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

Faryal Farooq[1], Noman Khan[2], Imran Khan[3], Faheemullah Khan[4], Tayyab Semab[5], Syed Mubarak Ali[6], Shaista Shaukat[7]

[1,7] Jinnah Post Graduate Medical Centre, Karachi - Pakistan.
[2] Pir Abdul Qadir Shah Jilani Institute of Medical Sciences, Kkhairpur - Pakistan.
[3,4] Aga Khan University Hospital, Karachi - Pakistan.
[5] Lady Reading Hospital, Peshawar - Pakistan.
[6] Abbassi Shaheed Hospital, Karachi - Pakistan.
Address for correspondence:
Faryal Farooq
Jinnah Post Graduate Medical Centre, Karachi - Pakistan.
E-mail: f.faryal2012@gmail.com
Date Received:
March 3,2020
Date Revised:
July 5, 2020
Date Accepted:
July 15, 2020

ABSTRACT

Objective: To determine difference in the in interpretation of findings on computed tomography (CT) scan in head trauma between radiology residents and radiologists.

Methodology: This cross-sectional study assessed the difference in interpretation of CT scans of head trauma between radiology residents and experienced radiologists at Abbasi Shaheed Hospital and Jinnah Postgraduate Medical Centre, Karachi, Pakistan, from March 2018 to February 2019. CT scans for head trauma performed in the emergency department were interpreted and reported by radiology residents and radiologists. They were assessed on the basis of major discrepancy, minor discrepancy or similarity of findings.

Results: During the study period, 1004 patients (365 women, 639 men) underwent CT scans for head trauma. Of these scans, 618 (61.6%) were reviewed by junior residents and 386 (38.4%) by senior residents. Compared with the radiologists, junior residents had similar findings on 339 scans (54.8%), but had major discrepancy on 111 (18.0%) scans. Senior residents had similar findings on 196 scans (50.7%), but major discrepancy on 84 scans (21.8%) scans. Chi-square test was applied to find difference.

Conclusion: Interpretation of CT scans by senior and junior residents in patients with head trauma did not differ significantly. Still, senior residents showed a greater difference with the radiologists than junior residents.

Key Words: CT Scan, Head trauma, Traumatic brain injury (TBI), Resident, Radiologist,

This article may be cited as: **Farooq F, Khan N, Khan I, Khan F, Semab T, Ali SA, Shaukat S. Differences in the interpretation of computed tomography scans of head trauma by radiology residents and radiologists. J Postgrad Med Inst 2020; 34(2): 91-4.**

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 status[1]. The leading causes of TBI are falls and road traffic accidents[3]. 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 fracture[4]. Secondary injuries result from the body's physiological response or complication of the primary injury. Management of TBI is aimed at prevention of secondary injury[1]. Glasgow Coma Scale (GCS) is clinical scoring system used to assess clinical severity of TBI. Up to 75% of TBIs' are of mild severity but are associated with significant medical costs for potential disability, loss in productivity and psychiatric complications[2]. 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 making[1]. 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 residents 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

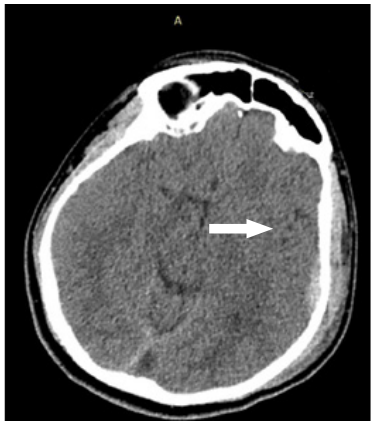
		Compared with an experienced radiologist		
	Total	Same	Minor discrepancy	Major disrepancy
Junior residents	618	339 (54.9%)	168 (27.2%)	111 (18.0%)
Senior residents	386	196 (50.8%)	106 (27.5%)	84 (21.8%)

Table 2: Types of discrepancies among junior and senior residents

Assessment	CT Findings														
	Fracture with subcutaneous swelling			Bleed			Fracture & Bleed			Fracture associated with extra cranial bleed			Intracranial bleed associated with cerebral edema		
	S	MiD	MD	S	MiD	MD	S	MiD	MD	C	MiD	MD	C	MiD	MD
Junior Residents (R2 and R3) N=618	121	52	43	119	78	39	99	38	29	76	22	31	58	24	20
Senior Residents (R4) N=386	88	33	21	72	47	38	36	26	25	52	12	8	39	12	11

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

Figure 3: CT scan axial image shows a showing a left subdural hematoma which was reported as normal by junior resident.



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[5]. 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 in-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[5,6]. 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[7].

Numerous studies have discrepancy rates with the range of 2% to 13%[6]. The finding in our study that accuracy is not significantly increased between junior and senior residents has also been reported by other studies[5,8]. 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[9–11]. Strub et al. reported discrepancies between overnight preliminary CT head interpretations by residents and the final report as 4.59%[12]. 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)[6]. 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-

idents[13].

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

1. Gean AD, Fischbein NJ. Head trauma. Neuroimaging Clin N Am [Internet]. 2010;20:527–56.
2. Nguyen R, Fiest KM, McChesney J, Kwon C-S, Jette N, Frolkis AD, et al. The International Incidence of traumatic brain injury: a systematic review and meta-analysis. Can J Neurol Sci. 2016;43:774–85.
3. Faul M, National Center for injury prevention and control (u.s.). division of injury response., Wald MM, Wu L, Coronado VG. Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths, 2002-2006 [Internet]. 2010. Available at: http://dx.doi.org/10.15620/cdc.5571
4. Finnie JW. Neuroinflammation: beneficial and detrimental effects after traumatic brain injury. Inflammopharmacology. 2013;21:309–20.
5. Cooper VF, Goodhartz LA, Nemcek AA Jr, Ryu RK. Radiology resident interpretations of on-call imaging studies: the incidence of major discrepancies. Acad Radiol. 2008;15:1198–204.
6. Tieng N, Grinberg D, Li SF. Discrepancies in interpretation of ED body computed tomographic scans by radiology residents. Am J Emerg Med. 2007 ;25:45–8.
7. ACGME Program Requirements for Graduate Medical Education in Diagnostic Radiology. Section VI.B.2. Effective July 1, 2008. Available at: http://www.acgme.org/acWebsite/downloads/RRC_progReq/420_dr_07012008.pdf.
8. Wechsler RJ, Spettell CM, Kurtz AB, Lev-Toaff AS, Halpern EJ, Nazarian LN, et al. Effects of training and experience in interpretation of emergency body CT scans. Radiology. 1996. p. 717–20. Available from: http://dx.doi.org/10.1148/radiology.199.3.8637994
9. Erly WK, Berger WG, Krupinski E, Seeger JF, Guisto JA. Radiology resident evaluation of head CT scan orders in the emergency department. AJNR Am J Neuroradiol. 2002;23:103–7.
10. Wysoki MG, Nassar CJ, Koenigsberg RA, Novelline RA, Faro SH, Faerber EN. Head trauma: CT scan interpretation by radiology residents versus staff radiologists. Vol. 208, Radiology. 1998. p. 125–8. Available from: http://dx.doi.org/10.1148/radiology.208.1.9646802
11. Ruchman RB, Jaeger J, Wiggins EF, Seinfeld S, Thakral V, Bolla S, et al. Preliminary radiology resident interpretations versus final attending radiologist interpretations and the impact on patient care in a community hospital. American Journal of Roentgenology. 2007; 189 :523–6.
12. Strub WM, Leach JL, Tomsick T, Vagal A. Overnight preliminary head CT interpretations provided by residents: locations of misidentified intracranial hemorrhage. AJNR Am J Neuroradiol. 2007;28:1679–82.
13. Erly WK, Ashdown BC, Lucio RW, Carmody RF, Seeger JF, Alcala JN et al. evaluation of emergency CT scans of the head: is there a community standard? Am J Roentgenol 2003; 180: 1727-30.

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.