Association of Cervical Spine Findings on Computed Tomography in patients with Blunt Head injury: Correlation with Mechanism of Injury

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in Diagnostic Radiology.

Johannesburg, 2016

Declaration

I, **Evance Chisama Jr**, declare that this research report is my own work. It is being submitted for the degree of MMed (RadD) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Dr. EVANCE CHISAMA Jr.

On this **26th** day of **January 2016.**

Dedication

I dedicate my work to my mother **Euphrasia Jane Chithode Chisama** who tirelessly encouraged and supported my will to excel and kept on reminding me that in her job as teacher she has been proud to help a lot of students that were not her children to success and now she wants to be proud of her own children success. To my late father, **Evans Joseph Chisama,** you opened the doors for my success, may your soul rest in eternal peace.

Publications and presentations

This work has never been published.

It has never been presented at a congress.

Abbreviations

ATLS	Advanced Trauma Life Support
CCR	Canadian C-spine Rule
CEO	Chief Executive Officer
CHBAH	Chris Hani Baragwanath Hospital
CT	Computed Tomography
C-spine	Cervical spine
GCS	Glasgow coma scale
HREC	Human Research Ethics Committee
MVA	Motor vehicle Accident
NEXUS	National Emergency X-Radiography Utilization Study
PVA	Pedestrian Vehicle Accident

Abstract

Introduction:

Blunt trauma to the head carries a greater risk of C-spine injuries due to the anatomical aspect of the region. However, this is influenced by a lot of factors which among them would be the mechanisms of injury. Understanding how the outcome of the C-spine injury is affected by the mechanisms of injury, this information could be used as predictor to C- spine injury hence prompt to further radiological investigations to patient with blunt head trauma.

Objective:

The study was performed to correlate the pathological findings involving the c-spine, as detected by CT in patients with blunt head injury and the mechanisms of injury

Material and Method:

Nine hundred and fifty CT scan reports of blunt trauma patient where CT brain and CT C-spine of the performed were retrospectively reviewed (75.58% male preponderance against 24.42% of females, mean age 34.96 range 18-96yrs).The major aspects of interest in this study were patients history of loss of consciousness, mechanisms of injury which was categorized into motor vehicle accidents, pedestrian vehicle accidents, assaults, falls and others, clinical findings of cervical spine tenderness and the initial GCS.

Results:

Of 950 cases, 53 (5.58%) showed acute spine injuries and only the mechanisms of injury showed significant association with the acute spine injuries (p=0.001). Furthermore, the linear regression model showed that among the mechanism of injury, the patient involved in motor

vehicle accidents and pedestrian vehicle accident carried highest probabilities of acute spine injuries (6 folds and 2 folds respectively) as compared to the patients that were assaulted.

Conclusion:

The study demonstrates a low incidence of acute Cspine injuries in patient with blunt head trauma as detected on CT with mechanism of injury being the only statistically significant a predictive factor of acute C spine injuries.

Acknowledgements

First and foremost I thank God for the gift of life and the blessings I enjoy as Psalms 121 says “I lift up my eyes to the hills. From where does my help come? My help come from the LORD maker of heaven and earth”.

I am grateful to my supervisor Dr L.T. Hlabangana for taking her time in assisting and encouraging me throughout my project, without her, my dream would not come true. May the blessings of the good LORD be upon her.

I would like to thank Prof. V. Mngomezulu and the entire department of Radiology of Wits for the support you put to my studies.

To my brothers Peter and Benjamin Chisama and the entire family thank you for moral and financial support you have given me throughout without you I could not have done this alone.

To all my friends and colleagues you have been so wonderful to me.

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1. Rationale

Blunt trauma to the head is one of the common presentations with a known associated risk to cervical spine (c-spine) injuries (1). However, among blunt trauma mechanisms of injury, blunt assault unlike other high energy mechanisms of injury, is known to have very low incidence of associated cervical spine injuries. This is due to low energy kinematics involved in the injury (2). Despite that different mechanisms of injury carry different associated risks of cervical spine injuries, the standard trauma care use protocols and principles that consider all head injuries carrying a similar risk of cervical spine injury. Therefore, as part of standard practice, prompt patient evaluation of the cervical spine injury recommends radiological assessment of the cervical spine as part of management (3).Of late, Advance Trauma Life Support (ATLS) principles recommends computed tomography(CT) scan as the modality of choice in evaluating cervical spine injuries due to its superiority in the sensitivity and specificity (99 -100%) over conventional radiography (85 -90%). This has lead to the increase in the number of CT scan done especially in trauma patients(3).

The rationale of this study is to explore whether there is a correlation of pathological findings involving the c-spine, as detected by CT in patients with blunt head injury, and the mechanisms of injury, especially those whose mechanism of injury are blunt assaults for patients referred to radiology department at Chris Hani Baragwanath Academic Hospital (CHBAH), a hospital with the highest referral for trauma services in South Africa.

2. Background

Doctors at CHBAH treat an estimated number of 16000 to 18000 of trauma cases annually including the blunt head trauma cases (4). According to the literature, blunt head trauma carries a risk of cervical spine injury based on the anatomical aspect of the region(5). Because of the devastating consequences cervical spine injury might carry, to avoid missing cervical spine injury prompt evaluation of the cervical spine after blunt trauma is mandatory as evident by the principles of American College of Surgeons that trauma occurring above the clavicle should raise a high suspicion for potential cervical spine injury(6).

The incidence of cervical spine injuries following blunt trauma ranges in the literature from 2.0 % -4.0% (7)but the incidence increases in unconscious patients to 34.4 %(7).

The Canadian cervical spine functional test has shown to have a very high sensitivity for unstable cervical spine injuries, which in the asymptomatic, awake, and alert patient with a normal neurological examination the range of motion of the cervical spine can be assessed and be cleared clinically(8). On the other hand the National Emergency X-Radiography Utilization Study (NEXUS) low – risk criteria indicates that all trauma patient meeting its criteria which includes being an awake patient with normal level of alertness; no history, signs, or laboratory evidence of distracting injury; no evidence of intoxication; no focal neurologic deficit; no cervical spine pain or midline tenderness must be cleared without imaging(9). However, Stiell et al has shown that alert patients with trauma who are in stable condition, the Canadian C-spine rule (CCR) is superior to the NEXUS Low –Risk Criteria (NLC) with respect to sensitivity and specificity for cervical-spine injury, and its use would result in reduced rates of radiography(10). According to the Eastern Association for the Surgery of Trauma (EAST) guidelines, from which most of trauma protocols were developed, there is less emphasis on the mechanism of injury being the pre-indicator for the outcome(11).

In comparing different mechanisms of injury, blunt assaults, unlike motor vehicle accident and other high imparted energy (IE) mechanisms, have low incidence of c spine injuries due to low energies kinematic involved. (2).

Kulavatunyou et al demonstrated a 0.7% incidence of cervical spine injuries following blunt assault of cervical spine when using the CT (2). This correlates with the low rates that have been found in other literatures including studies performed by Hadzizacharia et al (12) and Rhee et al (6). These two studies showed the incidence of cervical spine injuries in blunt assaults to be 0.6 % and 0.5% respectively. These findings are supported by a study done by Kim et al (13) where similar trends have also been demonstrated in children. Kim et al study also demonstrated that occurrences of c spine injuries in children are more often associated with major mechanism of injury such as motor vehicle accidents (13) . No studies of this nature have been conducted in South Africa.

3. Primary Objective

This study aims to correlate pathological findings involving the c-spine, as detected by CT in patients with blunt head injury, and the mechanisms of injury.

4. Methods

4.1. Research paradigm and Sample

A cross sectional, retrospective study was conducted in the department of radiology at CHBAH, a level 1 trauma center with catchment population of approximately 3,640,067 in Johannesburg, South Africa(4).

Radiological reports of patients with blunt trauma where CT of the brain and cervical spine were performed in the year 2013 were reviewed. These were chronologically selected and every other report was reviewed. The study population included patients of all ages above 18 years.

A representative sample size of this type of study as calculated using the literature prevalence and the formula below is 59. However, in this study a time frame of six months i.e.1st January 2013 –30 June 2013 was used to review radiological reports of patient that underwent CT scan of the brain and C-spine following blunt head trauma, since there was no known incidence in the literature for South Africa.

$$\frac{Z^2 \times P \times (1-P)}{C^2}$$

Z = 95% confidence interval ±1.96 SD. **P**- Prevalence of Cervical spine injuries (5%). **C**-Significance level 0.05

Therefore: $$\mathbf{SS} = \frac{1.96^2 \times (4/100) \times (1-4/100)}{0.05^2}$$

$$= \frac{3.8416 \times 0.04 \times 0.96}{0.0025}$$

$$= 59.01$$

4.2. Materials and Methods

4.2.1. Technical Aspects

All the scans that will be reviewed were performed on 64 and 128 slice CT (Toshiba Aquilon) scanners. As a standard way of practice, patients were scanned in supine position with or without head blocks. For CT brain patients were scanned from just above the vertex to the first

cervical spine (C1) and for c-spine patients were scanned from the bases of skull including the temporal bones to the first thoracic spine (T1). No contrast was used for both scans of the head and the c-spine. The average radiation dose of the studies was recorded on the request forms.

4.2.2 Radiological Aspects

All CT scan studies of the brain and C-Spine were reported on workstation by radiology registrars and consultants review the provisional reports within 24 hours. The feedback is given to the clinical team if there are any changes to the provisional reports.

CT C-spine findings are considered abnormal if there is an acute bony injury including fractures and sublaxation of C-spine vertebral body elements.

Abnormal findings on CT brain that indicate acute brain injury include the presence of skull fractures, intracranial bleeds and intraparanchymal bleeds with or without associated mass effects, mid line shift and entrapment hydrocephalus.

4.2.3 Clinical information

The clinical information of the patient was recorded retrospectively from the radiological request forms filled by the clinical team. The relevant information on patient's history included the mechanism of injury and history of loss of consciousness. On the other hand, the relevant examination findings included the level of consciousness which was recorded as Glasgow coma scale (GCS) and cervical spine tenderness status. The Glasgow coma scale was recorded as a value out of 15 with 3 as a minimum Glasgow coma scale and the cervical spine tenderness was recorded as present or absent

The mechanisms of injury for the blunt injury were categorized into:

1. Motor Vehicle Accident
2. Pedestrian Vehicle Accident
3. Assault
4. Fall and others

4.3. Data collection

All the information was collected on a data collection form (Appendix 1). When all the necessary data were collected they were entered into an Excel spreadsheet with variables for analysis coded accordingly (Appendix 2).

5. Data analysis and statistics

The data was analysed using statistical package for social science (SPSS) software. Study descriptors were analysed as frequencies and percentages proportions were compared using χ^2 *test*. The level of significance shall be defined as $p < 0.05$.

6. Ethics

6.1. Consent

The permission to use the hospital medical records was sought through a letter to Chief Executive Officer (CEO) of Chris Hani Baragwaneth Hospital and the Head of Department of Radiology department. The letter briefly explained the research objectives and how the medical records were used as well as assurance of confidentiality (Appendix 3). The human research ethic committee (medical- HREC) approved the research under clearance certificate number: M140932 (Appendix 4).

6.2. Data Safety

To maintain the patient's confidentiality, patient information was anonymously entered by study numbers that were randomly generated. To protect the data collected there was dedicated hard drive and a copy of it was only be accessible to the principal investigator and supervisor.

7. Results

7.1. Description of the Study population

The study population consisted of reviews of reports for the blunt trauma patients above the age of 18 years who underwent CT brain and C-spine scan at Chris Hani Baragwanath Academic Hospital.

A total 950 scans were performed for the period between 1 January 2013 and 30 June 2013

Of the 950 reviews the male to female preponderance represented about three quarters (75.58%) of the patients, against 24.42% of females as shown in figure 1.

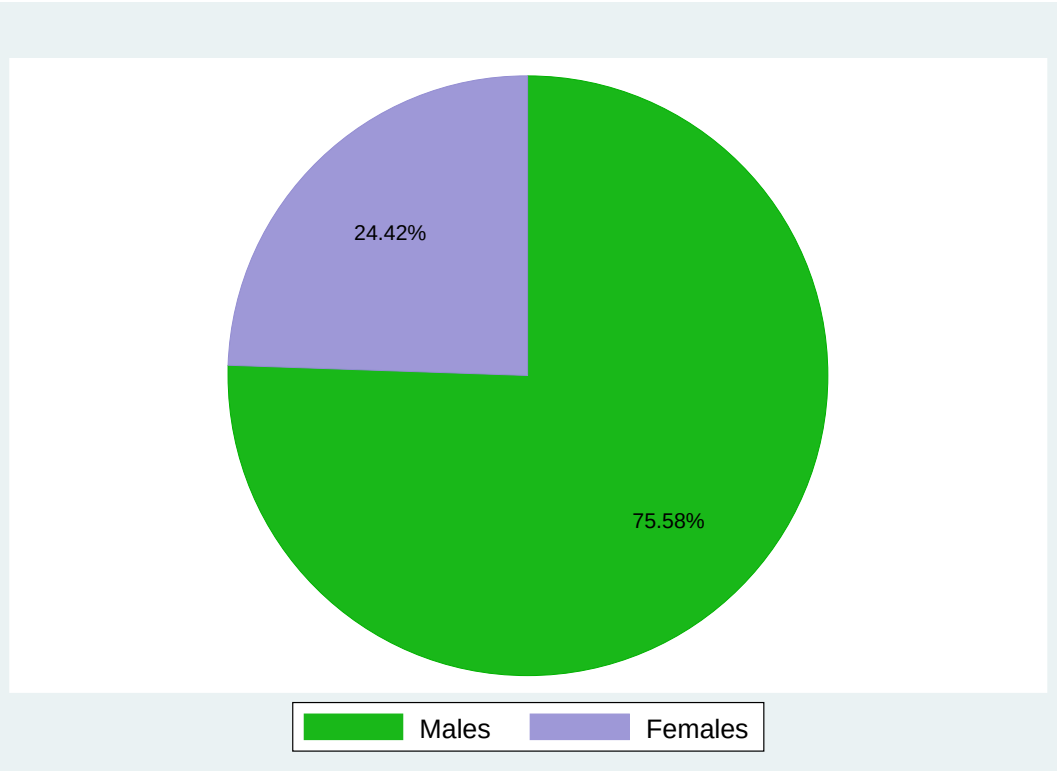


Figure 1. Gender Distribution of patients with blunt trauma where CT brain and C-spine were performed.

On average, these blunt trauma patients were 34.96 years with a standard deviation of 13.935 shown in figure 2

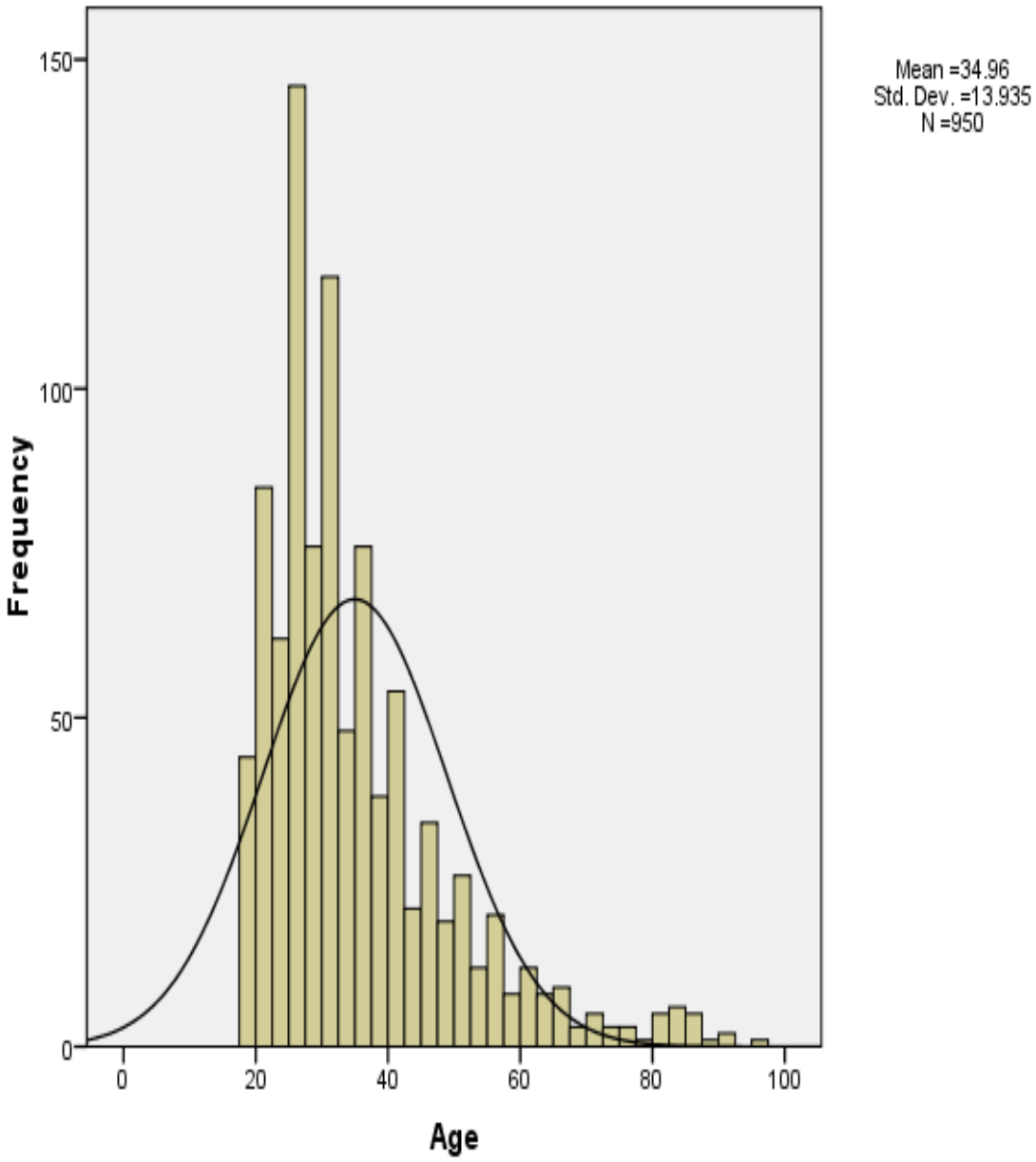


Figure 2. Age Distribution of patients with blunt trauma where CT brain and C-spine were performed.

There was a significant difference between males and females with respect to their age. As shown in figure 3, females presenting with injuries were relatively older compared to their male counterparts

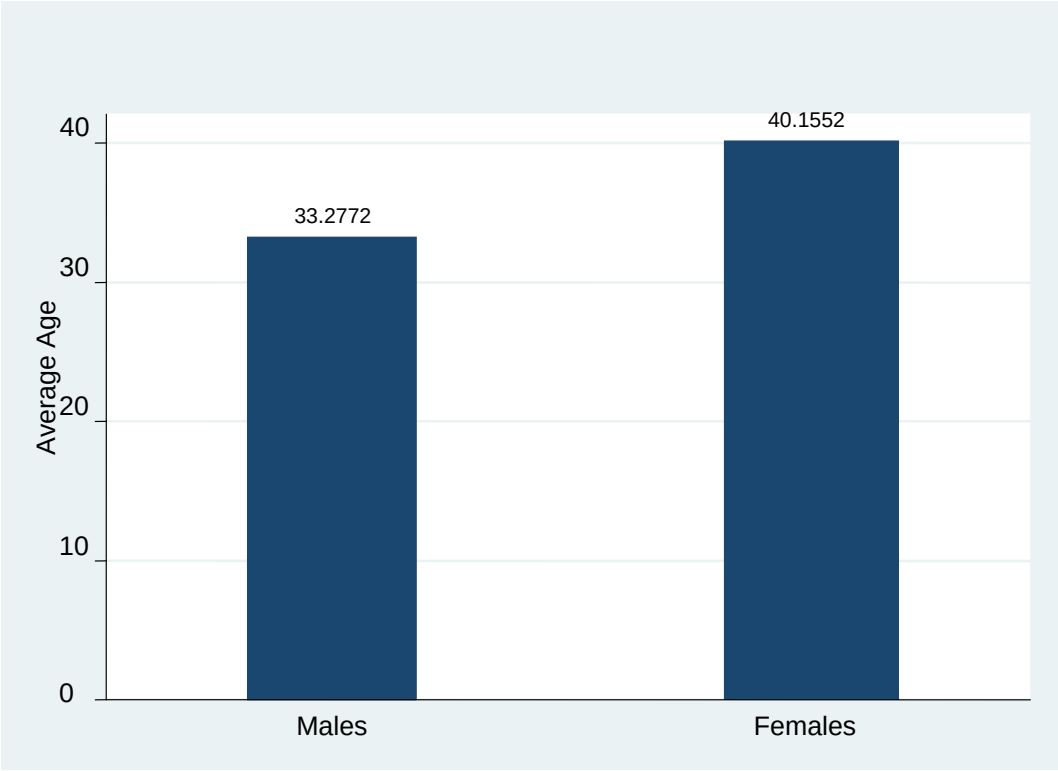


Figure 3. Age Distribution by sex of patients with blunt trauma where CT brain and C-spine were performed.

Table 1 below, summaries the baseline characteristics of the blunt trauma patients above the age of 18 years who underwent a CT brain and C-spine.

Table 1. Summary of baseline characteristics of patients with blunt trauma where CT brain and C-spine were performed.

Variable	
Mean age[†] (SD)	34.96 ($^{+}/_{-}$ 13.93)
Sex	
Male	718 (75.58%)
Female	232 (24.42%)
Mechanism of injury	
Motor vehicles Accident (MVA)	298 (31.37%)
Pedestrian vehicle Accident (PVA)	177 (18.63%)
Assaults	365 (38.42%)
Falls and others	110 (11.58%)
Glasgow coma scale (mean, SD)	13.75 ($^{+}/_{-}$ 2.51)
Loss of Consciousness	
Absent	2 (0.21%)
Present	948 (99.79%)
Cervical Tenderness	
Absent	8 (0.84%)
Present	942 (99.16%)
Acute Brain Injury	
Absent	768 (80.84%)
Present	182 (19.16%)
Acute Spine Injury	
Absent	897 (94.42%)
Present	53 (5.58%)

7.2. Association between the baseline characteristics of the injuries and C-Spine Injury

As demonstrated in table 1 above, of the 950 patients who were scanned, 53 (representing 5.58%) had an acute spine injury. The main interest of the study was to discuss whether the mechanism through which the injury occurred could affect the probabilities of developing an acute spine injury. Table 2 below summaries the results of the association between the above characteristics and C-spine injury

Table 2. Summary of the associations between characteristics of injuries and C-spine injuries in patients with blunt trauma where CT brain and C-spine were performed.

Variable	Acute Spine Injury Status		P-value[†]
	Present	Absent	
Mean age[†] (SD)	37.53 ($^{+}/_{-}$14.74)	34.80 ($^{+}/_{-}$13.88)	0.17
Sex			
Male	37 (5.15%)	681 (94.85%)	0.32
Female	16 (6.90%)	216 (93.10%)	
Mechanism of injury			
Motor vehicles Accidents (MVA)	33 (11.07%)	265 (88.93%)	**0.001**
Pedestrian vehicle Accidents (PVA)	9 (5.08%)	168 (94.92%)	
Assaults	8 (2.19%)	357 (97.81%)	
Falls and others	3 (2.73%)	107 (97.27%)	
Glasgow Coma Scale(mean, SD)	13.30 ($^{+}/_{-}$3.17)	13.77 ($^{+}/_{-}$2.46)	0.19
Loss of Consciousness			
Present	53 (5.59%)	0 (0.00%)	1.00[Fisher]
Absent	895 (94.41%)	2 (100.00%)	
Cervical Tenderness			
Present	52 (5.52%)	890 (94.48%)	0.37[Fisher]
Absent	1 (12.50%)	7 (85.50%)	
Acute Brain Injury			
Present	14 (7.69%)	168 (92.31%)	0.16
Absent	39 (5.08%)	729 (94.92%)	

Note: *p-values in this table refer to Pearson Chi Square test unless otherwise indicated*
p-value for equality of mean values for age and Glasgow coma scale between those with Acute spine injury and those without, refers to an independent t-test

The results of the tests of associations performed reveals that only mechanism through which injuries occurred were associated with acute C-spine injuries. Figure 4 below clearly demonstrates differences in the proportions of those with acute C spine injuries among the the different mechanisms of injuries.

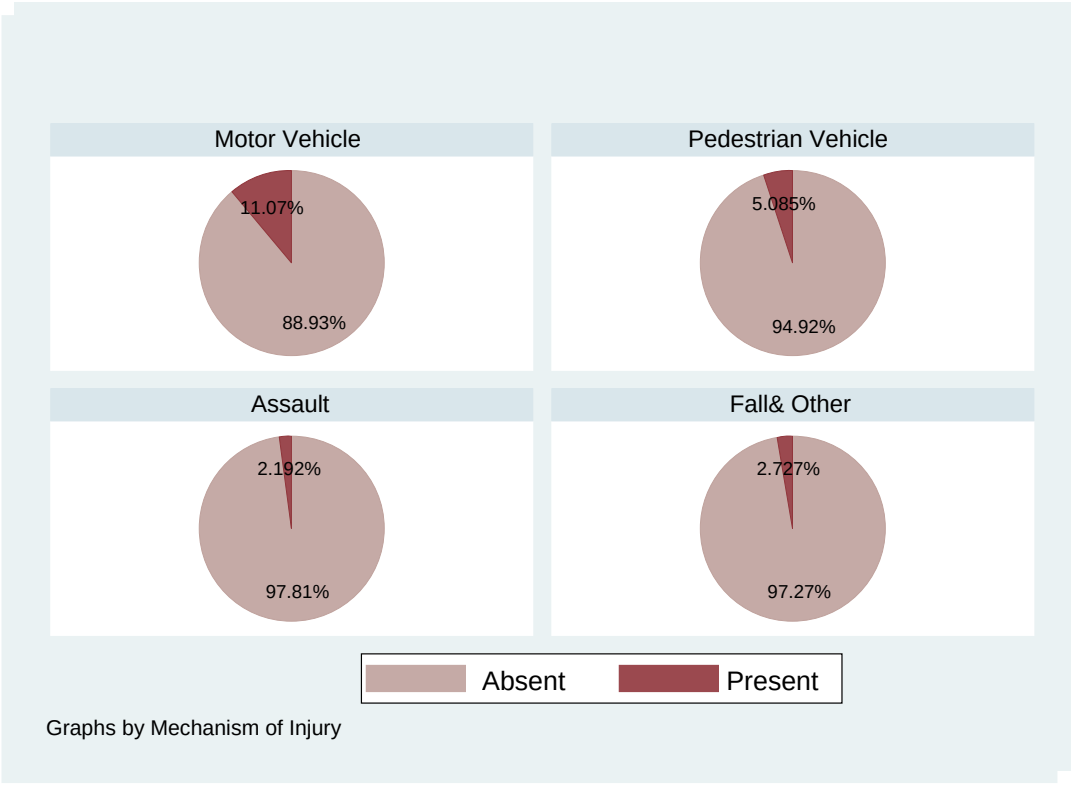


Figure 4. Distribution of mechanisms of injury by cervical spine injury status in patients with blunt trauma where CT brain and C-spine were performed.

Figure 4 vividly demonstrates that among the four mechanisms of injuries, acute spine injuries had a similar trend with large proportion of patients without acute injuries and with only 2 – 11% with positive findings. However, motor vehicle accidents seems to have the largest proportion of acute spine injuries (11.07%) of the motor vehicles injuries and assaults having the lowest proportions of spine injures (2.19%).

Glasgow coma scale showed no association with C- spine injuries irrespective of how severe the Glasgow Coma Scale were at presentation or initially recorded as clearly illustrated in figure 5 below.

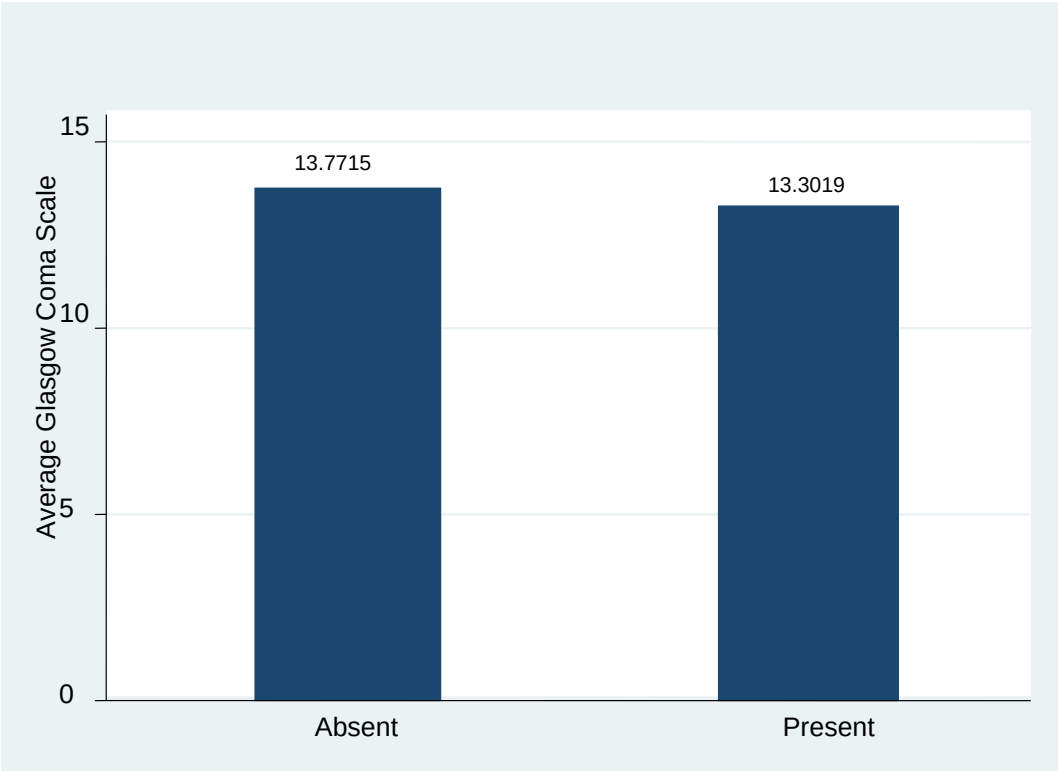


Figure 5. Distribution of Glasgow coma scale by cervical spine injury status in patients with blunt trauma where CT brain and C-spine were performed.

The same pattern was observed for cervical tenderness and loss of consciousness. No significant difference was observed between those patients that did not lose their consciousness and those that lost their consciousness with respect to spine injury status as shown in Figure 6 below.

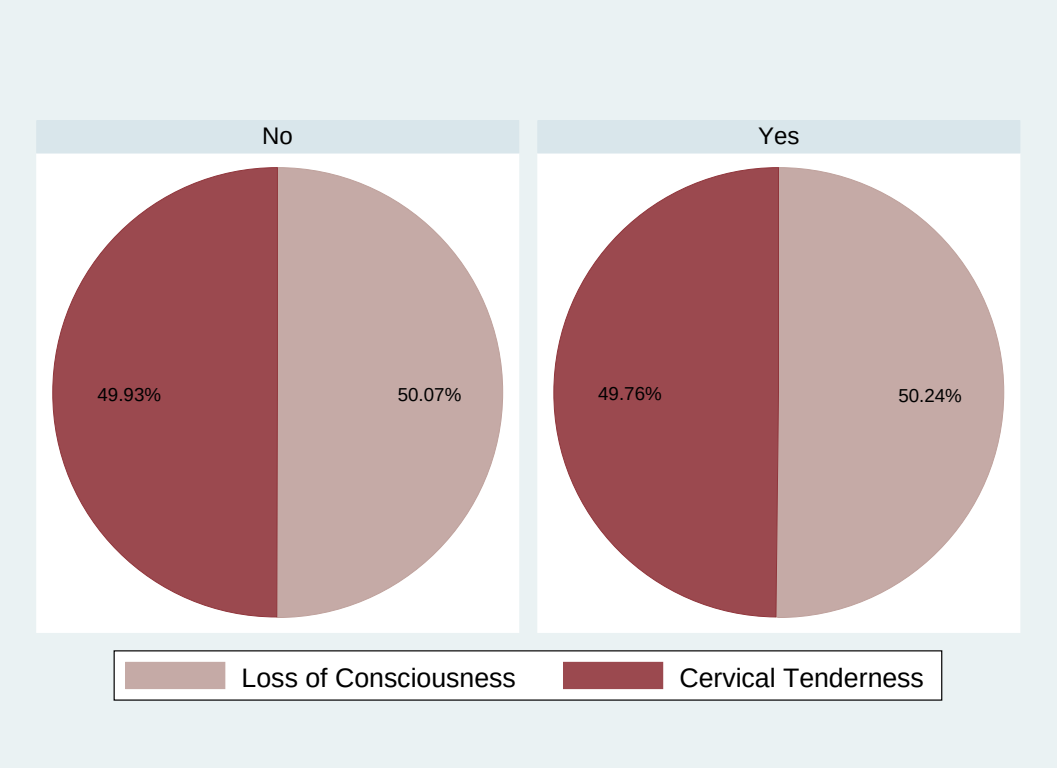


Figure 6. Distribution of cervical tenderness and Loss of consciousness by cervical spine injury status in patients with blunt trauma where CT brain and C-spine were performed.

Figure 6 above shows that loss of consciousness (50.07%) and cervical tenderness (49.93%) were evenly distributed between those with acute spine injures and those without injuries (50.24% and 49.76% respectively).

In addition, age and sex did not show any association with acute spine injuries as presented in table 2. Figure 7 clearly illustrates the relationship.

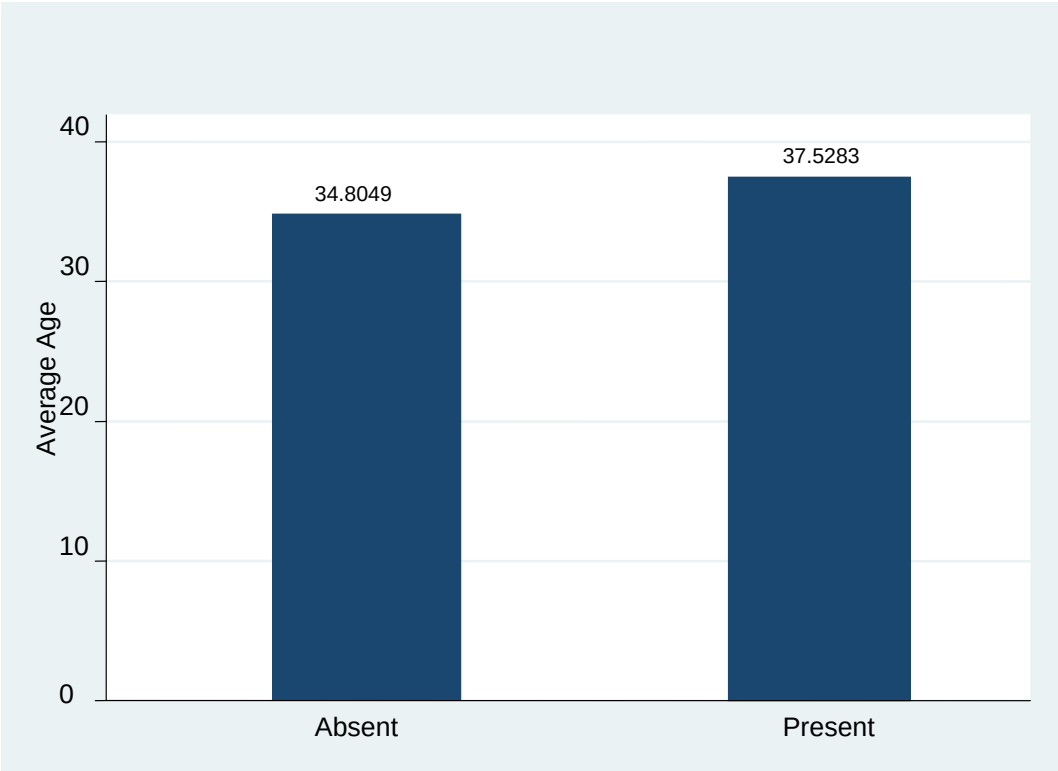


Figure 7. Distribution of age by cervical spine injury status in patients with blunt trauma where CT brain and C-spine were performed.

However, the above crude analysis was further stratified to according to gender to find out if disparities exist among different sex of these blunt trauma patients i.e. we stratified the association between age and acute spine injury by gender. The results revealed that among males, there is a marginal association (p-value: 0.07) compared to females where the age of the injured patients were almost equal. Figure 8 below provides a good illustration of this argument.

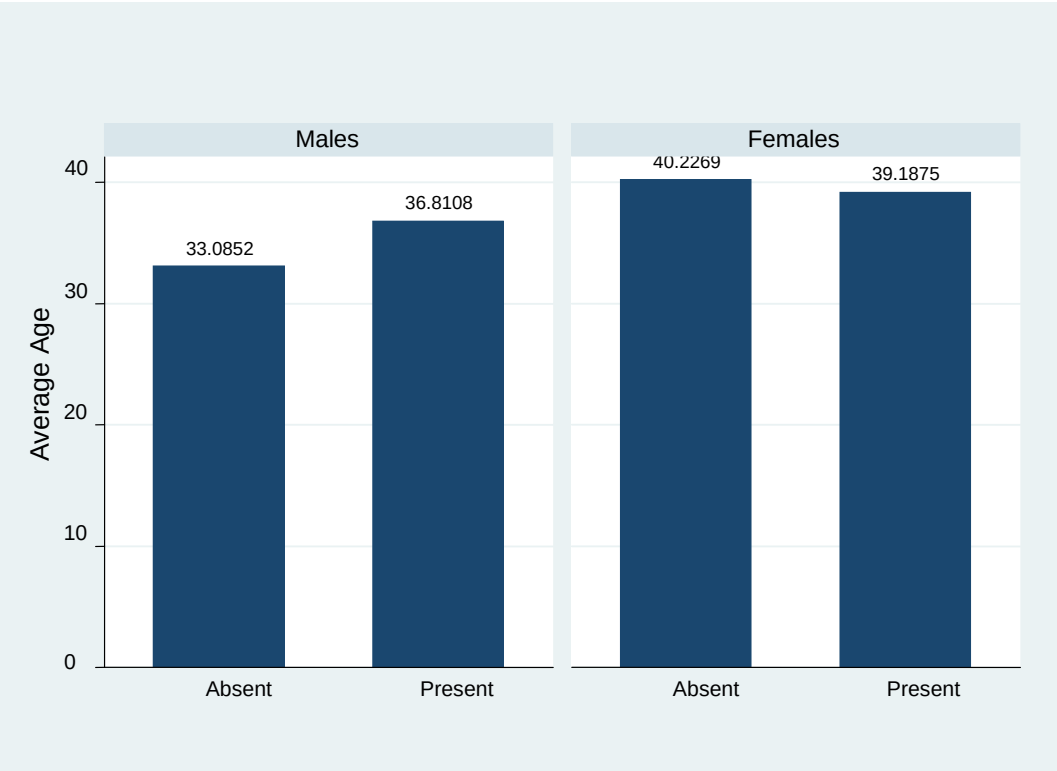


Figure 8. Distribution of age and gender by cervical spine injury status in patients with blunt trauma where CT brain and C-spine were performed.

7.3. Prognostic analysis of acute spine injury using logistic regression model

Knowing that the above analysis is restricted to show only associations, we further investigated the directions of associations found, using a logistic regression model.

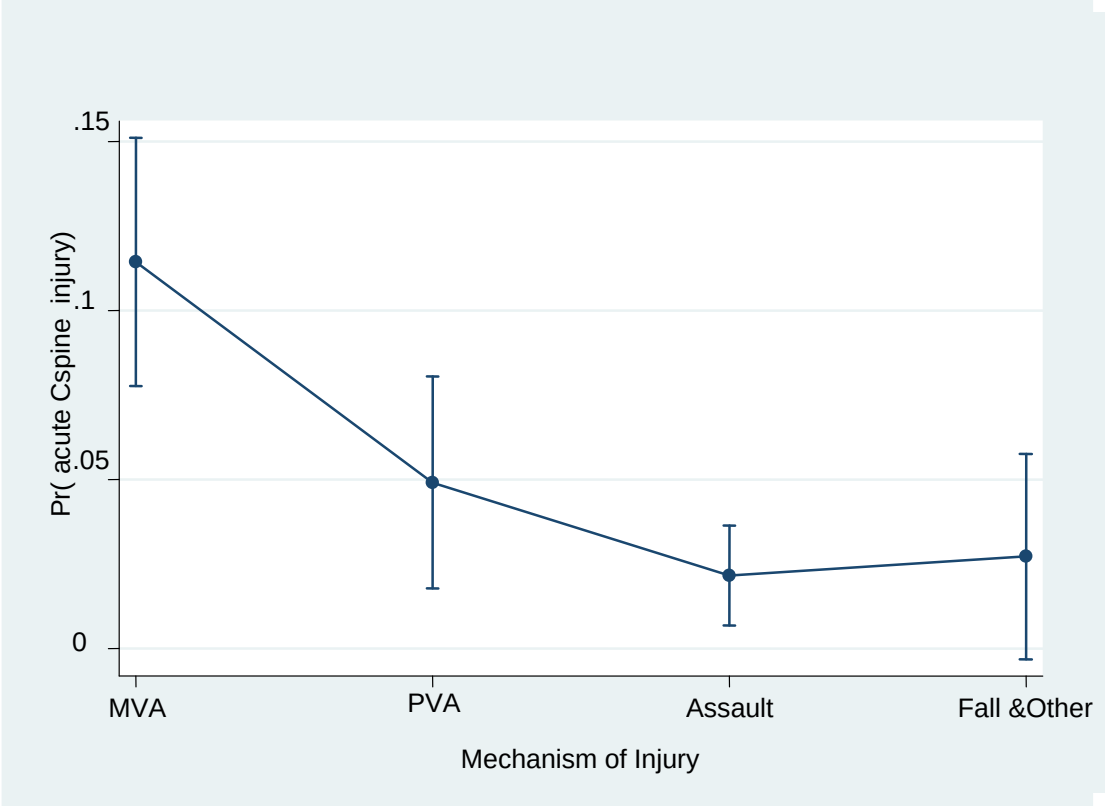
At baseline, patients received at the Department of were 94% (OR: 0.06; 0.04 – 0.08 less likely to had acute spine injury. Table 3 below summaries the results of the bivariate and covariate adjusted logistic regression models.

Table 3. Summary of results of the bivariate and covariate adjusted logistic regression models in patients with blunt trauma where CT brain and C-spine were performed.

Variables	Bivariate Logistic regression	Multivariate Logistic regression
	OR & 95% CI	OR & 95% CI
Mean age[†] (SD)	1.01 (0.99 – 1.03)	
Sex		
Male	1	
Female	1.36 (0.74 – 2.50)	
Mechanism of injury		
Assaults	1	1
Motor vehicles	5.56 (2.53 – 12.23)	5.87 (2.66 – 12.97)
Pedestrian vehicle	2.39 (0.91 – 6.31)	2.34 (0.88 – 6.18)
Falls and others	1.25 (0.33 – 4.80)	1.26 (0.33 – 4.87)
Glasgow Coma scale(mean, SD)	0.94 (0.86 – 1.03)	
Cervical Tenderness		
Present	1	
Absent	2.45 (0.30 – 20.24)	
Acute Brain Injury		
Absent	1	1
Present	1.56 (0.82 – 2.93)	1.85 (0.97 – 3.56)

In the bivariate logistic regression model, only mechanisms of injuries showed significant association with acute spine injuries, with motor vehicles accident carrying the heaviest probabilities of getting an acute spine injuries compared to assaults. For instance, patients who had motor vehicles accidents were 6 folds (OR: 5.56) more likely to have an acute spine injury compared to those who were assaulted. Besides pedestrian vehicles accidents were 2 times more likely to get spine injury compared to assaulted individuals. The patients with a presentation of falls and other miscellaneous mechanisms of injury e.g. sports injury were 25% more likely to have spine injury compared to those assaulted. On overall, mechanisms of injuries as a potential prognostic factor, was statistically significant. This is clearly demonstrated on figure 9 which plots the marginal probabilities for acute spine injuries for each mechanism of injuries. As discussed above, motor vehicles had the highest marginal probabilities[1] (0.11) of

being associated with spine injury with a large 95% confident intervals ranging from 0.8 – 0.15. On the other hand, as presented on table 3, assaults were associated had the lowest odds of being associated with spine injury. This is shown by the lowest marginal probabilities (0.02) with narrower confidence interval (0.01 – 0.04). The final model was refitted to investigate lack of fit using Hosmer and Lemeshow test. It did not show any lack of fit (p-value: 0.96).



Marginal probabilities refer to the probabilities

Figure 9. Marginal plots for prediction of acute C-spine injury by mechanism of injury in patients with blunt trauma where CT brain and C-spine were performed

8. Discussion

Despite the fact that this study is one of its kind to be done in South African literature, the incidence of C-spine injuries in blunt trauma found in this study of 5.58% is slightly higher than the range of 2-4%(7) demonstrated in the meta-analysis of Raza et al(7). However, this could be explained by the inclusion of patients in unconscious state as also Raza et al observed that it raises the incidence to 34.4 %(7). But it is unclear whether these finding were only found on CT or these patients also had Magnetic Resonance Imaging (MRI), which has addition sensitivity on soft tissue injury findings.

In other pieces literature of similar studies done elsewhere around the world on plain x-rays and CT of the blunt trauma patients with C-spine injuries, it has been demonstrated that incidence range between 2-6.6%(14, 15) of which in our case would be considered to within the range. On overall, this study still demonstrates a low incidence of C-spine injuries in patient with blunt trauma as other studies done elsewhere have been demonstrating although this is not a multicentre study here in South Africa.

The major aspect of this study was to find out the associations of C-spine injuries and it is only the mechanisms of injury that showed significant relationship with the C-spine injuries. The results further demonstrated that among the different mechanism of injury the motor vehicle accidents and pedestrian vehicle accidents carry a higher probability of sustaining a C-spine injury than assault. This exonerates the venerability of the cervical spine and the influence on the outcome of C-spine injury depending on the energy imparted during the injury which in our case the high energy injuries (MVA and PVA) shows significant number of associated C-spine injuries than assaults and fall which are

relatively low energy kinematic injuries as Kulvatunyou et al also described in their study(2). Therefore, the predilection of considering a request for the CT scan of the C-spine in the patient with blunt trauma based on the mechanism of injury should be considered much over the other variable that shows lack of association with the C-spine injuries explored in this study.

Although variables like cervical tenderness show no association with C-spine injuries, it is arguable that it should not be undermined after exclusion of acute spine bony injuries on CT scan hence the need to re assess the patient, as ligamentous injuries and other soft tissue injuries are not adequately assessed and may require further imaging if indicated as Tan et al also described that a negative CT does not preclude clearance of cervical spine(14).

9. Limitation/ Recommendation

The set back of this study is that it is a retrospective study and it is subject to biases. Therefore, it is recommend that prospective study of its kind to be carried out as it may be structured to capture very important additional information including the description of the injuries sustained and also help to take out the biases that come along with a retrospective study.

Another recommendation is to do a multicenter study that would give representative demographics and distributions in South Africa

10. Conclusion

Our study demonstrates that there is a low incidence of injuries involving the C-spine in blunt trauma patients with head injury as evaluated by CT scan and it is only the mechanisms of injury that has significant association to the C spine injuries with high probability being demonstrated on high kinematic energy injuries, hence, the mechanism of injury must be considered on requesting CT scan of the spine in blunt trauma patient with head injury.

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12. Appendix

1.Data collection sheet

DATA COLLECTING SHEET (APPENDIX 1)

A. **STUDY ID NO:**……

B. **GENDER:** 1. M 2. F

C. **DOS** ……**DOB**……**AGE(Years and Months):**……

D. **MECHANISM OF INJURY**

1. Motor Vehicle Accident
2. Pedestrian Vehicle Accident
3. Assault
4. Fall and others

E. **GLASSGOW COMA SCALE:** 1. 15/15 2. < 15/15

F. **LOSS OF CONSCIOUSNESS:** 1. Absent 2. Present

G. **CERVICAL SPINE TENDERNESS** 1. Absent 2. Present

H. **CT REPORT:**

a. Acute brain injury 1. Absent 2. Present
b. Acute C-spine Injury 1. Absent 2. Present

COMMENT:

……
……
……
……

2.Excel Spread sheet

STUDY ID NO	AGE	GENDER	MECHANISM	G C S	LOC	ACUTE BRAIN INJURY	ACUTE SPINE INJURY

3. Permission letter from CHBAH

health and social development
Department: Health and Social Development
GAUTENG PROVINCE

DEPARTMENT OF RADIOLOGY
UNIVERSITY OF WITSWATERSRAND
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
Tel: 011 933 8411/9406

4 September 2014

To the Chairperson

Human Research Ethics Committee,

Faculty of Health Sciences,

University of the Witwatersrand

Dear Chairperson

RE: Permission for Dr E Chisama to perform research at Chris Hani Baragwanath Diagnositc Radiology Department

Dr Chisama is planning on doing a retrospective review on the association of cervical spine findings on computed tomography in patients with blunt head injury, correlating the findings with the mechanism of injury. I hereby grant him permission to access the patient records for the purposes of this study.

Kind Regards

Dr Linda Tebogo Hlabangana

Chief Specialist and Head

Diagnostic Radiology

Chris Hani Baragwanath Academic Hospital

4. Clearance Certificate

R14/49 Dr Evance Chisama

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140932

NAME: (Principal Investigator)	Dr Evance Chisama
DEPARTMENT:	Radiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Association of Cervical Spine Findings on Computed Tomography in Patients with Blunt Head Injury: Correlation with Mechanism of Injury
DATE CONSIDERED:	03/10/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr TL Hlabangana
APPROVED BY:	Professor Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	12/12/2014

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date 18/12/2014

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES