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Quality of Computerized Tomography Reporting in Traumatic Brain Injury (TBI) Among First Year Radiology Residents: To Believe or Not To?

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Abstract
Aim: *To assess accuracy and reliability of the computed tomographic diagnosis of traumatic brain injury (TBI) of first-year radiology residents during the first 6 months of training and to compare the misreporting rates and ascertain causes.*
Materials And Methods: *A total of 464 cases of CT brain trauma performed during the first 6 months of training were reviewed. The provisional reports given by first year residents of 464 cases were compared to the reports issued by the consultant radiologists and results were interpreted by statistical analysis. The causes of the misinterpretation were also assessed, like lack of knowledge of anatomy, not seen those findings earlier, forgot to see coronal/sagittal images, negligence, etc.*
Results: *The discrepancy rate during the first three months of training ranged from 32-44%. This was rather high is due to inexperience in vast field of radiology and lack of knowledge of anatomy. However, the discrepancy rate during the next 3 months greatly reduced to 12-22%. This is quite obvious as over a period of time and experience the reporting standards had improved. The cause of misinterpretation varied in the subsequent months.*
Conclusion:*Over a period of time and experience, the reporting of first year radiology residents improved. Causes of misinterpretation in CT trauma reporting assessed can be helpful in improving quality and standards of reporting among first-year radiology residents. The accuracy of the residents on call is important to monitor to ensure continued patient safety and good quality care.*
Keywords: *CT- Computerized tomography; TBI- traumatic brain injury; GCS-Glasgow coma scale*

I. Introduction

Traumatic brain injury (TBI) is an extremely common and potentially life threatening problem.1 Cranial CT is currently the modality of choice in the initial work-up of head as it not only assesses the severity of injuries to help in any potential need for intervention but also helps in documentation for future needs.2 According to the New Orleans criteria, patients which require cranial CT in TBI include: headache, vomiting, age greater than 60 years, drug or alcohol intoxication, seizures, short term memory loss, evidence of trauma above clavicles.3 Radiology residents in our hospital play a vital role in reporting after hour trauma scans and are the first to provide a provisional report. Provisional reports are then followed by a consultant's final report the very next day. As a result CT reports provided by the residents must be both apt and precise. Therefore, misinterpretation has the potential for substantial morbidity and mortality. The purpose of this study is to evaluate precision and consistency of the computed tomographic diagnosis of traumatic brain injury (TBI) and to compare the inter-observer variation of CT reports of TBI between among first-year radiology residents during the initial 6 months of training with experienced consultant radiologists and to evaluate the misreporting rates and establish causes of misreporting.

II. Materials And Methods

A total of 464 cases for CT brain with brain trauma performed during the first 6 months of training were reviewed. The provisional reports given by first year residents of 464 cases were compared to the reports issued by the consultant radiologists and results were interpreted by statistical analysis. The causes of the misreading were also assessed, like lack of knowledge of anatomy, not seen those findings earlier, forgot to see coronal/sagittal images, negligence, etc.

All the study participants who included the four radiology residents who were on call and the consultant radiologists finalizing were double blinded with respect to the study. Furthermore, we determined whether any correlation existed between error rate and years of training.

The reports from both the consultants and residents was collected and entered in Microsoft excel 2014, all the four first year residents were interviewed individually for the individual reports they had reported and were assessed. Data was analysed using SPSS version 16.0 and presented as percentages and proportions.

III. Results

Data collected from the study is shown in table 1. It shows the distribution of CT brain trauma patients based on normal and abnormal findings (by consultant radiologists) with right and missed/wrong findings (by residents)

Statistical analysis of the test was interpreted and shown in table 2.

Any difference in interpretation was identified and quantified. Errors were divided into either major errors or minor errors. The frequency of major and minor errors was shown in table 3. Some of the major errors encountered include missed skull base fractures, mandibular fractures, missed small hemorrhagic contusions, missed nasal bone fractures, and missed tiny sub arachnoid hemorrhages in the sulci, Sub dural hemorrhage in the falx /interhemispheric fissures. (Figures 1,2,3,4) Minor findings included improper or failure to mention soft tissue swellings, sub galeal hematomas, lacerations in the provisional reports.

Causes of misreporting was also assessed and categorized into 5 causes namely, forgot to view coronal/sagittal images, lack of knowledge of anatomy, inexperience, negligence and inadequate time/urgency factors(as shown on table 4.1). The causes assessed were also categorized with each month (table 4.2).

IV. Discussion

Radiology requires acquaintance to master as with all other medical specialties. An assumption buoyed by a number of previous studies would be that residents during their initial months of training make more interpretation errors than their senior counterparts.

The rationale for quantifying errors (major v/s minor) was based on their impact on patient management. It is easy to accept that a major misinterpretation could result inmajor mismanagement of the patient. For example, when no mention is made of cerebral edema is made, the swelling may progress to herniation and eventually death. Similarly, by not recognizing important fractures, the patient may develop infection, hemorrhage or even paralysis.

The reviewed literature revealed discrepancy rates ranging from 0.9% to 25%. 4,5,6,7

The discrepancy rate during the first three months of training ranged from 32-44%. This was rather high is due to inexperience in vast field of radiology and lack of knowledge of anatomy. However, the discrepancy rate during the next 3 months greatly reduced to 12-22%. This is quite obvious as over a period of time and experience the reporting standards had improved.

During the first few months of training, the residents on call missed a significant number of soft tissue swellings, cerebral edema, skull base fractures, spine and mandibular fractures but in identifying obvious findings like extra-dural hemorrhages, large subdural hemorrhages and obvious fractures, the accuracy was good. The cause of misinterpretation varied in the subsequent months. The results show that false-positive findings were more common during the first 3 months of training. This included wrongly interpreting cerebral edema, reporting sutures as fractures, etc.

V. Conclusion

Results show that over a period of time and experience, the reporting of first year radiology residents improved. Factors which may have affected discrepancy rates were investigated. Causes of misinterpretation in CT trauma reporting assessed can be helpful in improving quality and standards of reporting among first-year radiology residents. The accuracy of the residents on call is important to monitor to ensure continued patient safety and good quality care. As always a quality audit helps improve outcomes. Regular quality audits must be performed at all tertiary care institutes so as to help in the management of patients and improve the overall outcome.

VI. Recommendations

A set protocol needs to be put into effect in reporting every case of CT in traumatic brain injury and every duty resident in their initial practicing days should follow the same to avoid most, if not all the errors.

Limitations

As the study only evaluates the discrepancy rate of all the residents working in the department overall, challenges like inter observer variation, knowledge and understanding of the subject with each resident could not be assessed. The study only involves assessing the quality of CT reporting of traumatic brain injury and does not assess the overall merit and caliber of the residents.

Footnotes
Conflict of interest- None
Financial Disclosure- None

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	NORMAL		ABNORMAL		TOTAL CT BRAIN TRAUMA
TRAINING PERIOD	RIGHT	MISSED/WRONG	RIGHT	MISSED/WRONG	
1ST MONTH	30	9	5	20	67
2ND MONTH	28	5	5	19	48
3RD MONTH	27	2	18	19	66
4TH MONTH	50	2	40	21	113
5TH MONTH	53	0	32	11	98
6TH MONTH	44	0	20	6	72
TOTAL	**232**	**18**	**120**	**78**	**464**

Table 1- showing distribution of CT brain trauma patients based on normal and abnormal findings (by consultant radiologists) with right and missed/wrong findings (by residents)
Normal

- Right- Refers to CT brain trauma which was normal and reported as normal by us
- Missed/wrong- refers to CT brain trauma which were falsely interpreted by us but where actually normal Eg- Sutures lines wrongly given as fractures, reporting as cerebral edema when it is not there
  Abnormal
- Right- findings which where abnormal and reported correctly
- Missed/Wrong- findings which where abnormal and missed

SENSITIVITY	93.33%	95% CI: 89.54% TO 96.07%
SPECIFICITY	37.8%	95% CI: 31.2% TO 44.75%
POSTIVE LIKELIHOOD RATIO	1.5	95% CI: 1.34 TO 1.68
NEGATIVE LIKELIHOOD RATIO	0.18	95% CI: 0.11 TO 0.29
POSITIVE PREDICTIVE VALUE	64.6%	95% CI: 59.5% TO 69.5%
NEGATIVE PREDICTIVE VALUE	82.2%	95% CI: 73.1% TO 89.3%

Table 2- Results of statistical analysis

FINDING MISSED	FREQUENCY	PERCENTAGE
MAJOR	73	76
MINOR	23	24
TOTAL	96	100%

Table 3: Frequency and percentages of Missed/ wrong major and minor findings
Major Findings- Missed Sdh,Sah, Hemorrhagic Contusions, All Types Of Maxillo Facial, Cranial And Spine Fractures, Cerebral Edema, Etc Minor Findings- Soft tissue swellings, lacerations.

CAUSE OF MIS- REPORTING	FREQUENCY	PERCENTAGE
1. FORGOT TO SEE CORONAL AND SAGITTAL IMAGES	12	16
2. LACK OF KNOWLEDGE OF ANATOMY	12	16
3. INEXPERIENCE/ NOT SEEN FINDINGS EARLIER	19	26
4. NEGLIGENCE	18	24
5. INADEQUATE TIME/ HURRY FACTOR	13	18
TOTAL	**74**	**100**

Table 4- Distribution of causes of misreporting with frequency and percentage

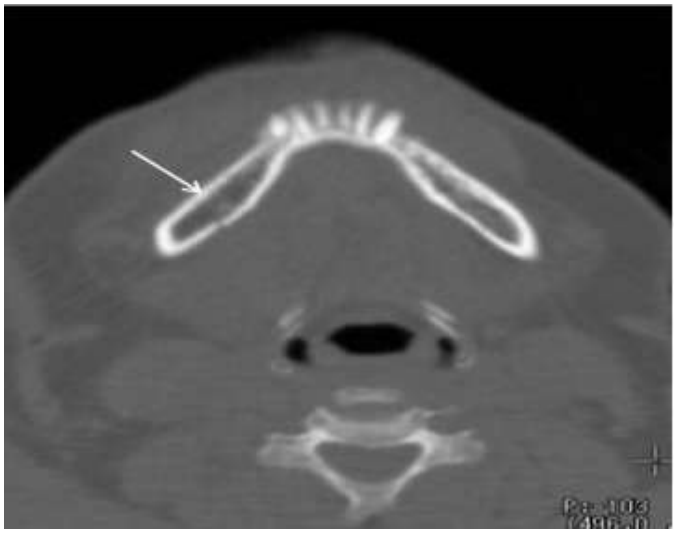

Figure 1- Axial CT image showing body of mandible fracture (white arrow), which was missed

Figure 2- Axial CT image showing missed findings of fracture spinous process of C2 (white arrow)

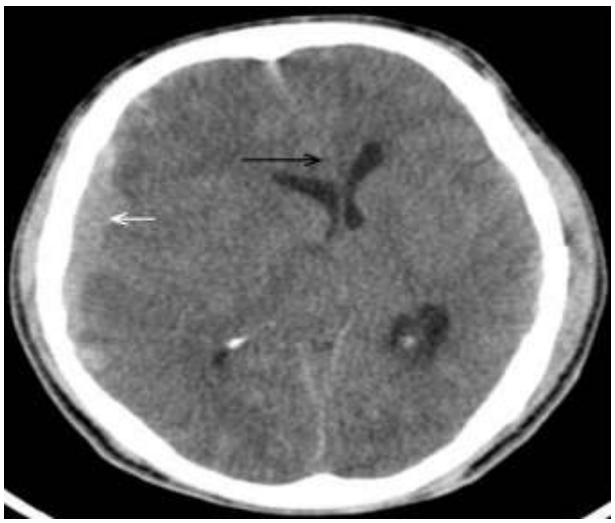

Figure 3- Axial CT image showing brain window. In this patient although SDH (white arrow) and midline shift (black arrow) was mentioned in the provisional report, there was no mention of cerebral edema.

Figure 4- Axial CT image showing a linear undisplaced hard palate fracture which was missed (white arrow).

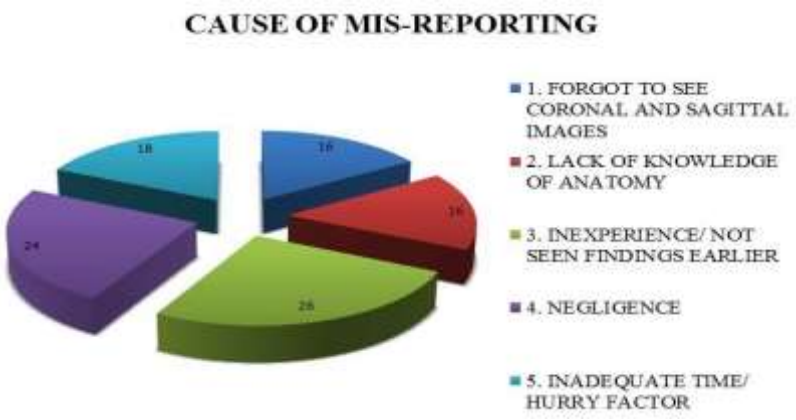

Figure 5- Pie chart showing the frequency distribution with the causes of misreporting (colour coded), as in table 4

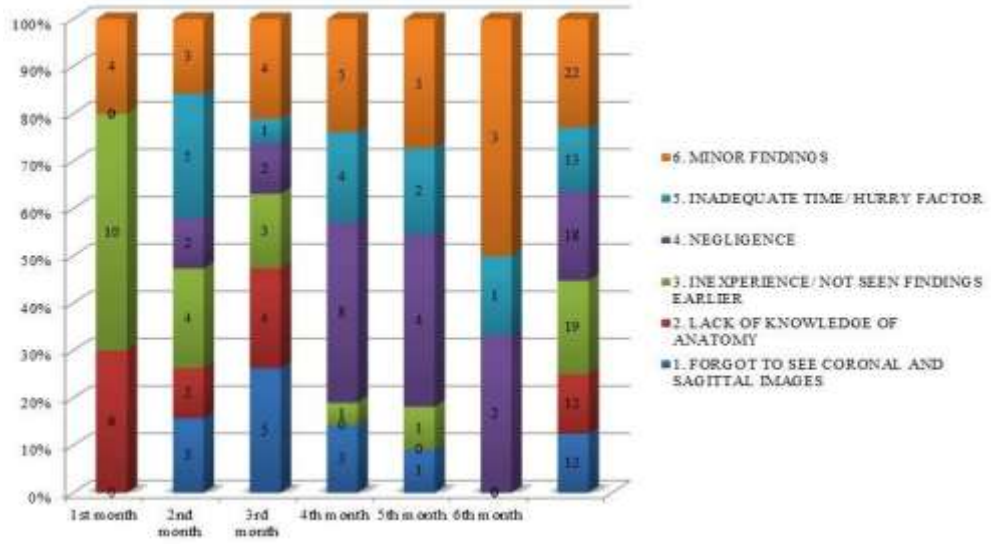

Figure 6- Bar chart showing the frequency of causes of misreporting (colour coded) with each month (as in table 4)