DIFFERENCES IN THE INTERPRETATION OF COMPUTED TOMOGRAPHY SCANS OF HEAD TRAUMA BY RADIOLOGY RESIDENTS AND RADIOLOGISTS

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INTRODUCTION

Worldwide, an estimated 10 million people are affected annually by traumatic brain injury (TBI)1,2. The risk factors for TBI are the extremes of age, male gender and low socioeconomic status3. The leading causes of TBI are falls and road traffic accidents3. Chronologically, TBI can be classified into primary and secondary. Primary injuries result from mechanical forces at the moment of impact and are considered irreversible. Primary injuries include axonal injury, intracerebral haemorrhage, subdural haemorrhage, extradural (epidural) haemorrhage, contusion, laceration and fracture4. Secondary injuries result from the body’s physiological response or complication of the primary injury. Management of TBI is aimed at prevention of secondary injury5. Glasgow Coma Scale (GCS) is clinical scoring system used to assess clinical severity of TBI. Up to 75% of TBI’s are of mild severity but are associated with significant medical costs for potential disability, loss in productivity and psychiatric complications6. Non contrast CT scan of the brain has high sensitivity for intracranial hemorrhage, hydrocephalus, herniation and skull fractures. Thus, it is the imaging modality of choice for assessment of TBI and clinical decision making7. Although trained neuroradiologists may be available at some centers at all hours every day, many centers in Pakistan do not have this capability. The interpretation of CT scans for TBI is often carried out by radiology residents especially during on call hours. Although the scans may be interpreted by the attending consultant and the report finalized later, the opinions given by the resident can change the direction of clinical management. Thus, misinterpretation of findings on CT
scans can lead to considerable morbidity and mortality.

The aim of the study was to determine the extent of differences on findings of CT scan in head trauma between radiology residents and radiologists.

**METHODOLOGY**

This dual center cross-sectional study was performed at Abbasi Shaheed Hospital and Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan from March 2018 to February 2019. Approval was obtained from research ethics review committee of JPMC with a waiver of informed consent.

A total of 1004 Patients with head trauma above 18 years of age, referred to the radiology departments of Abbasi Shaheed Hospital and JPMC for reporting CT scan of brain were included with consecutive sampling. Patients with any underlying pathology like tumor or demyelinating disease were excluded. The CT scans at both institutes were unenhanced and performed on either Toshiba Aquilion 16 CT scanner using standard cranial CT parameters (slice thickness of 5 mm, 120kv, 200-400 Mas, pitch vary according to patient weight). Window width varied taken narrow (80-100) for brain and wide (150-200) to differentiate between extra axial collection and skull. The studies were transferred to picture archiving and communication system (PACS). CT scans were randomly interpreted and reported by radiology residents. Year 2 and 3 were regarded as junior and those in year 4 of training as senior residents. CT scans were then read by attending radiologists with (more than 5 years of experience) in neuroradiology. They were assessed on the basis of major discrepancy, minor discrepancy or similar findings. Major discrepancy was hypothesized on missing primary injuries including bleed or fracture. While minor discrepancy was defined as missing secondary injuries including cerebral edema and subcutaneous swelling. The findings of both radiology residents and radiology consultants were recorded on a proforma. The proforma also recorded demographic details of the patients.

The data were entered into a Microsoft Excel worksheet (Microsoft, Redmond, Washington). Statistical analysis was performed by using commercial statistical software package SPSS version 20 (IBM, Armonk, New York). The questionnaire and excel output sheet of texture analysis were imported into SPSS for data analysis.

**RESULTS**

The study population comprised of 639 male and 365 females. Among them, 618 (61.6%) CT scans were interpreted by a junior resident and 386 (38.4%) by a senior resident (Table 1).

The junior residents had findings that were in agreement with findings on the final report. Compared with the consultant radiologists, junior residents had similar findings on 339 (54.8%), there was major discrepancy on 111 (18.0%) scans and minor discrepancy on 168 (27.2%) scans. The senior residents also had findings that were in agreement with findings on the final report. Compared with the consultant radiologists, senior residents had similar findings on 196 (50.7%) scans, but major discrepancy on 84 (21.8%) scans and minor discrepancy on 106 (27.5%) scans. In both residents group, subarachnoid and parenchymal bleeds with subtle subdural haemorrhages were major missed findings. Lesion such as those shown in figure 2 was easily identified by residents. However, a subtle subdural hematoma as in figure 3 was missed.

Chi-square test was applied and it was found that there were no significant differences in the findings of junior and senior residents (p = 0.264). The results are summarized in Table 2.

**Figure 1: Type of myocardial infarction**

**Figure 2: CT scan axial image at the level of frontal sinus showing a right fronto-temporal lobe contusion which the senior resident easily picked but he missed the subdural hematoma along right frontal bone and therefore, this is a major discrepancy.**
Table 1: Comparative accuracy of interpretation by junior and senior residents

<table>
<thead>
<tr>
<th>Compared with an experienced radiologist</th>
<th>Total</th>
<th>Same</th>
<th>Minor discrepancy</th>
<th>Major discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior residents</td>
<td>618</td>
<td>339</td>
<td>168 (27.2%)</td>
<td>111 (18.0%)</td>
</tr>
<tr>
<td>Senior residents</td>
<td>386</td>
<td>196</td>
<td>106 (27.5%)</td>
<td>84 (21.8%)</td>
</tr>
</tbody>
</table>

Table 2: Types of discrepancies among junior and senior residents

<table>
<thead>
<tr>
<th>Assessment</th>
<th>CT Findings</th>
<th>S</th>
<th>MiD</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture with subcutaneous swelling</td>
<td>Fracture &amp; Bleed</td>
<td>Intracranial bleed associated with cerebral edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior Residents (R2 and R3) N=618</td>
<td>S</td>
<td>MiD</td>
<td>MD</td>
<td>S</td>
</tr>
<tr>
<td>121</td>
<td>52</td>
<td>43</td>
<td>119</td>
<td>78</td>
</tr>
<tr>
<td>Senior Residents (R4) N=386</td>
<td>88</td>
<td>33</td>
<td>21</td>
<td>72</td>
</tr>
</tbody>
</table>

S=Similar findings, MiD=Minor Discrepancy, MD=Major Discrepancy.

DISCUSSION

Our study provides insight into the discrepancy in interpretation of posttraumatic cranial CT scan findings. To the best of our knowledge, this is the first study to explore this in the country and it also provides a snapshot into the quality of training at two major postgraduate training centers in the largest city of Pakistan.

Many institutions struggle to provide around-the-clock attending radiologist coverage, either with in-house coverage or using teleradiology. While independent interpretations during on-call reporting may be a valuable experience for residents, the accuracy and safety of this practice remains questionable as emergency medicine physicians rely on radiologists for management. The Radiology Resident Review Committee of the Accreditation Council for Graduate Medical Education (ACGME) has begun a requirement of 1 year of residency training before allowing a resident to take independent call. Discrepancies in interpretation of imaging studies have been reported. The rate of discrepancies is reported to be the lowest in CT head with lower rates of adverse clinical outcomes.

Numerous studies have discrepancy rates with the range of 2% to 13%. The finding in our study that accuracy is not significantly increased between junior and senior residents has also been reported by other studies. Studies have reported slight increase in resident accuracy with an increase in training level, but the error rates are similar to those of attending radiologists. Strub et al. reported discrepancies between overnight preliminary CT head interpretations by residents and the final report as 4.59%. Tieng et al. found a discrepancy rate of 10% between preliminary interpretation by radiology resident and the final interpretation by radiology attending radiologist for body imaging scans from emergency room (ER). A prospective analysis of 716 emergency head CT scans found that the discrepancy rate was 3%. Around 23% of these reports had final reviews that differed somewhat from residents’ preliminary interpretations. Of these 716 patients, three had pituitary abnormalities not mentioned by the res-
LIMITATIONS

1. Selection bias: the findings may be institution-dependent and not generalizable.

2. Clustering bias: Our study followed a consecutive series of patients during a specific period during which preliminary interpretations were made.

3. Our primary outcome was discrepant interpretations between radiology residents and radiology attending physicians, not accuracy.

CONCLUSION

Interpretations by senior and junior residents of CT scans in patients with head trauma did not differ significantly. However, senior residents showed a greater difference with the radiologist than junior residents.

RECOMMENDATIONS

Continuous monitoring of residents’ results is important to achieve an equal threshold of competency and for maintaining or improving patient safety. However, to improve the training of residents, further studies are needed with data masking for radiologists.

REFERENCES


CONTRIBUTORS

FF conceived the idea, planned the study, drafted initial manuscript and supervised the whole project. NK, IK and FK helped acquisition and analysis of data, critical revision of the manuscript, correction of manuscript and bibliography. TS, SMA and SS helped in critical revision, statistical analysis and finalization of the manuscript after reviewers’ corrections. All authors contributed significantly to the published article.