Original Article

Correlation of Computed Tomography Scan and Autopsy Findings in Fatal Open Cranio-cerebral Trauma

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Abstract

Background : The gold standard for the post-mortem Forensic assessment of neuro-traumatologic and neuro-pathological findings is Autopsy. The goal of the present study was to evaluate the value of CT imaging as a diagnostic tool in head injury and to investigate the potential benefits and limitations of it in comparison with autopsy.

Aims and Objectives : The present study has been attempted to correlate Postmortem examination findings with 128 Slice Dual source Computed Tomography findings in fatal open head injury cases.

Materials and Methods : The present study group comprised of 60 cases of fatal open cranio-cerebral injuries, admitted at AJ Institute of Medical Sciences & Research Centre Hospital /AJ Hospital & Research Centre, Mangaluru, Karnataka in which CT Scans and Autopsy findings were correlated.

Results : Fifty eight cases had fractures, of which 49 were detected at CT Scan. Thirty seven cases had lacerations, of which 13 were detected at CT Scan. Among the Skull fractures the sensitivity of CT Scan was highest for detecting Skull Vault fractures (83%) and lowest for detecting of Middle Cranial Fossa fractures (65%).

Conclusions : This study emphasises that Autopsy is the gold standard in observing the various lesions amongst fatal cases.

Key words : Autopsy, Correlate, Craniocerebral Injuries, CT Scan, Imaging.

Incidence of head injury is rapidly increasing in the world, especially in the developing countries like India, basically due to increased vehicular traffic and poor maintenance of the roads. This is reflected in the statistics that show traumatic head injury to be the cause of death or severe disablement for thousands of persons each year[1.2]. While clinical assessment and judgment are important, emphasis has, in the past, been placed on radiological investigation as an adjunct to effective and safe treatment. The CT scan of head is indispensable in the diagnosis of the various traumatic lesions and their management and it also carries an important prognostic value. The goal of this study was to evaluate the value of CT imaging as a diagnostic tool in cases of open head injury and to investigate the potential benefits and limitations of it in comparison with Autopsy.

Editor's Comment :

- Autopsy is the gold standard to identify head injuries.
- In any case of death due to head injury, autopsy is likely to reveal injuries undetected by CT scans.
- CT scan remains as good standard in cases of trauma management but the accuracy is limited due to the structure of the skull and the views possible in CT.
- The data obtained from this study may be used to improve CT technology for future.

Aims and Objectives

To correlate postmortem examination findings with 128 Slice Dual source Computed Tomography findings in fatal open head injury cases.

To identify the lesions caused by open head injuries, that rare most likely to be missed or may remain undetected by 128 Slice Dual source Computed

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Tomography but are appreciated at Autopsy or vice versa.

To correlate our study with other national and Global studies.

To recommend means to minimize the discrepancies between CT Scan and Postmortem examination.

Materials and Methods

Source of Data :

Materials for the present study consists of 60 victims of fatal head injury admitted at A J Institute of Medical Sciences & Research Centre Hospital / A J Hospital & Research Centre, Mangaluru, Karnataka succumbed while on treatment and autopsied at the mortuary of A J Institute of Medical Sciences & Research Centre, between December, 2016 and April, 2018.

Sampling Technique :

Universal Sampling Method of Collection of Data.

Ethical Clearance :

It obtained from Institutional Ethical Committee before conducting the study. Written informed consent were taken from the legal heirs after detailed information given to them regarding the study of the deceased victims prior to the recording of various findings. Permission was obtained from the Dean to access the Hospital records of the victim for recording of various findings. The Postmortem findings of fatal head injuries were correlated with the antemortem 128 Slice Dual source Computed Tomography findings as described by the radiologist which were documented in a proforma. Finally, a comparison of CT findings and Postmortem findings of fatal head injuries were carried out, with the findings documented in the Postmortem protocols.

Time Interval :

1½ years (December, 2016 to April, 2018).

Inclusion Criteria :

Materials for the present study consists of all victims of fatal head injury admitted at A J Institute of Medical Sciences & Research Centre Hospital / AJ Hospital & Research Centre, Mangaluru, Karnataka who succumbed while on treatment and autopsied at the mortuary of AJ Institute of Medical Sciences & Research Centre, between December 2016 and April 2018.

Exclusion Criteria :

Any fatal injury case wherein there is complete distortion of structure of contents of head are excluded from the study.

Plan for data analysis: Statistical analysis was carried out using IBM SPSS Statistics (IBM Inc, version 17 for Windows) software package. The findings of the Multi Slice Computed Tomography and Postmortem of fatal head injuries were quantified and analyzed statistically using IBM SPSS Statistics (IBM 45 Inc, version 17 for Windows) software package for sensitivity of the imaging methods for each diagnostic criterion. A radiologist from the Radio-diagnosis unit reviewed the MDCT and certified the neuro-imaging findings.

Results

Ninety six cases of fatal cranio-cerebral injuries were admitted at A J Institute of Medical Sciences & Research Centre Hospital / A J Hospital & Research Centre, Mangaluru, Karnataka during the study period of around $1^1/_2$ years between December, 2016 and April, 2018. Among these 96 cases, Computed Tomography Scan was done in 60 cases, which formed our present study group. The latest Computed Tomography Scans of these cases were taken into consideration for correlation with the Autopsy findings in the present study.

Lacerations :

Thirty Four lesions of cerebral lacerations were found, of which 21 were of frontal lobe, 19 were of temporal

Table 1 — *Correlation of Lacerations at Autopsy with Computed Tomography Scan*

Lacerations	Revealed at Autopsy	Revealed at CT Scan	Not Revealed at CT Scan
Cerebrum	34	0	34 (100%)
Cerebellum	2	0	2 (100%)
Brainstem	2	0	2 (100%)

Table 2 — *Correlation of Lacerations at Autopsy with Computed Tomography Scan*

Cerebral Lacerations	Detected at Autopsy	Detected at CT Scan	Not Detected at CT Scan
Frontal Lobes	21	3 (14.29%)	18 (85.71%)
Temporal Lobes	19	1 (5.26%)	18 (94.74%)
Parietal	5	1 (20%)	4 (80%)
Occipital	7	0	7 (100%)

lobe, 5 were of parietal lobe and 7 were of occipital, of these none were revealed at Computed Tomography, as depicted in Tables 1 & 2.

There were 18 false negative and 3 true positive cases of frontal lobe lacerations. The sensitivity of CT Scan to detect frontal lobe lacerations in the present study was 14.29%.

There were 18 false negative and one true positive cases of temporal lobe lacerations. The sensitivity of CT Scan to detect temporal lobe lacerations in the present study was 5.26%.

Skull Fractures :

Fifty eight skull fractures were found on Postmortem examination, of which 58 were that of vault and 48 were of base, of these 48 vault fractures and 36 base fractures were detected at Computed Tomography Scan.

The involvement of the bones fractured in the vault included 20 frontal, 23 temporal, 4 of parietal and 11 involved occipital bone, of which 4 parietal bone, 19 temporal bone and all the fractures of frontal bone and occipital bones were detected at CT Scan, as depicted in Table 3.

Among the 48 skull base fractures, 22 were of Anterior Cranial Fossa, 17 of Middle Cranial Fossa and 9 of Posterior Cranial Fossa. Five fractures of Anterior Cranial Fossa, 6 of the Middle Cranial Fossa and one of the Posterior Cranial Fossa were not detected at CT Scan, as depicted in Table 4.

There were 10 false negative and 48 true positive cases of skull vault fractures.The sensitivity of CT Scan to detect skull vault fractures in the present study was 82.76%.

Table 3 — *Correlation of Skull Vault Fractures at Autopsy with Computed Tomography Scan*

Skull Vault Fractures	Revealed at Autopsy	Revealed at CT Scan	Not Revealed at CT Scan
Frontal Bone	20	20 (100%)	0
Temporal Bones	23	19 (82.61%)	4 (17.39%)
Parietal Bones	4	4 (100%)	0
Occipital Bone	11	11 (100%)	0

Table 4 — *Correlation of Skull Base Fractures at Autopsy with Computed Tomography Scan*

Skull Base Fractures	Detected at Autopsy	Detected at CT Scan	Not Detected at CT Scan
Anterior Cranial Fossa	22	17 (77.27%)	5 (22.73%)
Middle Cranial Fossa	17	11 (64.71%)	6 (35.29%)
Posterior Cranial Fossa	9	8 (88.89%)	1 (11.11%)

There were 5 false negative cases and 17 true positive cases of Anterior Cranial Fossa (ACF) fractures. The sensitivity of CT Scan to detect ACF fractures in the present study was 77.27%.

There were 6 false negative and 11 true positive cases of Middle Cranial Fossa (MCF) fractures. The sensitivity of CT Scan to detect MCF fractures in the present study was 64.71%.

There were 1 false negative and 8 true positive cases of Posterior Cranial Fossa (PCF) fractures. The sensitivity of CT Scan to detect PCF fractures in the present study was 88.89%.

Among the 58 skull vault fractures, 12 were of Comminuted, 24 of Fissure/Linear, 8 of Sutural/ Diastasis, 9 of Depressed, one of Ring and 5 of Hinge fracture. Four Comminuted Fractures, 16 Fissure/ Linear Fractures, 7 Sutural/Diastasis Fracture, one Ring Fracture and 5 Hinge Fracture were not detected at CT Scan.

There were 4 false negative and 8 true positive cases of comminuted fracture. The sensitivity of CT Scan to detect comminuted fracture in the present study was 66.67%.

There were 16 false negative and 8 true positive cases of Fissure/Linear fracture. The sensitivity of CT Scan to detect Fissure/Linear fracture in the present study was 33.33%.

There were 7 false negative and 1 true positive cases of Sutural Diastasis. The sensitivity of CT Scan to detect Sutural Diastasis in the present study was 12.5%.

There were 9 true positive cases and none false negative case of Depressed Fracture. The sensitivity of CT Scan to detect Depressed fracture in the present study was 100%.

There were 1 false negative and none true positive case of Ring Fracture. The sensitivity of CT Scan to detect Ring fracture in the present study was 0%.

Discussion

CT Scan is a widely used diagnostic tool for head injury as it is rapid, readily available and cost effective. The intracranial lesions included in our study were lacerations and fractures. The commonest intracranial lesion found was fractures followed by lacerations[3].

In the present study, the sensitivity of CT Scan for

Skull fractures was highest for fractures of Posterior Cranial Fossa fractures (88.89%) followed by Skull Vault fractures (82.76%) and lowest for Middle Cranial Fossa fractures (64.71%). While the study conducted by Menon revealed less sensitivity for Skull Vault fracture (56%) and Skull Base fractures (21%). Poulsen, *et al* detected skull fractures in 35 patients at CT scans among the 44 cases at autopsy, while Pathak, *et al* opined that the linear fractures of the skull are difficult to detect[4,5].

The correlation of skull fractures in the present study revealed 10 false negative cases of Skull Vault fractures, 5 false negative cases of Anterior Cranial Fossa fractures, 6 false negative cases of Middle Cranial Fossa fractures and one false negative case of Middle Cranial Fossa fractures. During routine CT examination of the head as many as 30 to 40 percent of fractures are not seen[6]. Non-displaced hairline fractures of mastoid process and petrous part of temporal bone are usually missed at CT Scan. False-negatives may occur with subtle fractures or when suboptimal technique is utilized[7]. Linear fractures especially that run parallel in the axial plane and the basal fractures are easily missed on CT Scans[5,7-9].

Conclusion

The present study group comprised of 60 cases of fatal cranio-cerebral injuries in which CT Scans and Autopsy findings were correlated.

Fifty eight cases had fractures, of which 49 were detected at CT Scan.

Thirty seven cases had lacerations, of which 13 were detected at CT Scan.

Statistical Analysis of the various lesions are as follows :

Among the lacerations the sensitivity of CT Scan for detecting Frontal lobe lacerations was 14% and the sensitivity of CT Scan for detecting Temporal lobe lacerations was 5%.

Among the Skull fractures the sensitivity of CT Scan was highest for detecting Skull Vault fractures (83%) and lowest for detecting of Middle Cranial Fossa fractures (65%).

Suggestions and Recommendations :

CT Scan with special zoom cuts for Posterior Cranial Fossa to reduce beam artefacts.

CT Scan with thin slices (less than 3 mm thickness) along various planes for detecting lesions like hairline fractures.

Contrast enhanced CT Scan for delineating lesions over Posterior Cranial Fossa. Large sample size and repeat CT Scan at different intervals.

Strong Points : This study emphasises that Autopsy is the gold standard in observing the various lesions amongst fatal cases and that virtopsy (imaging techniques) can be an adjuvant only as the proper description and appreciation of these injuries form a very vital cog in medico legal cases for the administration of justice.

Limitations : In this study correlation was done between autopsy and CT scan findings in fatal head injury cases. Only CT scan reports were used to analyze and compare. It would be more significant if a Radiologist is also involved in the study and more number of CT Scan shall be performed at regular intervals to accommodate evolving/developing lesions.

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Conflict of Interest : None

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