, if possible.
11. To deduce any preventive and safety measures if possible.

REVIEW OF LITERATURE

HISTORICAL REVIEW

The physical violence on the head and its aftermath along with the mechanism of injury dates back to Neolithic period. The New York Historical Society Library keeps the records of Cranio-Cerebral Injury in the Papyrus of Egypt (2500 BC).

Effort trace the remotest evidence of these head injuries has the investigators stumble upon the three glaring incidents in the Bible itself.

The death of Siseta by the hand of Jad.

The skull fractures of Avimelech at tower of Tevetz.

The staying of Goliath by David.

These only provide a fascinating evidence and keen interest to study the head and its sustaining of injuries in greater depth and detail. Then started the various attempts to understand the mechanisms of these head injuries using philology, knowledge of art of Biblical warfare. Questions oriented towards the site of mortal blow to Sisera's head; the conspiracy behind Avimelech's killing; and whether the gaint form Gath was a rugged warrior or just an endocrinological cripple, arouse and led to differing hypothesis.

Such interesting mind and willingness to explore the much surprisingly cryptic and scientific wonder-organ, has paved way to heap and volumes of literature on head injuries.

The advancing knowledge of various forms of cranio-cerebral injuries has accumulated gradually ever since the first mention of it made by Edwin Smith Papyrus about 1600BC. The cranio-cerebral injuries were probably first scientifically studies by Hippocrates who chronicled his experience by the aid of Physiology and Anatomy of Skull and Brain and based on his clinical the 'the dead' observations. Celsus in 30 AD and Galen in 131-2021 AD described the acute symptoms of cranio-cerebral injuries.

The chapter on symptoms of cranial fractures and the briefings of pathology of concussion by Hanfranchi of Milan in 1326 AD is quite a prodigy.

Benergario de Capri in1518 AD probably first noted the petechiae in concussion and postulated the mechanism of concussion.

Jensen 1590 AD first studied the microscopic features of brain injury.

In 1681, Wepfer recognized chronic subdural haemorrhage and La Peyronie reported the first case of subdural abscess following head injury.

In 1705, Littre emphasized Peter Paw's findings and said fatal concussion would occur even without significant traumatic brain lesions.

In 1811, John Abernethy described extra-haemorrhage and acute subdural haemorrhage.

In 1831, Richard Bright observed punctate haemorrhages in brain in case of acute head injury.

In 1841, Duputyren postulated the triad of 3C's 'Concussion' Confusion and Compression.

In 1870, Fischer retold the same hypothesis with a term 'continued vasoparalysis' consequent to head injury.

In 1877, Hudwing rewrote the concussion theories with an inclination towards 'Neurogenic causation'.

In 1938, Courville CB opined that the vasomotor effects were secondary and did not account for the immediate effects of concussion and its direct effect of shock on vital centers.

Harvey in collaboration with Jefferson and Gilbert segregated Head injuries.

In 1943, the Oxford physicist Holbourn studied the mechanics of cranio-cerebral injuries, and Wilson 1946 acknowledges the same and deems the theory fit for pathology of brain lesions in cranio-cerebral injuries.

REVIEW OF RECENT LITERATURE

MKR Krishnan noticed a total of 25 cases of head injury (16.7%) out of 149 autopsies conducted in Kakatiya Medical College, Warangal, A.P. in 1996. He also noticed that contre coup injuries does not result in the occipital region from an impact in the frontal region as the reflections of dura and its attachments restricted the movements of the brain along the direction of impact. He stated that the converse of this situation would occur[23].

K. Ganapathy observed that throughout the world, India was the leading country exemplifying the number of deaths due to accidents (18 out of 100), followed by Bulgaria (16 out of 100) and by Pakistan (12 out of 100). The last in the list was Hong Kong (2 out of 100). Based on the Central Road Research Institute data, he stated that:

- 70% of road traffic accidents were due to negligence and ignorance of drivers out of whom 90% did not have any formal driving lessons, ignorant or road rules and some were having hearing and vision defects.
- About 1% of GDP/year (≈ Rs.2500 crore/year) was lost due to accidents.
- The probability of mortality was 5 times greater for a two wheeler driver than other vehicular drivers.
- The accidents rates/Km is higher than any other categories for two wheeler drivers.
- Buses and trucks (8% of all vehicles) were responsible for 43% of all reported accidents.

Based on the sources of Ministry of Transport of India, he showed that majority of deaths due to road traffic accidents involved pedestrians (25%), followed by tempo (17%) and two-wheeler (11%) and car (11%) occupants.

VC Vasantha studied 220 cases of head injuries out of 1397 deaths at Guntur Medical College, during the period of 1958 to 1967 and made distinctions between concussion, cerebral contusion and laceration. She observed 178 cases of fractures of vault, 35 cases of fractures of base skull and 37 cases of crush injuries of head. 74 cases showed laceration and contusion of brain. She concluded that linear fractures produced, shallow ribbon-like brain injury with blood clots filling the defects. Comminuted fractures showed ovoid or irregular lacerations. Frontal bone fractures were associated with lacerations of undersurface of frontal lobes and occipital fractures showed laceration of interior and posterior surface of cerebellum[51].

GR Bhaskar and R Chandulal studied 539 autopsies during the period from January 1965 to December 1966. Out of which road traffic accident deaths were 117 (21.7%). Out of these 117 cases, 26(24.1%) were due to run over. Out of these 26 cases, 12 cases were run over the head, 5 over the back, 4 over head and chest, and 2 over the extremities. He said ‘burst fractures’ of the skull was produced due to compression of head by tangential impact of the wheel on the head. Of all the injuries, fracture of skull with laceration of brain (58.8%) was the commonest, injuries to the ribs (46.1%), liver (38.3%), lungs (34.6%), and spleen (26.9%)[5].

R. Chandulal (1971) analyzed fatal road traffic accidents with respect to other cases, from 1963 to 1967 and noticed an increase of incidence of road traffic accidents from 38 to 81. Males dominated females (77% as compared to 29%), and the peak incidence was seen in 20-29 years age group of males and 1-9 year age group of females. The lowest incidence was among 70-79 years age group in males and females. Pedestrians (64%) topped the list of victims followed by cyclists (24%), vehicular occupants (9.8%), autos (9%) and cart deaths (1.8%). Lorries (48%) formed the majority, trailed by cycle (24%), cars (17%), buses (13%), 2 wheelers (9%), carts (4%) and autos (0.9%). Head injuries (60%) accounted for the major cause of death among these victims, as compared to deaths by other bodily injury[5].

Susan PB investigated 328 driver fatalities in high way crashes. From sources of National Safety Council, she estimated that drivers of 20-24 years are the most likely to be involved in fatal crashed and those of 50-54 years the least likely. She said that the neuropathological principles in the fatal craniocerebral injuries are:

1. Cerebro cortical contusions occur at a point opposite to point of cranial collision by impact of a moving head against firm unyielding surface.
2. Contusions beneath the point of impact are coup contusions.

3. A moving head may not sustain any contusions beneath the point of impact, or a resting head may not show contusions either, at the point opposite to impact.
4. Displacement of skull fracture margins may cause contusions regardless the resting or moving status of brain.
5. Falls cause compressing impact over head and show extensive lacerations but few contusions.

Lalwani Sanjeev et al studied fall from height and found that males (80.5%) were more to suffer fall commonly in the common age group of 21-40 years (47%). Most falls were accidental and occurred at residence due to lack of safety measures. The common cause of death was coma due to head injury (64.4%), with injury to scalp, fracture of left parietal bone and middle cranial fossa. Diffuse subdural haemorrhage was the commonest brain injury. Occiput was the most common site of impact. A large group belonged to Hindus. And in the age group, 21-30 years accounted for 27.58%, 31-40 years for 19.5%, children till 10 years and adults above 50 years accounted for 16.09%. In 19.6% only skull and brain were involved. Exterior scalp injuries were seen on both sides in almost equal number of cases and the extravasation was diffuse. Isolated right side extravasation was seen in 21 cases and on left side in 19 cases. Left parietal bone was commonest to fracture (in 22 cases), and biparietal in 19 cases, occipital in 15 cases, and frontal in 14 cases. Middle cranial fossa was more common to fracture followed by posterior cranial fossa. Subdural haemorrhage was found in 49 cases, subarachnoid haemorrhage in 34 cases. Laceration and contusion was seen only in 16% cases[24].

Shih Tseng Lea et al studied features of head injury in a developing country – Taiwan and observed that, the most common causes of injury were motor cycle accidents (56.3%) and pedestrian accidents (29.47%). The commonly affected age groups were 16-20 years, 21-25 years and 25-30 years. The overall mortality was 17.26%. In a country of population of 20 million and 19 million living in a major cities, the motor cycle was the common mode of transportation with 2 million automobiles registered in 1987. The lowest incidence of head injury was at 4 AM. It increased through the day continuing to rise with highest at 8 PM and gradually decreasing with a sharp fall at midnight. The peak occurrence was at the end of the weak and during the month of October. In general the occurrence was higher in latter half of the year.

WH Rutherford felt the need to approach of forensic textbooks to answer many of the medicolegal questions arising out of the head injury and alcohol consumption cases, for drunkenness diagnosis and differentiating it from concussion and contusion. He said that coma should not be attributed for cause of death when blood alcohol was >300 mg/dL, nor concussion and contusion when the blood alcohol was >200 mg/dL. He emphasized the calculation of amount of alcohol based on blood alcohol fall of 15 mg/dL/hr, to diagnose coma or contusion[53].

Julian and Henry suggested a substantial increase in the proportion of road traffic accidents attributed to drinking problem. They studied the drinking behaviour pattern in drivers and social drinkers and made these observations. Pedestrian accidents consisted of <15 years and >65 years victims commonly, 62% out of theses were males 90% of the road traffic accident victims involved drivers. Alcohol was found in 78% of fatalities of 15-24 years and in 16% of >65% years age group. Over a third of both age groups had <150mg% and 86% had <200mg%. Younger drinking drivers posed more of a problem[21].

Rufus Crompton studied alcoholism and fatal road traffic accidents analyzing 208 cases. Specimens of blood and urine was analyzed by gas chromatography in carbo wax 1500 on carbopak C80/100 column, using propanol as internal standard. 141 cases were males and 67 were females among 208 cases. 88 of these showed positive blood alcohol and 120 negative level. Young males under 30 years predominated with peak age of 19 years. Fatal accidents occurred before the alcohol in blood and urine had reached equilibrium. Middle aged male pedestrians had the highest alcohol levels[38].

ANATOMY OF THE SKULL AND BRAIN

The Skull

The bony vault of the cranium, the calvaria, consists of 22 bones, 21 of which are firmly bound together, mostly through sutures while one, the mandible is movable and articulates with the remainder of the skull through paired synovial joints.

Hardness and Elasticity

The skull is not a rigid box and it retains considerable elasticity throughout life. Blows can deform it, yet return to original shape explaining the injuries to the brain without fracture of the skull.

In childhood the elasticity of the skull is great, the bones themselves being relatively soft and resilient. The skull can therefore become indented (pin-pong ball fracture) and can sometimes expand again.

Structure of skull

The skull is composed of an outer and an inner table with an intermediate vascular diploe. To the outer table the pericranium is adherent at the suture lines, while to the inner table the dura is closely applied but not adherent except over the base. The inner table is thinner and more brittle than the outer and may be fractured by blows which leave the outer table intact.

Thickness of skull

The bony vault of the skull is relatively thick measuring about 5mm. The thickness of the skull varies considerably with the individual and in addition shows variations due to age, sex, race and disease. The whole skull is relatively thinner in childhood and old age than in adult life.

The thinnest parts of the skull are the squamous temporal, the orbital plates and that part of the occipital bone overlying each cerebellar hemisphere. The skull is also thinned over the sinuses and grooves for the meningeal vessels. The thickest parts are the external occipital protruberance and the mastoid process.

The interest of the skull lies less in the cranium itself than in its contents and in the structures passing through the foramina. The skull is a spheroid structure containing semi-liquid contents including brain, blood and C.S.F. Gurdjian et al points out that this closed cavity feature of the head is a major consideration. The cavity of the head is solidly supported by bones. The cranial dura is intimately attached to the inner layer of the bone. At the cranio spinal junction, however the cranial contents which is encased in a canal where dura and bone are not as intimately opposed as in the skull cavity. For this reason large deformations can occur which tend to prevent the pressure built up in the spinal canal. However, a sudden increase in the intracranial pressure results in pressure gradients through the region of the brain stem and cerebellum in the direction of foramen magnum. This pressure gradient produces shear strains throughout the region in which it acts, the magnitude of the shear strains being proportional to both the magnitude of the pressure gradient and its time duration.

The Brain

The brain constitutes about 1/50th of the body weight and lies within the cranial cavity.

The membranes of the Brain

The dura mater, the most external dense fibrous membrane closely attached to the bones of the skull, and continuous with the dura mater of the spinal cord through the foramen magnum. The fibrous part of the dura mater is divided into two layers, which in certain situations forms the sinuses. The processes of dura mater include, the falx cerebri, and the tentorium cerebelli.

The arachnoid mater is a thin membrane lying in contact with the dura and outside the pia mater.

The pia mater consists of a fibrous membrane supporting blood vessels and closely investing the brain dipping into the sulci. At the transverse fissure it is prolonged into the lateral ventricles and over the 3rd ventricle pushing the ependymal lining of these cavities in front of it and forming the tela choroidea carrying the choroid plexus of the lateral and 3rd ventricle. It is prolonged over the roof of the 4th ventricle, sending inwards two vascular fringes, the choroid plexus of that cavity.

The extradural space – lies between the spinal dura mater and the periosteum and ligaments lining the vertebral canal, contains loose fat, areolar tissue and a plexus of veins.

The subdural space – is a potential space between the dura mater and the arachnoid mater, containing a film of tissue fluid which does not communicate with the subarachnoid space.

The subarachnoid space is the space between the arachnoid and the pia mater, is larger in some places than in others and communicates with the cerebral ventricles by the median aperture of 4th ventricle.

Circle of Willis

The brain is chiefly supplied by internal carotid and vertebral artery branches. After piercing the dura, the internal carotid artery gives, ophthalmic, anterior cerebral and middle cerebral arteries, posterior communicating artery and the anterior choroidal artery.

'**Anterior cerebral arteries'** from the internal carotid arteries runs forwards and medially crossing the optic nerve to reach the longitudinal fissures separating the two cerebral hemispheres. The arteries are united by anterior communicating artery, and turns sharply to reach genu of corpus callosum.

The **'middle cerebral artery'** runs laterally from the ICA into the depth of lateral sulcus. The main stem of the artery can be seen by separating the lips of sulcus.

'Posterior communicating artery' runs backwards and anastomoses with posterior cerebral artery.

Right and left vertebral arteries unite at the lower border of pons to form the basilar artery, ascending in the median sulcus over the pons and divides into right and left posterior cerebral arteries.

The structures forming the brain are:

1. The Cerebrum
2. The mid brain
3. The Pons
4. The medulla Oblongata
5. The Cerebellum

Within the cerebrum the gyri are connected by masses of nerve fibres which make up the white matter of the brain, viz. 1) The association tracts 2) The Commissural tracts 3) The Projection tracts .

Important masses of grey matter include 1) The basal ganglia, 2) The thalami, 3) The hypothalami.

Cerebral injuries

The mechanism of the brain and its constituent injury has already been dealt with a citation of pioneers and their conflicting and arguable theories. The types of cerebral injuries would be:

1. Concussions with diffuse neuronal and axonal injury.
2. Contusions.
3. Lacerations and
4. Intracerebral haemorrhages.

Concussion

Definition

By Trotter: "a condition of widespread paralysis of the function of the brain which comes on as an immediate consequence of a blow on the head, has strong tendency to spontaneous recovery and is not necessarily associated with any gross organic change in the brain substance". The stress is on the reversibility of the process. Large amounts of acetylcholine have been demonstrated in the C.S.F. in animals after experimental concussion and after head injury in man. The definition implies the process as reversible but it cannot occur without damage to nerve cells which in milder cases is reversible but in severe cases permanent. Microscopically there is a disintegration of the tigroid material and alterations in the nucleus of the nerve cells. Clinically, there is disordered vaso-motor system the typical symptom complex recorded in the EEG and also in the C.S.F.

Mechanics of cerebral concussions

Studies of Denny Brown and Russell conclude that injuries to the moving or freely movable head resulted in concussion (acceleration concussion) much more easily than when force was applied to the fixed head (compression concussion) and this was attributed to the brain itself and was allied to the physical effects of the injury in the form of contusion. Cerebral concussion is commonly encountered as the result of traffic accidents and of injuries to the head sustained in industry.

Cerebral contusion

Is a focal or diffuse disturbance in the brain following head injury and characterised by Oedema and Capillary haemorrhage and chromatolysis of the cortical nerve cells. Multiple intracerebral haemorrhages are found in fatal cases of head injury.

Cerebral laceration

When cerebral contusion is sufficiently severe to cause a visible breach in the continuity of the brain substance. This immediately beneath the site of the blow or by contre-corp on the opposite side of the brain.

Trauma and vascular lesions of the brain

It occurs in the form of extradural, subdural, subarachnoid, intracerebral and ventricular extravasations. It may be either a direct or indirect effect of trauma and is often the immediate cause of death in fatal cases.

Extradural haemorrhage

Almost exclusively due to trauma the exception being blood dyscrasias of infancy and is consequent to laceration of meningeal arteries and their vanae comites or dural sinuses. A depressed fracture over the affected sinus or a linear fracture across the line of meningeal arteries is usually found. Extradural haemorrhages are common in the temporal region and middle fossa consequent to the laceration of middle meningeal vessels on that side.

Subdural haemorrhage

Is usually traumatic in origin but can also occur due to ruptures of aneurysms and other spontaneous effusions. In traumatic cases two types, viz. a primary and a secondary are described, former is due to laceration of superior cerebral vein at their debouchment into the superior longitudinal sinus. This type may be contre coup as it lies in the subdural space opposite to the side of the impact but may also occur from falls on the back of the head due to shearing stresses exerted in the midline of the head. The accumulation of blood occurs over the upper part of the dorsolateral surface of the hemisphere, either anteriorly or posteriorly sometimes over the entire hemisphere. The typical effect is flattening of the convolutions of the dorsolateral surface of the opposite hemisphere with a widening of the sulci and ridging of the convolutions of the underlying hemisphere and distortion and dislocation of the ventricular pattern.

Secondary subdural haemorrhages occur as a consequence of a gross contusion or contused laceration of the frontal or temporal lobes with bleeding through the covering meninges into the subdural space.

Subarachnoid haemorrhage

Usually traumatic in origin milder degrees of which namely the primary type occurs in a patchy distribution over the parieto-occipital region of one or both sides or about the posterior margins of the cerebellum and regional superior vermis.

Intracerebral haemorrhage

Usually traumatic in origin sustained in traffic accidents or falls (coup-contre-coup mechanism). They may be primary resulting from direct force or secondary caused by other traumatic lesion namely gross contusions.

Mention may be made among the sequels to head injury, as the patient recovers to post concussional syndrome, organic dementia, psychoses including punch drunkenness, cap gas syndrome and prolonged coma.

PIONEERS IN HAEMORRHAGES OF BRAIN

Rowbotham:

1. In 3% of head injury, extra-dural haemorrhage is large enough to be of surgical significance.
2. Chronic subdural haemorrhage expands and compresses brain due to small repeated haemorrhages in the membrane formed around the previous hematoma.
3. Sub-dural hygroma occurs only when tear in arachnoid acts as one way valve to allow cerebrospinal fluid into the subdural space.

Greenfield: 5mm thin subdural haemorrhage may cover entire cerebral hemisphere to produce increased intracranial pressure resulting in tentorial herniation, giving rise to midbrain haemorrhage and ischemia leading to death.

Peper and Wecht: Tabulated histology of subdural haemorrhage from 244 hours to 1 year.

Gardner: Chronic subdural haemorrhage membrane has semipermable properties and draws cerebrospinal fluid into the haematoma.

Ingraham and Matson gave high incidence of subdural haemorrhage in infants at birth.

PATHOPHYSIOLOGY OF HEAD INJURY

The head injury results in injury to the brain tissue and loss in neuronal function, which may be permanent or temporary. This section discusses the subsequent train of events. However as head injury has a varied cause and course, the effects are also varied. On gross simplification it could be assumed that all neurological symptoms arise due to impairment of oxygen and glucose supply to the neurons. This constitutes the primary tissue injury.

This is followed by secondary sequence of events that aggravate the hypoxia viz. Alteration in intracranial hemodynamics, reduction in oxygen tension, cerebral edema, changes in brain-water content and increased intracranial pressure. Then the third accident occurs wherein there is superimposition of injuries due to other systems like endocrine disturbances, deranged water and electrolyte balance, pulmonary dysfunctions and cardiac irregularities.

A detailed discussion of all these events is beyond the purview of this study. Here only the raised intracranial pressure changes will be discussed. Depressed respiration and systemic changes compound the rise of intracranial pressure following trauma.

The intracranial pressure is raised following head injury due to haematoma formation, cerebral edema and block to cerebrospinal fluid flow. The intracranial pressure does not rise due to compensatory mechanism and the patient is conscious. As the intracranial pressure further rises the mean arterial pressure remaining constant the cerebral perfusion pressure decreases. In response to this the arterial pressure rises (Cushing's phenomenon). After a certain level this becomes inoperative and a further rise in intracranial pressure results in vasomotor paralysis. There is hypoxia damage and metabolic disturbances resulting in coma and then brain death. Various haematomas act like space occupying lesions. Sometimes it tends to compress the overlying brain tissue and displace it, causing brain tissue to herniate across various dural partitions. This herniation depending on the site produces its own unique neurological symptoms and effects. Once pressure is relieved it causes the herniated brain tissue to return back to its original site resulting in further injury.

Focal edema is associated with contusions and lacerations of brain and edema in brain stem is usually fatal. Generalised edema results in cerebral compression. Further, the uncus and tentorial herniation occur and the midbrain is squeezed from side to side and lengthened anteroposteriorly, which ruptures the vessels in the pons and midbrain causing paralysis of vital centers. Similarly cerebellar tonsils herniated through foramen magnum causing compression of midbrain. Uncal grooving and foraminal indentation may be seen on cerebellar tonsils at autopsy.

Death in Head injury is due to

- Damage of vital centers resulting in respiratory failure and cardiac arrest.
- Infections, pneumonia, pulmonary embolism and renal failure may ensue in cases of prolonged survival.

MICROSCOPY OF BRAIN INJURY

In areas of bruising of the cerebral or cerebellar cortex, severe lesions of nerve cells, nerve fibres and neuroglia are seen. Areas, showing lesions of ischemic or mechanical orgin surround small hemorrhagic lesions in the cortex.

Two types of lesions of nerve cells, which may be found in bruised areas and not seen in purely ischemic lesions and therefore, are probably directly caused by physical stresses. These are:

1. Rapid disintegration of neurons within a few hours of injury. This may be associated with rupture of the nuclear membrane, (Rand and Courville) disappearance of the nucleus or 'neuronophagy' by neutrophil leucocytes or microglia.
2. Binucleated and multinucleated nerve cells found on the margin of the bruised areas of cortices. The cell body might be relatively intact or might have an indistinct outline as though its cytoplasm were blending with the surrounding group substance. Various other nuclear changes are

found including constriction of the nuclear membrane as a preliminary stage of nuclear division.

The ischemic changes in bruised areas are similar to those found in other vascular lesions pallor and eosinophilia of the cytoplasm with hyperchromia and shrinkage of the nucleus is commonly seen. Within the first few days many of the neurons in bruised areas of the cortex may contain collections of birefringent, dark brown or black crystals or granules. At a later stage granules of iron-containing pigment appear in the peripheral zone of the cytoplasm of pyknotic neurons on the edges of the contused areas and still later many nerve cells are transformed into pyramidal agglomerations of strongly hematoxophylic granules and similar can be traced for some distance along the lines of the dendrites. These incrustations stain deeply by the Prussian blue. The extent to which neurons eventually disappear from a contused area of cortex depends on the severity of the lesion.

Diffuse histological lesions:

Rand and Courville have described more wide spread changes in cortical nerve cells.

1. Chromatolysis which is directly due to the injury.
2. Vacuolation which they consider to be secondary to edema.

Chromatolysis is seen in its early stages as soon as 1 ½ hours after severe head injury. In a case of death after 24 hours of head injury, most of the cortical nerve cells had lost Nissl granules' and in others the chromatic substance was irregularly distributed. In case in which life is prolonged for 2-5 weeks the nerve cells is still chromatolytic, similar changes are seen in the Purkinje cells, although the cerebellum showed no macroscopic lesions. Neurofibrillar changes, which are visible by *Cajal's reduced silver technique*. The nuclear chromatin also become coarser or is arranged in short chain like strands.

Vacuolation of nerve cells is seen in cases of cerebral edema. It begins within a few hours of the injury in the nucleus where numerous vacuoles might displace the nuclear chromatin. At the same time two or three vacuoles, instead of the single one, might be seen in the nucleolus. After 24 hours small perinuclear vacuoles might appear. Cytoplasmic vacuoles are found rarely only in cases, which had survived for several days.

A BRIEF ACCOUNT OF ROAD TRAFFIC ACCIDENTS IN INDIA

Accidents:

Are defined as unexpected, unpianned occurrence, which may involve injury.

WHO Definition:

"Occurrence in a sequence of events which usually produce unintended injury, death or property damage".

Road traffic accident may be considered as a "major epidemic of non-communicable disease, a part of the price we pay for technological progress".

Accidents rank third in order among the leading causes of death, next to ischemic heart disease and cancer. They are responsible for approximate 10% of all deaths in developed countries. And in developing countries like India, accidents are at least as numerous as in developed countries. It is increasing rapidly as a cause of death in absolute numbers and in terms of proportion. An estimated 3.5 million people die globally due to injuries. Among this 2.5 million die due to unintentional injuries as a result of road, domestic, industrial accidents, falls, natural disasters.

Road accidents account for around 22% of reported mortality for males and females. In absolute numbers 86,000 people were killed in Road Traffic Accident 2003, and in India has a fatality rate in road traffic accidents that is 20 times that in the developed countries.

India has one of the highest road accidents in the world. One out of every 110 vehicles in the country met with an accident in 2003. The death toll is about 6 for every 1000 vehicles as compared to in industrialized countries.

The number of people injured in road traffic accidents over the past 10 years has touched 38 lakh. The peak mortality and morbidity are seen in 15-24 years age of males (Park & Park).

A BIRD'S EYE VIEW OF R.T.A. STATISTICS IN INDIA (1994-2003)

1. Total number of road traffic accidents of all state including union territories in India for 10 years (1994-2003) was 38,05,521. Out of which Maharashtra stands first registering 7,44,290 followed by Tamil Nadu 5,35,000 and Gujarat 3,56,400.
2. Number of persons killed in road traffic accidents in India during the year 2003 is 85,998. Andhrapradesh tops the list with 9,679 deaths, followed by Maharashtra 9,483 and Tamilnadu 9,275.
3. Number of persons injured in road traffic accidents in India in 2003 is 4,35,122.
4. In 2003, in Tamilnadu 3,017 persons were killed out of 13,837 accidents which occurred on National Highways, 2,461 persons were killed out of 10,844 accidents on State Highways, and 3,797 persons out of 26,344 accidents on other roads, totaling to 9,275 deaths out of 51,025 accidents.
5. In Tamilnadu during the year 2003, among the type of vehicles involved, trucks were in majority (2928 death out of 12316 accidents) followed by buses and mini lorries (1786 of 8278), other heavy vehicles (1265 of

5056), cars, jeep and taxis (836 of 6806), three wheelers (202 of 3660), two wheelers (784 of 7694) and vehicles not known (490 of 1452).

6. Among the major metropolitan cities in India in 2003, Mumbai saw the highest number of accidents (27,960) followed by Kolkata (11,256), Delhi and Chennai (10,233 and 6250) respectively.
7. In Madurai city during the year 2003, there were 793 accidents due to which 69 killed and 711 persons injured.

Source: Statistics of Road Accidents in India (1970-2003), Ministry of Surface Transport, Road Safety Cell, Government of India, New Delhi.

MATERIAL AND METHODS

This study comprises a prospective part of autopsies of all head injuries cases, totaling 775 cases conducted at Govt. Rajaji Hospital Mortuary, Madurai from January 2004 to December 2005.

The whole study was classified initially under three main heads, viz.,

1. Road Traffic Accidents
2. Assault
3. Fall

Head injuries by railway accidents were omitted as the findings at the outset were not suggestive of any mechanism of trauma since sequence of events was difficult to be reconstructed.

The incidence in the district is compared with that of other states in India by analyzing the National Statistical Data from the source of Ministry of Surface Transport, Government of India.

Various epidemiological demographic, and forensic aspects of head injuries were investigated. A clinical case study with regard to head injury was attempted with 20 cases. Conventional autopsy technique was employed to dissect the whole body meticulously to meet the complete autopsy standards. A brief history pertaining to the etiology and circumstances leading to the head injury was gathered from the inquest reports and information was gathered directly from the police officers, relatives, friends, the nearest kin of the deceased and the eye-witnesses of the incident. Details regarding age, sex, date time, place manner of death and the circumstances of the incident were scrutinized.

With regard to head injuries in particular, details like scalp injures; fractures of skull with respect to type, extent and location; intracranial haemorrhage with respect to location; and brain lesions only with respect to 'gross findings' only were studied. Photographs were taken wherever necessary. Associated injuries in the body were also noted.

In determination of cause of death all autopsy findings were evaluated and if multiple factors lead to the death, then the most obvious and most important finding was considered to be the cause of death.

OBSERVATIONS AND DISCUSSION

Detailed post-mortem study was conducted on 775 cases in the prospective analysis with regard to cranio-cerebral injuries.

Age and Sex Incidence (Table 1 & 2)

In all the 3 main modes of trauma, the age groups were divided in terms of fifteen years intervals and into 5 groups.

In RTA, no age seemed to escape trauma. The youngest victim was 6 months and the oldest was 94 years old. Among males, the largest number of cases were found in the age group of 16-30 years, followed by 31-45 years and the least being in >60 years group.

But among females, large number of victims were in the 0-15 years age group followed by 31-45 years group and the least was in >60 years group.

The above findings are similar to those in the study conducted by Chandulal R, Srivastava AK and Gupta.

In assault, among males, large number of victims were in the age group of 16-30 years followed by 31-45 years, and the least was in the above 60 years age group. In case of fall, among males, the 31-45 age group dominated the list followed by 16-30 years age group and the least was in above 60 years age group. In females, 31-45 years age group peaked, but the least was seen in 45-60 years age group.

Shih Tseng Lea et al in their study found that commonly affected age groups were 16-20 years, 21-25 years and 25-30 years. The overall mortality was 17.26%. In a country of population of 20 million and 19 million living in major cities, the motor cycle was the common mode of transportation. The lowest incidence of head injury was at 4 AM. It increased through the morning continuing to rise with highest at 8 PM and gradually decreasing with a sharp fall at midnight[41].

Chandulal R (1971) analyzed fatal road traffic accidents with respect to other cases, during a period 1963 to 1967 and noticed an increase of incidence of RTA from 38 to 81. Males dominated females (77% as compared to 29%), and the peak incidence was seen in 20-29 years age group of males and 1-9 years age group of females. The lowest incidence was among 70-79 years age group in males and females.

Head injuries (60%) accounted for the major cause of death among these victims, as compared to deaths by other bodily injury[5].

Srivastava AK and Gupta RK studied 462 fatal road accidents in Kanpur, in 1986 which constituted ¼th of total autopsies, and 6.4 fatalities per 1000 vehicles on road. They noticed that no age group from infancy to old age is free from risk factor. Large numbers of victims were of 21-30 years age group, and males prepondered[43].

Recently, even in a city like Madurai, increasing involvement of women at work places and other outdoor activities made them increasingly vulnerable to injuries by various accidents.

Mode of Trauma

During the two year period, among the total 775 cases involved, 601 cases of road traffic accident (77.5%) were studied among which 498 (82.9%) were males and 103 (17.1%) were females. 405 (67.3%) accidents occurred during daylight and 196 (32.6%) accidents occurred during night. Higher incidence of road traffic accident during day may be attributed to a higher density of vehicles on road and increased vehicular activities during work time.

The mortality among children is quite high since the average Indian child is less protected from traffic accidents. This can be explained by the habits of child, playing on the streets, jay walking, 'rowing-in' suddenly in front of a moving vehicle, crossing the streets without elders guidance or help.

Vehicular incidence (Table -3)

Of 668 vehicles involved, among the heavy motor vehicles 201 (30.2%) lorries form the major culprits, followed by buses 81 (12%) and jeep/tempo/maxicab 147 (22%), and tractors 68 (10.2%). They form the chief mode of transport to Madurai from interior rural places as well as these vehicles were a mode of luggage carriers. Chandulal study shows that among vehicles lorries were 48% followed by cycle 25%, cars 17%, buses 13%, two-wheelers 9%, carts 4% and auto 0.9%[5].

Banerjee KK et al, based on their reports, found that the commonest offending vehicles were trucks (42.1%) followed by bus (26%)[4].

In our study, among the light motor vehicles, jeeps, tempos, maxicabs are the major culprits in public transport followed by autos 26 (3.9%). Even as the incidence of autorickshaw accidents seems to be less, it is quite significant since the concentration of autos are seen only in the city limits and almost all the auto accidents have occurred in the city limits. This could be due to rash, negligent, erratic driving behaviour of autodrivers. The congested roads with adverse traffic environment may also be complementary.

Of the two wheelers 105 (15.7%) accidents were due to involvement of two wheelers, among which only 6 were scooters, 9 were light-weight mopeds and 20 cycles.

Five road traffic accidents were due to stray animal menace, 4 cases were school going children who crossed the street, 2 was due to playing on street, 10 cases of public overloaded vehicles, 7 cases of luggage overloaded vehicles, 3 cases of foot board travel. From all these cases it appears that due care and caution by people involved would have averted the disaster and that accidents were indeed preventable.

Types of victims involved in Road Accidents (Table – 3)

Although literature shows that pedestrians form the largest group of victims, the present study shows that the vehicle occupants were the largest group of victims involved in both types of vehicles, i.e., heavy motor vehicles and light motor vehicles. In two wheeler and cyclist accidents, it was again the rider showing higher incidence followed by pillion riders. When 2 or more vehicles are involved in a collision as in head on or with some stationary fixed structures or even by overturning of vehicles, it is the occupants and the driver who pay the penalty. The contributory factors for the fatal injuries to the vehicle occupants include ejection and blunt impact or movement and impact within the vehicles, deformation of vehicles, trapping inside the vehicle, etc. The comparative incidence to the driver is less than that of occupants possibly because of the anticipation and causation among the drivers, which elicits protective reflexes against injuries. The mortality incidence was more in vehicle occupants compared to the drivers merely because of more number of passengers involved.

In cases of two-wheeler riders show increased mortality than pillion riders or pedestrians, as they require increased maneuverability to control a small sized speeding vehicle. As the study shows, it is the recklessness and negligence of the rider, with speed, and more than 2 people on the two-wheeler, which has caused injuries than any other factors.

Among pedestrians, 105 (17.5%) were involved in heavy motor vehicles, 30 (5%) in light motor vehicles, 9 (1.5%) in motor cycle and only 2 (0.2%) in cycle accidents were seen. It seems that due caution and careful attitude by pedestrian on streets, complying strictly with road rules may prevent a large number of pedestrian accidents. Correct precautions by the pedestrian road users may avert many accidents bringing down the motorway causalties drastically.

Shih Tsen Lea noted that common victims were motor cyclists (56.3%) and then pedestrians (29.45%)[41].

Chandulal noticed that in RTA, there were 64% pedestrians, 24% cyclists, 9.8% vehicular occupants, 9% autos and 1.8% cart deaths[5].

Gissane and Bull noted that pedestrians were the frequent victims of road traffic accidents[14].

Solheim K, in his series of 168 pedestrian deaths in a 10 year study period noted that 55% were 60 years old and 12% under 9. 20-40 years age group was the least to sustain pedestrian injuries. Of the injured, more than 20% were alcohol intoxicated. Head injury led the list of cause of death accounting for 79 cases (47%)[22].

Mackay GM studied the mechanism of primary and subsequent injuries of pedestrians when hit by a vehicle, the head usually striking the windscreen due to leaping forward after primary impact over the lower limbs. He noticed

72.15% head injury in pedestrians, 43.02% in motorcyclists and 71.02% in cyclists[28].

Alcohol incidence in Road Traffic Accidents

Generally accepted notion is that the incidence of accidents is directly related to alcohol consumption. This plays a major role especially if the driver maneuvering the vehicle is under the influence of alcohol or substance. The study, even if it has shown 3 cases of alcohol in the driver, it cannot substantiate the already convincing theory. In majority of the cases the PM conducting doctor need to produce irrefutable evidence as to affirmatively pronounce alcohol intoxication in the victims. This gives rise to compensation, insurance settlements and complicated litigation, which the doctor usually evades, mentioning the presence of alcohol by way of suspicion only. In other cases even as the doctor preserves the blood and viscera for alcohol estimation, the results are much awaited and delay the whole process in terms of months to years. Very few cases showed a confirmative evidence of alcohol in this study and we could not elicit any association between the accident and alcohol.

Grajam R Foster, James AD et al states that more than 5000 fatal RTA's occur killing about 5500 road users every year in Britain out of which as many as a quarter of these RTA are due to consumption of alcohol. They found that 71 of 304 road accident deaths were attributable to alcohol consumption. 25 of them were pedestrians out of which 23 were intoxicated. 47 were drink driving, 9 were passengers, on average more than one innocent is killed every day by a driver who has been drinking[15].

Rutherford WH felt the need to approach forensic textbooks to answer many of the medicolegal questions arising out of the head injury and alcohol consumption cases and for a detailed drunkenness diagnosis and differentiating it from concussion and contusion. He said that coma should not be attributed for cause of death when blood alcohol was >300 mg/dL, nor concussion and contusion when the blood alcohol was >200 mg/dL. He emphasized the calculation of amount of alcohol, based on blood alcohol fall of 15 mg/dL/hr, to diagnose coma or contusion[53].

Julian and Henry suggested a substantial increase in the proportion of road traffic accidents attributed to drinking problem. They studied the drinking behaviour pattern in drivers and social drinkers and made these observations. Pedestrian accidents consisted of <15 years and >65 years victims commonly, 62% out of these were males and 90% of the road traffic accident victims involved drivers. Alcohol was found in 78% of fatalities of 15-24 years and in 16% of >65 years age group. Over a third of both age groups had <150 mg% and 86% had <200 mg%. Younger drinking drivers posed more of a problem[21].

Rufus Crompton studied alcoholism and fatal road traffic accidents analysing 208 cases. Specimens of blood and urine were analyzed by gas chromatography in carbowax 1500 on carbopak C80/100 column, using propanol as internal standard. 141 cases were males and 67 females among 208 cases. 88 of these showed positive blood alcohol and 120 showed negative level. Young men less than 30 years predominated with peak age of 19 years. Fatal accidents occurred before the alcohol in blood and urine had reached equilibrium. Middle aged male pedestrians had the highest alcohol levels[38].

Survival time with respect to accident victims (Table – 4)

It is observed that the number of persons who died within 6 hours 181 (30.1%) from the time of occurrence were maximum followed by instantaneous death on the spot. The longest survival period in the present study in RTA is about 29 days. When survival of victims in RTA were associated with different age groups it was noted in 0-15 years age group, instantaneous deaths 43 (35.83%) were seen on the higher side as compared to the deaths with 6 hours 30 (25%).

The 16-30 years age group, 46-60 years age group and >60 years age group showed an inclination of survival for 6 hours. In all the 3 age groups, majority of the victims succumbed within 24 hours. Once these groups survived for 24 hours, they appeared to revive with continued care. A lesser proportion in all the age groups however seemed to succumb after 72 hours.

Chi square test and ‘p’ value was applied to the observations and was found to be less than 0.05. Hence, association of age and survival time was found to be statistically significant.

Deaths within 24 hours can definitely be reduced to a minimum provided energetic trauma care services or mobile trauma care services are instituted. If units with trained and equipped paramedical personnel who can establish the airway and circulation, are placed at short distance intervals on the major accident prone roadways, it can bring down the accident mortality significantly.

This is substantiated by the glaring evidence of a good number of RTA victims dying instantly of asphyxia (16 cases) or haemorrhage (380 cases) at the accident site than any other cause. The rapidity of transport of victims to the nearest help station also affects the survival time after head injury. Pre-hospital care and inhospital care are of paramount importance in dictating the terms of survival time. The marked difference noted in the incidence of deaths within 12 hours and instantaneous death, is perhaps due to the quality of treatment given immediately after trauma, physical status of the patient to withstand injury, any pre-existing or associated diseases and injuries.

Based on survival time one may broadly categorize the deaths as:

1. **Death within first few hours:** The injury itself or its complications are so grave and rapidly progressive that death was inevitable.
2. **Death within 24 hours:** The primary injury by itself may likely be sublethal, and death may occur due to progressive and unrelieved secondary complications.

3. **Survival of 2 or more days and delayed death:** These cases include not only primary brain stem injury but also those with extensive cortical brain damage, pulmonary edema, infections, metabolic and nutritional disorders and such other complications.

Simon Sivett noted that 16% of RTA cases died on spot, 44% died with 24 hours, 28% within 6 hours, 9% within hour and 16% between 6-24 hours[40].

Day and Month distribution of RTA and Head Injury cases

(Table 1 & 5)

The peak occurrence of RTA was noted on Fridays in the week, and in the months of April, May and December. This time pattern generally being that of Government and Public Sector holiday period, people usually tend to visit their hometowns travelling from their work/study places, or the time is supposed to be auspicious for marriage and other cultural activities. Association between RTA and day in our study was not found to be statistically significant as the 'p' value was greater than 0.05 and chi square value was 11.05.

Shih Tseng Lea noticed in his study that the peak occurrence of RTA was during weekend, in the month of October and in the later half of the year[41].

Heulke and Gikas studied accident fatalities and found that single fatality accidents were the most frequent, and occur more on Saturday or Sunday then on weekdays especially during midngiht[10].

Assault

A total of 60 (8.8%) cases of assault were studied, out of which 45 (75%) cases involved men and 15 (25%) cases women. 31 (51.7%) cases of assault occurred during night and 29 (48.3%) cases occurred during daytime. The common notion, that assaults are more common during nights does not hold good in this study as the number of assault cases appear to be more or less equally spread round the clock. Majority of the cases involved more than one assailant and clubs, iron rods, sticks, knife, reefers, stones, axe were used as weapons of assault. Interestingly three females were murdered without using any weapon by way of jamming the head to the wall or ground holding their mane of hair. Six cases showed evidence of alcohol, like smell in stomach and blood. Two cases were suspected to be poisoned in addition, and chemical analysis report is still awaited.

Fall

A total of 114 cases (14.7%) of fall were studied out of which 80 (70.2%) were males and 34 (29.8%) were females. 84 cases (73.7%) of fall occurred during daytime and 30 (26.3%) occurred during nighttime. This again can be attributed to increased involvement of men in hard, routine activities during daytime. Three cases were a result of stray animal menace, 36 cases due to adverse weather conditions. 5 cases were due to epileptic seizures and fall, 8 cases due to chest pain and fall, 14 cases as a result of negligence at construction site or during domestic work. 8 cases were due to fall from terrace while asleep, 4 cases were due to fall into well and drowning and 4 cases were due to suspected alcohol consumption and fall. Only one case of fall was confirmed by Forensic Science Laboratory as blood alcohol concentration of 91%. One case where live-electric wire was touched in the fields but died to head injury. 2 cases were children below 10 year age group who fell in the garden while play swinging. These findings were similar to the study conducted by Lestrine AM who analyzed 1463 cases of trauma out of which 25% cases were of fall related head injury deaths.

Injuries due to fall from height constitute a significant proportion of urban trauma especially in children. Falls are the leading cause of non-fatal injury in USA, second only to motor vehicle crashes leading to death. Lestrine AM et al analyzed 1463 trauma cases and found 25% of these as a result of fall. 70 patients fell off 10 feet or greater or at least one storey. 93% falls occurred at or near home. 365 originated from windows, 26% from roof, porch or balcony; and 23% from stairs. Head trauma (54%) was the commonest injury in these cases, showing closed head injury in 19 cases, skull fracture in 17 cases, sub-dural haemorrhage in 2 cases, extra-dural haemorrhage in 1 case. Preschool children were the predominant victims in falls and 19% had history of family neglect and violence. Based on the study, the New York City Department of Health developed education program and in 1976 paned a law of procuring window guards in apartments. After 12 years, there was a 96% decrease in fall from windows[30].

Thomas SH et al described low falls as falls from less than 20 feet and studied the pattern and severity of injuries. The majority of patients were <50 years and about 81% were found to have died of head injuries due to falls. Out of 176 patients studied, 36% occurred at homes during household work from ladders, roof, trees, 13 falls occurred from construction sites, 17 falls down the stairs, 12 falls from windows. 2 patients suffered head injury but survived with extradural haemorrhage and intra cerebral haematoma.

In analysis of 161 falls from height by T.Scalea, it was found that vertical deceleration injuries were more often multiple. And the mortality was due to intra-abdominal and extremities injuries rather than head injury. The mean age of the patients was 31.7 years and 123 were males, 37 females. 40% were suicide attempts, 50% were apparently accidents, 5% were crime related. Only 32 cases suffered head injury. Out of this 6 had skull fractures, 2 had bleeding ears, 3 subdural haemorrhage, 1 extradural haemorrhage, 4 subarachnoid haemorrhage, 2 intra cerebral bleeding and 8 contusions[34].

Lalwani Sanjeev et al studied fall from height and found that males (80.5%) were more to suffer fall, in the common age group of 21-40 years (47%). Most falls were accidental at residence from roof due to lack of safety measures or surface. The common cause of death was coma due to head injury

(64.4%), with injury to scalp, fracture of left parietal bone and middle cranial fossa as commonest injury. Diffuse subdural haemorrhage was the commonest brain injury. Occiput was the most common site of impact. A large group belonged to Hindus. And in the age group, 21-30 years accounted for 27.58%, 31-40 years for 19.5%, children till 10 years and adults above 50 years accounted for 16.09%. In 19.6% only skull and brain were involved. Exterior scalp injuries were seen on both sides in almost equal number of cases and extravasation was diffuse. Isolated right side extravasation was seen in 21 cases and on left side in 19 cases. Left parietal bone fracture was commonest (in 22 cases). Biparietal fracture in 19 cases, occipital in 15 cases, and frontal in 14 cases. Middle cranial fossa fracture was more common followed by posterior cranial fossa. Subdural haemorrhage was found in 49 cases, subarachnoid haemorrhage in 34 cases. Laceration and contusion was seen only in 16% cases[24].

External injuries to the Head (Table - 6)

Contusions in road traffic accident was more common in the frontal area 77 (29.3%) followed by temporal 41 (15.6%), occipital 28 (10.6%) and parietal 23 (8.7%) areas. Multiple site contusions were equally significant suggesting that any part of the head is vulnerable for injury in road traffic accident. The events are fast and do not give the victim enough time for his trauma evading reflexes to act and protect himself.

As witnessed in contusions of assault and fall, it is the prominent parts of head like parietal and occipital areas that are more susceptible. This suggests the events preceding death of the victim were moderated and the protective evading reflexes were active during his life.

As compared to contusions, lacerations are also higher in frontal 67 (23.3%), and parietal 38 (13.2%), and temporal 33 (11.5%) areas. Diffuse lacerations are infact high in RTA than in assault or fall for the same reasons mentioned above.

Lacerations are less common as a whole in falls and assaults as compared to contusions. Among lacerations, in majority there were a component of contusions associated giving rise to an admixture of contused lacerations. In all the 775 cases, only 4 cases of RTA showed avulsed type of lacerations in parietal and vertex regions. Based on these observations of scalp injuries, it is indeed acceptable that opinion as to number of blows on the head, the ‘fatal blow’, number of weapons and number of assailants, cannot be given.

Fractures of Skull (Table – 7 & 11)

Types of fractures of skull were studied separately in the three modes of trauma.

In RTA	Vault fractures constituted – 169 cases Basal fractures – 88 cases.
In Assault	Vault fractures constituted – 22 cases Basal fractures – 5 cases.
In fall	Vault fractures constituted – 51 cases Basal fractures – 16 cases.

Vault fractures were further divided into fissured, comminuted and depressed fractures. In RTA, fissured fractures 101 (59.7%) head the list. These fissured fractures were seen more in temporal (20.8%) and frontal bones (20.8%) and were frequently associated with contusions of respective areas. Next followed parietal (17.8%) and lastly occipital (8.9%) fissured fractures.

Comminuted fractures in RTA constituted 38 (22.5%) and involved predominantly fronto-temporo-parietal bones (73.7%). Depressed fractures in RTA constituted 30 (17.7%) and involved, frontal (23.3%), parietal (16.6%) and temporal bones (6.7%). Basal fractures in RTA were more in anterior cranial fossa 44% followed by middle 28% and posterior cranial fossae 28%.

When the association of contusion of scalp with skull fractures were studied in RTA, it was interesting to note that out of 84 frontal contusions in RTA, only 14(16.7%) skulls were intact, whereas 21 (25%) cases showed linear fracture and 40 (47.6%) cases showed anterior cranial fossa fractures. Two cases showed comminuted fractures and 7 cases (8.3%) showed depressed fractures. This shows that an impact on the forehead is more likely to cause severe damage to the skull.

In 41 temporal contusions, 21 cases (51.2%) showed fissured fractures and 2 cases (4.8%) of depressed fractures, 7 cases (17%) showed middle cranial fossa fracture and only 11 cases (26.8) were intact.

Out of 34 occipital contusions 9 (26.4%) cases showed fissured fractures, two depressed (5.8%) and one (2.9%) comminuted fractures. 11 (32.3%) cases showed basal fractures and 11 cases (32.3%) were intact. Out of 25 parietal contusion, 18 cases showed linear fracture, 5 showed depressed fracture and two showed comminuted.

In assault, 3 cases showed frontal contusion and the skulls in all were intact; out of 16 temporal contusion, 6 cases fissured fractures, 2 MCF fractures and 8 cases were intact. Out of 8 parietal contusions, 2 fissured and 1 comminuted fractures were seen and 5 were intact and out of 5 occipital contusions, 2 fissured fractures observed and 3 cases were intact.

In fall, out of 4 frontal contusions, two showed linear frontal and another two basal fracture. Out of 12 temporal fractures, 10 showed linear fracture and two basal fractures. In case of parietal contusions, two depressed fractures were seen. Out of 19 occipital contusions, 8 linear and 6 depressed fractures were seen and 5 cases showed intact skulls.

Skull Fractures

When different types of fractures of skull were studied only with respect to site, in RTA, out of 182 fissured fractures, 39 (21.4%) showed frontal distribution, 40 (22%) showed temporal distribution, 26 (14.3%) showed parietal distribution and 16 (8.8%) showed occipital fractures.

Out of 67 depressed fractures, 16 cases (23.9%) each were seen in frontal and parietal bones whereas 9 (13.4%) cases and 4 cases (6%) showed temporal and occipital bones distribution respectively.

Out of 110 comminuted fractures, 35 (31.8%) showed diffuse multiple bone fractures, 21 (19%) showed temporo-parietal bones and 22 (20%) showed fronto-tempero-parietal bones. Occipital bone was less involved.

In crush fractures, out of 67 cases, 26 (39%) showed diffuse multiple bone involvement where the bones could not be differentiated. In the rest of the 41 cases (61%) the fracture site could be delineated. In almost all of the diffuse crush comminuted fractures, the cases were of run over of heavy motor vehicles on head. Where the fracture sites could be delineated in this type, majority were of run over cases and few sustained impact within the body of the vehicle.

In assault, 47 cases showed vault fractures and 9 cases showed basal fractures. Of the vault fractures, 8 were temporal linear fractures, 6 were temporo-parietal linear fractures, 5 were parietal linear fractures. 3 cases showed depressed fracture in temporo-parietal and frontal bones and 9 cases showed comminuted fractures. In general, temporal and parietal areas are predominantly susceptible in assaults.

In falls, fissured fractures 51 (45.5%) were more common followed by basal fractures 26 (23.2%). Fissured fractures were common in fronto-temporo-parietal areas. Among basal fractures, posterior cranial fossa accounted for maximum number of fractures followed by middle and anterior cranial fossa. Skull fractures alone are not significant unless they are accompanied by intracranial lesions.

Gissane and Bull noticed that skull fracture with brain injury was found maximum with vehicle occupants followed by pedestrians and then motor cyclist[14].

In our series, we found skull fracture with brain injuries more in vehicle-occupants followed by motor cyclists and then pedestrians.

In Simon Sivetts study of 800 fatal RTA cases, 72% cases were having skull fractures. Vital Centre contusions like that involving brain stem and around III ventricle were found in 39 cases. The subjects having these findings had the highest incidence of skull fractures, frequently extensive or comminuted. He also recognized mechanism like anterior, lateral and posterior forces. Anterior forces caused frontal comminution with radiation fractures around sella turcica with fracture of facial bones. Lateral forces caused fractures of middle cranial fossa involving sella and basisphenoid. Posterior forces caused fractures into or near foramen magnum[40].

Intracranial Haemorrhages (Table 8, 10-13)

Out of all the haemorrhages, subdural haemorrhage 261 (43.8%) were high in incidence, followed by subarachnoid haemorrhage 137 (23%), intracerebral haemorrhage 102 (17.1%) and extradural haemorrhage 95 (16%).

Extra-dural haemorrhage, in majority of the cases was situated either in the temporal (35.7%) and parietal (32.6%), or both temporo-parietal areas (21%). In 8 cases (8.4%), it was situated in parieto-occipital area and only in two cases (2.1%) it was situated in frontal region.

Subdural haemorrhage was diffuse in 77 (29.5%) cases, but when found in delineated areas, it shows a predilection for temporo-parieto-occipital areas. Sub-arachnoid haemorrhage was again diffuse throughout the space, but in most of the site-specific cases, it showed a predilection to the anterior and posterior cranial fossae, fronto-temporo-parietal areas, and lateral, III and IV ventricles.

Intracerebral haemorrhage was again diffuse in majority and in few cases it was possible to locate the haemorrhage in frontal, parietal, and temporal parenchyma.

When intracranial haemorrhages were studied with respect to age groups, it was noted that, extra-dural haemorrhage was common in 16-30 years, 44 (46.3%) followed by 31-45 years, 32 (33.7%), subdural haemorrhage was more common in 16-30 years age group 91 (35%), followed by 31-45 age group 84 (32.3%). Both subarachnoid haemorrhage and parenchymal haemorrhages were common again in 16-30 years age group.

When intracranial haemorrhages were studied with respect to fractures and age groups, it was found that extra-dural haemorrhage and subdural haemorrhage was common when skull fractures were present and predominantly in 16-30 years age group. Extra-dural haemorrhage is rare without any associated fracture but is still possible as witnessed by 6 cases in our study. But as age advanced, it was noted that in older age groups, the presence or absence of skull fractures was not of much significance towards production of haemorrhages.

Hence, extra-dural haemorrhage and subdrual haemorrhage were always more common with skull fractures in 16-30 years age group in all modes of trauma, while SDH was noted also without any associated skull fractures.

Ghosh PK (1991), studied pattern of injuries in pedestrian victims among 90 autopsied cases at M.A.M.C., New Delhi and found that, in 47 cases (62.22%) injuries were limited to head, followed by injuries to abdomen in 19 cases. Out of 47 cases, 45.55% had fracture skull with combined intracranial haemorrhages (40%). In 28 cases (12.17%) there were evidences of intra-cranial haemorrhages without any fracture of skull[13].

Brain Injuries (Table -14)

A total of 129 coup contusions were noted and they were situated more in the frontal (22.4%) followed by parietal (15.5%), occipital (14.7%) and temporal (13.2%) areas. Coup contusions are prominently seen in the occipital area in cases of fall (9.3%). Out of 63 contre-coup contusions, parietal (19%) and occipital (17.5%) areas were common. Out of 100 coup lacerations, frontal area (37%) showed more predilections followed by parietal (9%) and temporal (9%) area. Contre-coup lacerations are less common but when occur, it is more commonly seen in frontal areas (50%). Lacerations of brain were more common with fracture of skull but also occurred on movement of brain within skull without any associated fracture.

Basal cerebral injuries are more common in RTA (75%) followed by fall (16.6%) and assault (8.3%). Cerebellar haemorrhages are grossly prominent in RTA’s (79%) than fall (16%) and assault (5%).

Adams JH et al in his paper says about gliding contusions as introduced by Lindenberg and Freytag. These gliding contusions were haemorrhages in the white matter of dorsal paramedial portions of cerebral hemispheres, a well-defined haematoma in the classic form. He gave the mechanism of these contusions, as the pulling arachnoid granulation and the bridging veins being pulled at the time of injury. It often appears in the absence of any skull fracture in RTA. Diffuse axonal injury and deep hemispheric traumatic hematomas are associated frequently with these contusions[1].

In our study, though we found contusions similar to the gliding contusions mentioned above, these were associated with more significant coup and contre-coup contusions and haemorrhages. Gliding contusions were not studied separately as it would only add to the volume of data and complicate other findings.

Krishnan MKR noticed a total of 25 cases of head injury (16.75) out of 149 autopsies conducted in Kakatiya Medical College, Warangal, A.P. in 1996. He also noticed that contre-coup injuries does not result in the occipital region from an impact in the frontal region as the reflections of dura and its attachments restricted the movements of the brain along the direction of impact. He stated that the converse of this situation would occur[23].

Associated Injuries (Table – 16)

Only fractures of limb bones and gross visceral injuries were considered. Facial injuries included soft tissue injury, maxilla, mandibular and nasal bone fractures. The injuries were more frequently seen in road traffic accidents and in majority involved the extremities. Chandra J et al, Gonzales et al have observed associated injuries highest in road traffic accidents which is true in present study also.

This clinical progress and the prognosis depend upon these associated injuries. Timely recognition and trauma management with respect to associated injuries play a vital role in the prognosis of a head injury patient. The association of head injury with a concomitant thoracic or abdominal injury is particularly sinister. Even uncomplicated rib fractures render the outcome grave due to respiratory embarrassment leading to anoxia. Likewise splenic, liver and renal, aorta and lung injuries hamper the prognosis of the head injury patients by way of hemodynamic and respiratory compromise.

In this study, 250 cases of facial injuries were seen, 308 cases showed chest injuries, 253 cases showed abdominal injuries and 426 cases showed limb injuries.

Bhaskar GR and Chandulal R studied 539 autopsies during the period from January 1965 to December 1966. Out of which road traffic accident deaths were 117 (21.7%). Out of these 117 cases, 26 (24.1%) were due to run over.

Out of these 26 cases, 12 cases were run over the head, 5 over the back, 4 over head and chest, and 2 over the extremities.

Srivastava AK and Gupta in their study noticed that head and extremity injuries topped the list (36.36 and 37.01% respectively) followed by chest, abdomen and other parts. They said ‘burst fractures’ of skull was produced due to the susceptibility of head by compression by tangential impact of the wheel on the head. Of all the injuries, fracture of skull with laceration of brain (58.8%) was the commonest, injuries to the ribs (46.1%), liver (38.3%) and spleen (26.9%).

Causes of Death (Table – 15)

Out of 601 road traffic accidents, 529 (88%) victims died exclusively due to head injuries, and 72 912%) died due to associated injuries along with head injury.

Out of the total 775 cases 23 (3%) cases showed only external evidence of scalp injury but no internal findings except for a few petechiae. These cases neither showed significant head injury nor any associated injury. These cases showed a clinical history of deep unconsciousness, and the consciousness never relapsed before death. Only on the basis of exclusion, these cases were presumed to be of diffuse axonal injury or concussion deaths.

A large proportion of i.e. 305 (51%) of cases however were deaths due to severe haemorrhage and shock. Majority showed intracranial haemorrhages along with pallor of mucosa and viscera. These victims rarely survived beyond 48 hours and most of them succumbed within 24 hours.

Another proportion i.e. 117 (19%) died instantaneously and either showed extensive fractures of skull and significant brain damage in terms of contusion and laceration which were deemed to be incompatible with life or even if they survived, it was for not more than 6 hours.

14 (2%) cases showed evidence of generalized infection like that of slimy foul smelling organs, pus in the pleural cavities and cut-section of lungs, tracheo bronchial tree, renal pelvis, and meninges etc. these cases generally showed a survival of more than 5-7 days.

3% of the cases showed evidence of blockade of respiratory passages and were pronounced death due to asphyxia. Majority were of traumatic asphyxia where the individuals were trapped inside a collapse vehicle in an accident. In some cases, sand, mud and other load covered the victim while they were travelling in loaded trucks.

In 60 (10%) cases, the victims died due to secondary complications due to head injury like brain edema (6), brain stem compression (8), cerebral compression (4) and herniation (3), wound infection and meningitis (2), secondary pneumonia (5), aspiration and hypostatic pneumonia (1), renal failure (3) and crush syndrome (2).

In our study, in contrast we have found that in 16.6% cases, there were occipital contre-coup contusions.

Kamdar BA and Arden GP, states that of 142 PM analysis in 1959-1970, in the Windsor group of hospitals, head injuries account for 40% of fatalities, 33 out of 142 died of intra-cranial haemorrhages and 17 victims died of severe brain damage. Cerebral contusion accounted for 34 cases out of which 4 cases showed cerebrallar damage too. Damage to mid brain and brain stem proved fatal in 8 cases.

Solheim K noticed that small aspirations could critically worsen the condition of head injured patients due to supervening asphyxia. Hence, if doctors and specially trained personnel accompanied the ambulance from the site of occurrence, he said fewer would have succumbed due to aspiration.

CONCLUSION

Among the blunt force impacts on the head, RTA is the commonest cause for head injury. To try and avoid the injury by this means, puts a challenging task ahead of us. It is necessary for a general hospital to be equipped with necessary equipment and trained medical and paramedical personnel to manage a head injury victim effectively. A separate neurosurgery and trauma care unit in every general hospital would be preferable in the interest of saving the life of head injury patient. Head injury by traffic accidents alone is a huge problem by its magnitude that prevention of an accident seems to be the only next best solution. The consequences of injury to the head are of great diversity and offer many vexing diagnostic problems. They contribute often thought provoking material to the conducting Forensic Expert. They are also important because of many Medico-legal implications that arise in connection with these injuries like time of survival, presence or absence of alcohol and compensation settlements, etc. Cranio-cerebral injuries form a considerable proportion towards cause of deaths.

In blunt force impacts even trivial injury looks apparently normal and when death supervenes, only a careful autopsy will enable us to assess every important fact with respect to cause of such deaths.

The present study is based on the observation of 775 cases comprising of blunt force impact by way of mechanical violence and consists of road traffic accidents, assaults and falls. Various results were arrived at after detailed post-mortem examination and review of PM reports, regarding age, sex, their relation to impacts, various types of skull fractures, intracranial lesions and associated injuries. Causes of death in all the cases were inferred. Epidemiological and scientific analysis of head injury data was done to successfully meet the objectives listed in the initial stages of the study.

SUMMARY

- In the present study there were 775 deaths due to head injury in a period of 2 years (January 2004 to December 2005)
- The cases consisted of three groups of victims viz:
  - Victims of RTA – 77.5% (601cases)
  - Victims of Assault – 7.7% (60cases)
  - Victims of Fall – 14.8% (114cases)
- Males showed a preponderance in all the categories (80.3%) and the maximum incidence was seen in 16-30 years age group in RTA and assault but in 31-45 years age group in fall.
- Road traffic accidents showed highest peak in the month of April, and a second peak in the month of May and December. Assault and fall incidences were more or less equally spread throughout the year.
- Majority of RTA deaths involved vehicle occupants (42%) followed by drivers (30%) and pedestrians (28%).
- 74.2% of the victims succumbed within 24 hours of accident.
- 51.4% cases showed scalp contusions and 46.6% cases showed lacerations of scalp.

- 45% (351 cases) showed skull fracture out of which 69% were vault fractures and the rest 31% were basal fractures. 44.7% (157) cases showed linear fractures, 11% (40 cases) depressed fractures, and comminuted fractures.
- 596 cases (77%) showed intracranial haemorrhages. Out of which 95 (16%) were extradural, 260 (33.5%) were sub-dural, 129 (21.6%) sub-arachnoid and 112 (18.8%) parenchymal hemorrhahges.
- 87 cases (88%) of extra-dural haemorrhage was associated with skull fracture and only 12% not associated with any skull fracture.
- Subdural haemorrhage does not have any significant association with presence or absence of skull fracture though it appears to be more with skull fracture.
- Presence of subarachnoid haemorrhage with all the other injuries to the head provides a stronger evidence of trauma.
- 60% (192) contusions and 40% (128) lacerations were seen in brain. 67% were coup contusions and 33% contre-coup contusions.
- Contusions were most common in multiple sites (37.5%), frontal (20.3%) and parietal lobes (16.7%) followed by occipital (15.6%) and temporal (9.8%) lobes.

- ❖ Lacerations were maximum in frontal lobes (55.8%), followed by parietal (18.8%), temporal (17.4%) and occipital lobes (7.8%). Multiple site lacerations were seen in 63.2% cases.
- ❖ Majority of the head injuries in road traffic accidents was associated with other bodily injuries. In 250 cases facial injuries, in 308 cases chest injuries, in 253 cases abdominal injuries and in 426 cases limb injuries were seen. Lung, liver and spleen injuries played a major role in compounding to the mortality of these cases.
- ❖ The primary causes of death in head injury were Haemorrhage, Neurogenic shock and Diffuse axonal injury. Equally significant was other secondary causes like bronchopneumonia, infection, herniation and cerebral compression, renal failure and crush syndrome.

RECOMMENDATIONS AND SUGGESTIONS

Based on our study, we like to stress the importance of the following suggestions:

- Proper education right from school level regarding the right way of using the roads.
- Improve the road and traffic sense among road users by camps, road shows, etc.
- Strict enforcement of traffic rules.
- Observation of traffic weeks regularly to bring traffic awareness among various sections of population.
- Improvement of quality of roads by widening , proper asphalting, incorporation of signal lights, sign boards, road dividers, lane segregation for slow, medium and fast moving vehicles.
- Entry of animals into the roads must be checked.
- Drivers should not be allowed to drink-drive, use mobile phones or engage in casual attitude while driving. Two wheeler drivers should wear protective helmets. Public transport driver and police should be trained in first aid and emergency management techniques.

- Permissible limits of blood alcohol to be fixed and serious measures with respect to provisions in Indian Penal Code to be made to punish drunken drivers.
- Regular health check-up of drivers to be made compulsory.
- Vehicles should be conditioned and overhauled regularly and unfit vehicles to be condemned. Speed check devices to all vehicles should be made mandatory, halogen lamps on the vehicles to be avoided. Drivers should be instructed to avoid high beam headlamps within city limits. The vehicle should be equipped with glare-proof infrared night vision system, protective seat belts, collapsible steering wheel, crash resistant body and bucket seats. The interior of the vehicle should not be fitted with sharp and hard material. All such devices should be padded with soft foam. Saree guard, engine guard should be compulsorily installed in two wheelers.
- Overloading of passengers in vehicles to be avoided.
- Vendors and Hawkers should not be allowed on foot path or at the sides of road.
- Different timing of schools, colleges and factories would help in reducing traffic congestion.
- Laser and radar gadgets to be employed in checking the speed of the vehicles[31].

- A sense of general awareness should be brought. Until the general public tries to bring a change in the traffic attitude from a personel level, the incidence of traffic accidents is feared to remain on the increasing verge. Public cooperation should be sought by the traffic enforcing authorities by gentle approach, but simultaneously should be strict to admonish and punish the traffic offender.

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LIST OF ABBREVIATIONS

RTA	Road traffic accident
ASLT	Assault
HMV	Heavy motor vehicle
LMV	Light motor vehicle
MC	Motor cycle
AB	Abrasion
CO	Contusion
LA	Laceration
CCO	Coup contusion
CCCO	Contre-coup contusion
CLA	Coup laceration
FR	Frontal
PA	Parietal
TE	Temporal
OC	Occipital
FTP	Fronto-temporo-parietal
TPO	Temporo-parieto-ccoipital
FT	Fronto –temporal
TP	Temporo-parietal
PO	Parieto-occipital
LIN	Linear
DEP	Depressed
COM	Comminuted
EDH	Extra-dural haemorrhage
SAH	Subarachnoid haemorrhage
ICH	Intra-cerebral haemorrhage
COD	Cause of death
ABD	Abdomen
Rt	Right
Lt	Left
BIL	Bilateral
Ass Inj	Associated injury
ACF	Anterior cranial fossa
MCF	Middle cranial fossa
PCF	Posterior cranial fossa

PROFORMA

A TWO YEARS STUDY OF CRANIO-CEREBRAL INJURIES BY MECHANICAL VIOLENCE WITH SPECIAL REFERENCE TO TRAFFIC ACCIDENTS IN AND AROUND MADURAI CITY (JANUARY 2004 TO DECEMBER 2005)

Name: Address: PM No. & Date:

Age : UDR/Cr No. U/s

Sex : ---------- PC N. ------- Police

Station Despatch time & date:

Hospital No. OP/IP:

D.O.A: D.O.E.

1. Date, Time & Place of Injury :
2. Brief History :
3. Time of Death :
    - ❖ Immediately after the incident
    - ❖ During Transition
    - ❖ Delayed
4. Brought dead:
5. Period of Survival after injury (Hours):
6. Any bodily deformities:
    - ❖ Extremities
    - ❖ Pelvis
    - ❖ Trunk
7. H/o Alcohol Consumption prior to the incident:
8. Other precipitating factors:

9. Condition of the person immediately after death:

10. Any vision impairment:

A) External Examination:

1. Presence of foreign material: Dust / Oil/ Grease / Others.

2. Bleeding: Ear: Rt/Lt Nose: Mouth

3. Black Eye: Right / Left

4. Head Injury:

Scalp

- ❖ Intact
- ❖ Abrasions
- ❖ Contusions
- ❖ Lacerations

B) Internal Examination:

Head:

i) Skull : Vault

Base

ii) Meninges:

iii) Haemorrhages:

- Extradural haemorrhage
- Subdural haemorrhage
- Subarachncid haemorrhage
- Intracerebral / Ventricular /Cerebellar / Pontine haemorrhage

iv) Brain:

- Contusion
- Laceration

Other Regional Injuries:

Face & Neck / Limbs / Thorax / Abdomen / Pelvis

Thorax:

Abdomen:

Pelvis and genitalia:

Any other findings:

Relevant Investigation:

Routine

X-Ray

CT Scan

MRI Scan

Surgical Interventions, if any:

Microscopic Examination, if any:

Opinion as to Cause of Death:

Date

Place Signature

Entire scalp contusion

Split lacertaion

'Burst' compound fracture of frontal bore with right to left flattening of head & face

'V' shaped fissured fracture of occipital & matoid temporal bone

Depressed fracture of frontal bone

Wedge shaped fracte of skull (Right posterior cranial fossa) with laceration of cerebellum

Transverse fracture of base of skull (Posterior cranial fossa)

Entradural haemorrhage on right parietal surface

Sub-dural haemorrhage in right middle cranial fossa

‘Glinding Contusion’ in the right paramedian surface of right cerebral hemisphere with sub-arachnoid haemorrhage in the sulci

Chronic sub-dural haematoma
Subarachnoid haemorrhage and cerebellar haemorrhage

Contusion of cerebellum

Contusion of right temporal lobe of brain

Cutsection of brain showing petechial haemorrhages

Table No. 1: Distribution of Cases with respect to Month, and Mode of Trauma

Month	Mode of Trauma						Total
	2004			2005			
	RTA	ASLT	FALL	RTA	ASLT	FALL	
January	15	2	3	20	2	2	**44**
February	20	1	7	23	2	5	**58**
March	27	2	4	22	1	6	**62**
April	49	3	8	45	2	6	**113**
May	29	2	3	40	1	5	**80**
June	27	1	8	21	3	7	**67**
July	12	4	2	18	6	3	**45**
August	26	1	11	22	2	8	**70**
September	18	5	3	25	4	5	**60**
October	13	3	3	17	2	4	**42**
November	19	2	4	14	2	3	**44**
December	36	3	2	43	4	2	**90**
Total	**291**	**29**	**58**	**310**	**31**	**56**	**775**

Table No. 2: Distribution of Cases with respect to Mode of Trauma, Sex and Age

Age (Years)	Mode of Trauma																	
	RTA						Assault						Fall					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-15	75	15.06	45	43.69	120	19.96	5	11.11	2	13.33	7	11.67	6	7.50	8	23.53	14	12.28
16-30	205	41.16	18	17.47	223	37.10	20	44.44	9	60.00	29	48.33	23	28.75	6	17.65	29	25.44
31-45	121	24.29	23	22.33	144	23.96	14	31.11	0	0.00	14	23.33	41	51.25	12	35.29	53	46.49
46-60	76	15.26	14	13.60	90	14.97	3	6.67	1	6.67	4	6.67	8	10.00	2	5.88	10	8.78
>60	21	4.23	3	2.91	24	3.99	3	6.67	3	20.00	6	10.00	2	2.5	6	17.65	8	7.01
Total	**498**	**100.00**	**103**	**100.00**	**601**	**99.98**	**45**	**100.00**	**15**	**100.00**	**60**	**100.00**	**80**	**100.00**	**34**	**100.00**	**114**	**100.00**

Table No.3: Distribution of Cases with respect to Type of Vehicles and victims

Sl. No.	Type of Vehicle	Type of Victim	No. of Victims	Percent	Total
1	Heavy Motor Vehicle	Pedestrian	105	17.50	**283**
		Vehicle occupant	120	20.00	
		Driver	58	9.50	
2	Light Motor Vehicle	Pedestrian	30	5.00	**108**
		Vehicle occupant	58	9.50	
		Driver	20	3.30	
3	Motor Cycle/Scooter	Pedestrian	9	1.50	**111**
		Pillion Rider	38	6.40	
		Rider	64	10.60	
4	Cycle	Pedestrian	1	0.16	**19**
		Vehicle occupant	4	0.66	
		Driver	14	2.32	

Table No.4: Survival Time with respect to Age in RTA

Survival time	Age Group (Years)						
	0-15	**16-30**	**31-45**	**46-60**	**>60**	**Total**	**Percent**
Instantaneous death	43	58	39	19	2	161	26.79
Death within 6 hrs	30	81	37	28	5	181	30.12
Death within 12 hrs	10	25	11	11	7	64	10.65
Death within 24 hrs	14	7	12	4	3	40	6.65
Death within 72 hrs	5	12	9	5	4	35	5.82
Death after 72 hrs	10	14	14	18	3	59	9.82
Time not known	8	26	22	5	--	61	10.15
Total	**120**	**223**	**144**	**90**	**24**	**601**	**100.00**

χ^2 2.4 d.f. = 40.22 $p<0.05$.

Table No. 5: Distribution of Cases with respect to Day and Mode of Trauma

Day	Mode of Trauma			
	RTA	**Assault**	**Fall**	**Total**
Sunday	93	14	12	119
Monday	88	14	16	118
Tuesday	86	8	16	110
Wednesday	77	9	10	96
Thursday	73	5	20	98
Friday	109	4	18	131
Saturday	75	6	22	103
Total	**601**	**60**	**114**	**775**

χ^2 12 d.f. = 11.05 $p>0.05$

Table No. 6: Distribution Scalp Injury with respect to Site

Scalp Injury	Mode of Trauma	Site											Total
		Frontal	**Temporal**	**Parietal**	**Occipital**	**Vertex**	**Diffused**	**Fronto-temporal**	**Temporo-Parietal**	**Parieto-Occipital**	**Fronto-Temporo-Parietal**	**Temporo-Parieto-Occipital**	
Contusion	RTA	40	37	21	21	8	--	11	11	19	23	5	196
	Assault	3	6	8	5	2	0	2	--	5	2	1	34
	Fall	12	6	4	21	4	--	--	8	4	2	--	61
	Total	**55**	**49**	**33**	**47**	**14**	**0**	**13**	**19**	**28**	**27**	**6**	**291**
Contused Abrasion	RTA	37	12	2	7	1	--	2	4	2	--	--	67
	Assault	--	--	--	--	1	--	2	--	--	--	--	3
	Fall	2	4	2	2	--	--	--	--	2	1	--	13
	Total	**39**	**16**	**4**	**9**	**2**	**--**	**4**	**4**	**4**	**1**	**--**	**83**
Laceration	RTA	56	19	25	17	9	28	12	14	9	23	4	216
	Assault	2	--	5	5	2	2	1	3	--	--	3	23
	Fall	10	4	2	8	--	2	2	2	--	--	2	32
	Total	**68**	**23**	**32**	**30**	**11**	**32**	**15**	**19**	**9**	**23**	**9**	**271**
Contused Laceration	RTA	11	14	11	9	--	3	5	2	12	--	--	67
	Assault	2	3	2	--	--	--	--	4	--	--	--	11
	Fall	4	4	3	12	--	--	--	--	--	3	--	26
	Total	**17**	**21**	**16**	**21**	**--**	**3**	**5**	**6**	**12**	**3**	**--**	**104**
Avulsed Laceration	RTA	--	--	2	--	2	--	--	--	--	--	--	4
	Assault	--	--	--	--	--	--	--	--	--	--	--	
	Fall	--	--	--	--	--	--	--	--	--	--	--	
	Total	**--**	**--**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**4**

Table No. 7: Distribution of cases with respect to Skull Fractures and Site

Type of Fracture	Mode of Trauma	SITE										Total
		Frontal	Temporal	Parietal	Occipital	Diffused	Fronto-temporal	Temporo-Parietal	Parieto-Occipital	Fronto-Temporo-Parietal	Temporo-Parieto-Occipital	
Linear	RTA	39	40	26	16	--	12	16	19	7	7	182
	Assault	--	8	5	3	--	2	6	4	3	--	31
	Fall	3	12	8	7	--	4	4	3	10	--	51
	Total	**42**	**60**	**39**	**26**	**--**	**18**	**26**	**26**	**20**	**7**	**264**
Depressed	RTA	16	9	16	4	--	5	9	1	7	--	67
	Assault	1	--	--	--	--	--	2	--	--	--	3
	Fall	2	--	2	5	--	--	--	--	4	--	13
	Total	**19**	**9**	**18**	**9**	**--**	**5**	**11**	**1**	**11**	**--**	**83**
Comminuted	RTA	7	--	5	5	35	12	21	3	22	--	110
	Assault	--	--	4	2	1	--	1	--	1	--	9
	Fall	2	1	--	--	5	--	3	1	5	--	17
	Total	**9**	**1**	**9**	**7**	**41**	**12**	**25**	**4**	**28**	**--**	**136**
Crush Comminuted	RTA	4	--	2	--	26	5	7	7	12	4	67
	Assault	--	--	--	--	2	2	--	--	--	--	4
	Fall	--	--	--	--	3	--	--	2	--	--	5
	Total	**4**	**--**	**2**	**--**	**31**	**7**	**7**	**9**	**12**	**4**	**76**

Distribution of Basal Skull Fractures

Mode of Trauma	Anterior Cranial Fossa	Middle Cranial Fossa	Posterior Cranial Fossa
RTA	63	49	32
Assault	2	5	2
Fall	5	9	12
Total	**70**	**63**	**46**

Table No. 8: Distribution of Intracranial Haemorrhages in relation to Site

Type of Haemorrhage	Mode of Trauma	SITE													Total
		Frontal	Temporal	Parietal	Occipital	Diffuse	Fronto-temporal	Temporo-Parietal	Parieto-Occipital	Fronto-Temporo-Parietal	Temporo-Parieto-Occipital	Anterior Cranial Fossa	Middle Cranial Fossa	Posterior Cranial Fossa	
Extra-dural haemorrhage	RTA	--	24	21	--	--	--	16	5	--	--	--	--	--	**66**
	Assault	--	--	6	--	--	--	--	3	--	--	--	--	--	**9**
	Fall	--	10	4	--	--	2	4	--	--	--	--	--	--	**20**
	Total	**0**	**34**	**31**	**0**	**0**	**2**	**20**	**8**	**0**	**0**	**0**	**0**	**0**	**95**
Sub-dural haemorrhage	RTA	3	19	9	2	56	7	30	16	9	16	3	2	--	**172**
	Assault	--	--	3	2	4	--	7	3	5	7	--	--	--	**31**
	Fall	--	4	4	2	17	2	17	4	4	--	--	--	4	**58**
	Total	**3**	**23**	**16**	**6**	**77**	**9**	**54**	**23**	**18**	**23**	**3**	**2**	**4**	**261**
Sub-Arachnoid haemorrhage	RTA	2	2	--	2	58	5	7	2	2	3	3	4	5	**95**
	Assault	--	--	--	--	6	--	2	--	--	3	--	--	--	**11**
	Fall	--	--	2	2	17	3	5	--	--	--	--	--	2	**31**
	Total	**2**	**2**	**2**	**4**	**81**	**8**	**14**	**2**	**2**	**6**	**3**	**4**	**7**	**137**
Intra-cerebral haemorrhage	RTA	4	--	2	--	45	3	--	2	--	--	--	--	--	**56**
	Assault	--	--	--	--	12	--	--	--	--	--	--	--	--	**12**
	Fall	--	--	--	--	30	2	--	--	--	2	--	--	--	**34**
	Total	**4**	--	**2**	--	**87**	**5**	--	**2**	--	**2**	--	--	--	**102**

Table No.9: Association between Site of Contusion and Type of Skull Fracture in various Modes of Trauma

Contusion Site	Mode of Trauma																	
	RTA						Assault						Fall					
	Type of Fracture						Type of Fracture						Type of Fracture					
	Linear	**Depression**	**Comminuted**	**Basal**	**Intact**	**Total**	**Linear**	**Depression**	**Comminuted**	**Basal**	**Intact**	**Total**	**Linear**	**Depression**	**Comminuted**	**Basal**	**Intact**	**Total**
Frontal	21	7	2	ACF-40	14	**84**	--	--	--	--	3	**3**	2	--	--	ACF-2	--	**4**
Temporal	21	2	--	MCF-7	11	**41**	6	--	--	MCF-2	8	**16**	10	--	--	MCF-2	--	**12**
Parietal	18	5	2	--	--	**25**	2	--	1	--	5	**8**	--	2	--	--	--	**2**
Occipital	9	2	1	PCF-11	11	**34**	2	--	--	--	3	**5**	8	6	--	--	5	**19**
Fronto-temporal	8	2	5	MCF-7	--	**22**	1	--	--	--	2	**3**	--	--	--	ACF-2	--	**2**
Temporo-parietal	11	5	14	MCF-3	--	**33**	2	--	--	MCF-1	--	**3**	2	2	--	--	--	**4**
Parieto-occipital	--	2	--	--	16	**18**	3	--	2	PCF-2	--	**7**	2	--	--	MCF-2	6	**10**
Fronto-temporo parietal	10	5	14	MCF-7	--	**36**	3	--	--	--	--	**3**	13	--	4	ACF-2	--	**19**
Temporo-parieto-occipital	3	--	--	PCF-13	--	**16**	--	--	--	--	1	**1**	--	--	--	PCF-6	6	**12**
Vertex	--	--	--	--	--	**--**	--	--	--	--	3	**3**	--	--	--	--	--	**--**
Total	**101**	**30**	**38**	**88**	**52**	**309**	**19**	**--**	**3**	**5**	**25**	**52**	**37**	**10**	**4**	**16**	**17**	**84**
	Vault fracture = 169			Basal Fracture = 88			Vault fracture = 22			Basal fracture = 5			Vault fracture = 51			Basal fracture = 16		

Table No.10: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in RTA

Age Group (Yrs)	RTA							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	9	17	11	5	--	9	--	2
16-30	29	51	31	16	--	10	5	10
31-45	17	40	16	10	2	14	7	5
46-60	4	11	11	7	2	9	4	5
>60	2	7	5	4	4	7	3	2
Total	**61**	**126**	**74**	**42**	**8**	**49**	**19**	**24**

Table No.11: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in Assault

Age Group (Yrs)	Assault							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	--	2	--	--	--	3	2	--
16-30	3	12	4	2	2	3	--	--
31-45	5	4	2	7	--	2	--	--
46-60	--	--	--	2	--	3	1	2
>60	--	2	2	--	--	--	--	--
Total	**8**	**20**	**8**	**11**	**2**	**11**	**3**	**2**

Table No.12: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in Fall

Age Group (Yrs)	Fall							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	--	6	4	6	--	2	--	--
16-30	8	10	4	2	2	2	8	4
31-45	10	15	13	11	--	10	0	4
46-60	--	4	6	4	--	--	2	2
>60	--	--	--	--	--	4	4	4
Total	**18**	**35**	**27**	**23**	**2**	**18**	**14**	**14**

Table No.13: Association of Incidence of Intracranial Haemorrhages with age in various modes of Trauma

Age group (Yrs)	Mode of Trauma														
	RTA					Assault					Fall				
	EDH	SDH	SAH	ICH	Total	EDH	SDH	SAH	ICH	Total	EDH	SDH	SAH	ICH	Total
0-15	9	26	9	7	51	--	3	--	--	3	--	8	4	6	18
16-30	30	58	30	27	145	4	15	5	2	26	10	18	7	4	39
31-45	19	53	19	14	105	5	6	2	7	20	8	25	14	16	63
46-60	5	19	14	12	50	--	3	2	3	8	--	4	8	5	17
>60	5	14	9	5	33	--	4	2	--	6	--	4	4	4	12
Total	**68**	**170**	**81**	**65**	**384**	**9**	**31**	**11**	**12**	**63**	**18**	**59**	**37**	**35**	**149**

- Pontine Haemorrhage – 5
- Cerebellar & IV Ventricular Haemorrhage - 7

Table No.14: Distribution of Brain Injuries in relation to site

Type of Brain Injury	Mode of Trauma	Site										Total
		Frontal	Temporal	Parietal	Occipital	Diffuse	Fronto-temporal	Temporo-Parietal	Parieto-Occipital	Fronto-Temporo-Parietal	Temporo-Parieto-Occipital	
Coup Contusion	RTA	26	11	12	5	--	5	12	4	7	4	86
	Assault	3	4	6	2	--	--	3	2	2	--	22
	Fall	--	2	2	12	--	--	2	2	1	--	21
	Total	**29**	**17**	**20**	**19**	**--**	**5**	**17**	**8**	**10**	**4**	**129**
Contre-Coup Contusion	RTA	7	2	12	11	--	3	3	2	5	2	47
	Assault	1	--	--	--	--	2	3	--	--	2	8
	Fall	2	--	--	--	2	2	2	--	--	--	8
	Total	**10**	**2**	**12**	**11**	**2**	**7**	**8**	**2**	**5**	**4**	**63**
Coup Laceration	RTA	29	4	7	--	7	5	4	3	7	4	70
	Assault	2	--	2	4	--	--	2	--	1	--	11
	Fall	6	5	--	--	2	4	--	--	2	--	19
	Total	**37**	**9**	**9**	**4**	**9**	**9**	**6**	**3**	**10**	**4**	**100**
Contre-Coup Laceration	RTA	12	2	3	2	--	--	3	--	--	--	22
	Assault	--	--	2	--	--	--	--	--	--	--	2
	Fall	2	--	--	--	--	2	--	--	--	--	4
	Total	**14**	**2**	**5**	**2**	**--**	**2**	**3**	**--**	**--**	**--**	**28**

	RTA	Assault	Fall
Base	54	6	12
Cerebellum	30	2	6

Table No. 15: Different Causes of Death in various Modes of Trauma

MODE OF TRAUMA	CAUSE OF DEATH							
	Diffuse Axonal Injury	Neurogenic Shock	Hemorrhagic Shock	Septicemic Shock	Associated Injury	Others	Asphyxia	Total
RTA	17	117	305	14	72	60	16	601
Assault	--	8	39	2	7	4	--	60
Fall	4	10	84	2	4	10	--	114
Total	**21**	**135**	**428**	**18**	**83**	**74**	**16**	**775**

Table No. 16: Associated Injuries in Different Modes of Trauma

MODE OF TRAUMA	AREA OF ASSOCIATED INJURY			
	Face	Chest	Abdomen	Limbs
RTA	203	259	229	370
Assault	12	20	8	17
Fall	35	29	16	39

Table No. 1: Distribution of Cases with respect to Month, and Mode of Trauma

Month	Mode of Trauma						Total
	2004			2005			
	RTA	ASLT	FALL	RTA	ASLT	FALL	
January	15	2	3	20	2	2	**44**
February	20	1	7	23	2	5	**58**
March	27	2	4	22	1	6	**62**
April	49	3	8	45	2	6	**113**
May	29	2	3	40	1	5	**80**
June	27	1	8	21	3	7	**67**
July	12	4	2	18	6	3	**45**
August	26	1	11	22	2	8	**70**
September	18	5	3	25	4	5	**60**
October	13	3	3	17	2	4	**42**
November	19	2	4	14	2	3	**44**
December	36	3	2	43	4	2	**90**
Total	**291**	**29**	**58**	**310**	**31**	**56**	**775**

Table No. 2: Distribution of Cases with respect to Mode of Trauma, Sex and Age

Age (Years)	Mode of Trauma																	
	RTA						Assault						Fall					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-15	75	15.06	45	43.69	120	19.96	5	11.11	2	13.33	7	11.67	6	7.50	8	23.53	14	12.28
16-30	205	41.16	18	17.47	223	37.10	20	44.44	9	60.00	29	48.33	23	28.75	6	17.65	29	25.44
31-45	121	24.29	23	22.33	144	23.96	14	31.11	0	0.00	14	23.33	41	51.25	12	35.29	53	46.49
46-60	76	15.26	14	13.60	90	14.97	3	6.67	1	6.67	4	6.67	8	10.00	2	5.88	10	8.78
>60	21	4.23	3	2.91	24	3.99	3	6.67	3	20.00	6	10.00	2	2.5	6	17.65	8	7.01
Total	**498**	**100.00**	**103**	**100.00**	**601**	**99.98**	**45**	**100.00**	**15**	**100.00**	**60**	**100.00**	**80**	**100.00**	**34**	**100.00**	**114**	**100.00**

Table No.3: Distribution of Cases with respect to Type of Vehicles and victims

Sl. No.	Type of Vehicle	Type of Victim	No. of Victims	Percent	Total
1	Heavy Motor Vehicle	Pedestrian	105	17.50	**283**
		Vehicle occupant	120	20.00	
		Driver	58	9.50	
2	Light Motor Vehicle	Pedestrian	30	5.00	**108**
		Vehicle occupant	58	9.50	
		Driver	20	3.30	
3	Motor Cycle/Scooter	Pedestrian	9	1.50	**111**
		Pillion Rider	38	6.40	
		Rider	64	10.60	
4	Cycle	Pedestrian	1	0.16	**19**
		Vehicle occupant	4	0.66	
		Driver	14	2.32	

Table No.4: Survival Time with respect to Age in RTA

Survival time	Age Group (Years)						
	0-15	16-30	31-45	46-60	>60	Total	Percent
Instantaneous death	43	58	39	19	2	161	26.79
Death within 6 hrs	30	81	37	28	5	181	30.12
Death within 12 hrs	10	25	11	11	7	64	10.65
Death within 24 hrs	14	7	12	4	3	40	6.65
Death within 72 hrs	5	12	9	5	4	35	5.82
Death after 72 hrs	10	14	14	18	3	59	9.82
Time not known	8	26	22	5	--	61	10.15
Total	**120**	**223**	**144**	**90**	**24**	**601**	**100.00**

$\chi^{2}_{2.4}$ d.f. = 40.22 . p<0.05.

Table No. 5: Distribution of Cases with respect to Day and Mode of Trauma

Day	Mode of Trauma			
	RTA	Assault	Fall	Total
Sunday	93	14	12	119
Monday	88	14	16	118
Tuesday	86	8	16	110
Wednesday	77	9	10	96
Thursday	73	5	20	98
Friday	109	4	18	131
Saturday	75	6	22	103
Total	**601**	**60**	**114**	**775**

χ^{2}_{12} d.f. = 11.05 p>0.05

Table No. 6: Distribution Scalp Injury with respect to Site

Scalp Injury	Mode of Trauma	Site											Total
		Frontal	Temporal	Parietal	Occipital	Vertex	Diffused	Fronto-temporal	Temporo-Parietal	Parieto-Occipital	Fronto-Temporo-Parietal	Temporo-Parieto-Occipital	
Contusion	RTA	40	37	21	21	8	--	11	11	19	23	5	196
	Assault	3	6	8	5	2	0	2	--	5	2	1	34
	Fall	12	6	4	21	4	--	--	8	4	2	--	61
	Total	**55**	**49**	**33**	**47**	**14**	**0**	**13**	**19**	**28**	**27**	**6**	**291**
Contused Abrasion	RTA	37	12	2	7	1	--	2	4	2	--	--	67
	Assault	--	--	--	--	1	--	2	--	--	--	--	3
	Fall	2	4	2	2	--	--	--	--	2	1	--	13
	Total	**39**	**16**	**4**	**9**	**2**	**--**	**4**	**4**	**4**	**1**	**--**	**83**
Laceration	RTA	56	19	25	17	9	28	12	14	9	23	4	216
	Assault	2	--	5	5	2	2	1	3	--	--	3	23
	Fall	10	4	2	8	--	2	2	2	--	--	2	32
	Total	**68**	**23**	**32**	**30**	**11**	**32**	**15**	**19**	**9**	**23**	**9**	**271**
Contused Laceration	RTA	11	14	11	9	--	3	5	2	12	--	--	67
	Assault	2	3	2	--	--	--	--	4	--	--	--	11
	Fall	4	4	3	12	--	--	--	--	--	3	--	26
	Total	**17**	**21**	**16**	**21**	**--**	**3**	**5**	**6**	**12**	**3**	**--**	**104**
Avulsed Laceration	RTA	--	--	2	--	2	--	--	--	--	--	--	4
	Assault	--	--	--	--	--	--	--	--	--	--	--	
	Fall	--	--	--	--	--	--	--	--	--	--	--	
	Total	**--**	**--**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**4**

Table No. 7: Distribution of cases with respect to Skull Fractures and Site

Type of Fracture	Mode of Trauma	SITE										Total
		Frontal	**Temporal**	**Parietal**	**Occipital**	**Diffused**	**Fronto-temporal**	**Temporo-Parietal**	**Parieto-Occipital**	**Fronto-Temporo-Parietal**	**Temporo-Parieto-Occipital**	
Linear	RTA	39	40	26	16	--	12	16	19	7	7	182
	Assault	--	8	5	3	--	2	6	4	3	--	31
	Fall	3	12	8	7	--	4	4	3	10	--	51
	Total	**42**	**60**	**39**	**26**	**--**	**18**	**26**	**26**	**20**	**7**	**264**
Depressed	RTA	16	9	16	4	--	5	9	1	7	--	67
	Assault	1	--	--	--	--	--	2	--	--	--	3
	Fall	2	--	2	5	--	--	--	--	4	--	13
	Total	**19**	**9**	**18**	**9**	**--**	**5**	**11**	**1**	**11**	**--**	**83**
Comminuted	RTA	7	--	5	5	35	12	21	3	22	--	110
	Assault	--	--	4	2	1	--	1	--	1	--	9
	Fall	2	1	--	--	5	--	3	1	5	--	17
	Total	**9**	**1**	**9**	**7**	**41**	**12**	**25**	**4**	**28**	**--**	**136**
Crush Comminuted	RTA	4	--	2	--	26	5	7	7	12	4	67
	Assault	--	--	--	--	2	2	--	--	--	--	4
	Fall	--	--	--	--	3	--	--	2	--	--	5
	Total	**4**	**--**	**2**	**--**	**31**	**7**	**7**	**9**	**12**	**4**	**76**

Distribution of Basal Skull Fractures

Mode of Trauma	Anterior Cranial Fossa	Middle Cranial Fossa	Posterior Cranial Fossa
RTA	63	49	32
Assault	2	5	2
Fall	5	9	12
Total	**70**	**63**	**46**

Table No. 8: Distribution of Intracranial Haemorrhages in relation to Site

Type of Haemorrhage	Mode of Trauma	SITE													Total
		Frontal	**Temporal**	**Parietal**	**Occipital**	**Diffuse**	**Fronto-temporal**	**Temporo-Parietal**	**Parieto-Occipital**	**Fronto-Temporo-Parietal**	**Temporo-Parieto-Occipital**	**Anterior Cranial Fossa**	**Middle Cranial Fossa**	**Posterior Cranial Fossa**	
Extra-dural haemorrhage	RTA	--	24	21	--	--	--	16	5	--	--	--	--	--	**66**
	Assault	--	--	6	--	--	--	--	3	--	--	--	--	--	**9**
	Fall	--	10	4	--	--	2	4	--	--	--	--	--	--	**20**
	Total	**0**	**34**	**31**	**0**	**0**	**2**	**20**	**8**	**0**	**0**	**0**	**0**	**0**	**95**
Sub-dural haemorrhage	RTA	3	19	9	2	56	7	30	16	9	16	3	2	--	**172**
	Assault	--	--	3	2	4	--	7	3	5	7	--	--	--	**31**
	Fall	--	4	4	2	17	2	17	4	4	--	--	--	4	**58**
	Total	**3**	**23**	**16**	**6**	**77**	**9**	**54**	**23**	**18**	**23**	**3**	**2**	**4**	**261**
Sub-Arachnoid haemorrhage	RTA	2	2	--	2	58	5	7	2	2	3	3	4	5	**95**
	Assault	--	--	--	--	6	--	2	--	--	3	--	--	--	**11**
	Fall	--	--	2	2	17	3	5	--	--	--	--	--	2	**31**
	Total	**2**	**2**	**2**	**4**	**81**	**8**	**14**	**2**	**2**	**6**	**3**	**4**	**7**	**137**
Intra-cerebral haemorrhage	RTA	4	--	2	--	45	3	--	2	--	--	--	--	--	**56**
	Assault	--	--	--	--	12	--	--	--	--	--	--	--	--	**12**
	Fall	--	--	--	--	30	2	--	--	--	2	--	--	--	**34**
	Total	**4**	--	**2**	--	**87**	**5**	--	**2**	--	**2**	--	--	--	**102**

Table No.9: Association between Site of Contusion and Type of Skull Fracture in various Modes of Trauma

Contusion Site	Mode of Trauma																	
	RTA						Assault						Fall					
	Type of Fracture						Type of Fracture						Type of Fracture					
	Linear	**Depres sion**	**Commi Nuted**	**Basal**	**Intact**	**Total**	**Linear**	**Depres sion**	**Commi Nuted**	**Basal**	**Intact**	**Total**	**Linear**	**Depres sion**	**Commi nuted**	**Basal**	**Intact**	**Total**
Frontal	21	7	2	ACF-40	14	**84**	--	--	--	--	3	**3**	2	--	--	ACF-2	--	**4**
Temporal	21	2	--	MCF-7	11	**41**	6	--	--	MCF-2	8	**16**	10	--	--	MCF-2	--	**12**
Parietal	18	5	2	--	--	**25**	2	--	1	--	5	**8**	--	2	--	--	--	**2**
Occipital	9	2	1	PCF-11	11	**34**	2	--	--	--	3	**5**	8	6	--	--	5	**19**
Fronto-temporal	8	2	5	MCF-7	--	**22**	1	--	--	--	2	**3**	--	--	--	ACF-2	--	**2**
Temporo-parietal	11	5	14	MCF-3	--	**33**	2	--	--	MCF-1	--	**3**	2	2	--	--	--	**4**
Parieto-occipital	--	2	--	--	16	**18**	3	--	2	PCF-2	--	**7**	2	--	--	MCF-2	6	**10**
Fronto-temporo parietal	10	5	14	MCF-7	--	**36**	3	--	--	--	--	**3**	13	--	4	ACF-2	--	**19**
Temporo-parieto-occipital	3	--	--	PCF-13	--	**16**	--	--	--	--	1	**1**	--	--	--	PCF-6	6	**12**
Vertex	--	--	--	--	--	**--**	--	--	--	--	3	**3**	--	--	--	--	--	**--**
Total	**101**	**30**	**38**	**88**	**52**	**309**	**19**	**--**	**3**	**5**	**25**	**52**	**37**	**10**	**4**	**16**	**17**	**84**
	Vault fracture = 169			Basal Fracture = 88			Vault fracture = 22			Basal fracture = 5			Vault fracture = 51			Basal fracture = 16		

Table No.10: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in RTA

Age Group (Yrs)	RTA							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	9	17	11	5	--	9	--	2
16-30	29	51	31	16	--	10	5	10
31-45	17	40	16	10	2	14	7	5
46-60	4	11	11	7	2	9	4	5
>60	2	7	5	4	4	7	3	2
Total	**61**	**126**	**74**	**42**	**8**	**49**	**19**	**24**

Table No.11: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in Assault

Age Group (Yrs)	Assault							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	--	2	--	--	--	3	2	--
16-30	3	12	4	2	2	3	--	--
31-45	5	4	2	7	--	2	--	--
46-60	--	--	--	2	--	3	1	2
>60	--	2	2	--	--	--	--	--
Total	**8**	**20**	**8**	**11**	**2**	**11**	**3**	**2**

Table No.12: Association of Intracranial Haemorrhages with & without skull fractures in various age groups in Fall

Age Group (Yrs)	Fall							
	With Skull Fracture				Without Fracture			
	EDH	SDH	SAH	ICH	EDH	SDH	SAH	ICH
0-15	--	6	4	6	--	2	--	--
16-30	8	10	4	2	2	2	8	4
31-45	10	15	13	11	--	10	0	4
46-60	--	4	6	4	--	--	2	2
>60	--	--	--	--	--	4	4	4
Total	**18**	**35**	**27**	**23**	**2**	**18**	**14**	**14**

Table No.13: Association of Incidence of Intracranial Haemorrhages with age in various modes of Trauma

Age group (Yrs)	Mode of Trauma														
	RTA					Assault					Fall				
	EDH	SDH	SAH	ICH	Total	EDH	SDH	SAH	ICH	Total	EDH	SDH	SAH	ICH	Total
0-15	9	26	9	7	51	--	3	--	--	3	--	8	4	6	18
16-30	30	58	30	27	145	4	15	5	2	26	10	18	7	4	39
31-45	19	53	19	14	105	5	6	2	7	20	8	25	14	16	63
46-60	5	19	14	12	50	--	3	2	3	8	--	4	8	5	17
>60	5	14	9	5	33	--	4	2	--	6	--	4	4	4	12
Total	**68**	**170**	**81**	**65**	**384**	**9**	**31**	**11**	**12**	**63**	**18**	**59**	**37**	**35**	**149**

- Pontine Haemorrhage – 5
- Cerebellar & IV Ventricular Haemorrhage - 7

Table No.14: Distribution of Brain Injuries in relation to site

Type of Brain Injury	Mode of Trauma	Site										Total
		Frontal	Temporal	Parietal	Occipital	Diffuse	Fronto-temporal	Temporo-Parietal	Parieto-Occipital	Fronto-Temporo-Parietal	Temporo-Parieto-Occipital	
Coup Contusion	RTA	26	11	12	5	--	5	12	4	7	4	86
	Assault	3	4	6	2	--	--	3	2	2	--	22
	Fall	--	2	2	12	--	--	2	2	1	--	21
	Total	**29**	**17**	**20**	**19**	**--**	**5**	**17**	**8**	**10**	**4**	**129**
Contre-Coup Contusion	RTA	7	2	12	11	--	3	3	2	5	2	47
	Assault	1	--	--	--	--	2	3	--	--	2	8
	Fall	2	--	--	--	2	2	2	--	--	--	8
	Total	**10**	**2**	**12**	**11**	**2**	**7**	**8**	**2**	**5**	**4**	**63**
Coup Laceration	RTA	29	4	7	--	7	5	4	3	7	4	70
	Assault	2	--	2	4	--	--	2	--	1	--	11
	Fall	6	5	--	--	2	4	--	--	2	--	19
	Total	**37**	**9**	**9**	**4**	**9**	**9**	**6**	**3**	**10**	**4**	**100**
Contre-Coup Laceration	RTA	12	2	3	2	--	--	3	--	--	--	22
	Assault	--	--	2	--	--	--	--	--	--	--	2
	Fall	2	--	--	--	--	2	--	--	--	--	4
	Total	**14**	**2**	**5**	**2**	**--**	**2**	**3**	**--**	**--**	**--**	**28**

	RTA	**Assault**	**Fall**
Base	54	6	12
Cerebellum	30	2	6

Table No. 15: Different Causes of Death in various Modes of Trauma

MODE OF TRAUMA	CAUSE OF DEATH							
	Diffuse Axonal Injury	Neurogenic Shock	Hemorrhagic Shock	Septicemic Shock	Associated Injury	Others	Asphyxia	Total
RTA	17	117	305	14	72	60	16	601
Assault	--	8	39	2	7	4	--	60
Fall	4	10	84	2	4	10	--	114
Total	**21**	**135**	**428**	**18**	**83**	**74**	**16**	**775**

Table No. 16: Associated Injuries in Different Modes of Trauma

MODE OF TRAUMA	AREA OF ASSOCIATED INJURY			
	Face	Chest	Abdomen	Limbs
RTA	203	259	229	370
Assault	12	20	8	17
Fall	35	29	16	39