Analysis of Orthopaedic Injuries in Polytrauma Patients at Charlotte Maxeke Johannesburg Academic Hospital

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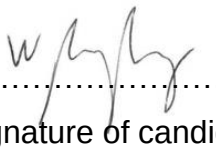
Declaration

I, Wezley Laney declare that this research report in the format of a “submissible” paper is my own, unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Orthopaedic Surgery at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



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(Signature of candidate)

10th day of March 2022 in Johannesburg

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Nomenclature

CHBAH	Chris Hani Baragwanath Academic Hospital
CI	Confidence interval
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
CT	Computer Tomography
FFH	Fall from Height
GSW	Gunshot Wound
IQR	Interquartile Range
MOI	Mechanism of Injury
MVA	Motor Vehicle Accident
PACS	Picture Archiving and Communication System
PVA	Pedestrian Vehicle Accident
RR	Relative Risk

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Abstract

Background:

Traumatic injuries represent a significant burden globally, accounting for ten percent of the global burden of disease. In South Africa we commonly see patients who have sustained major trauma, often with multiple injuries. This significant burden of trauma necessitates the demand for rapid diagnostic assessment of injuries for appropriate therapeutic intervention. A whole body computed tomography (CT pan scan) allows for a rapid multisystem injury diagnosis of trauma patients. There is a scarcity of literature evaluating the extent of orthopaedic injuries in polytrauma patients.

Study Aim:

The aim of the study was to evaluate the local epidemiology of orthopaedic injuries in polytrauma patients who have undergone a CT pan scan.

Methods:

A retrospective, observational analysis, based at Charlotte Maxeke Johannesburg Academic Hospital, was done of polytrauma patients who underwent a CT pan scan, during a 2-year period from 01/01/2018 – 31/12/2019. A database was compiled by accessing the picture archiving and communication system for CT reports. The qualitative data was reported using frequencies and percentages. Categorical variables were analysed using the Chi-squared test (or Fisher's exact test).

Results:

Over the two-year study period a total of 296 polytrauma patients had a reported CT pan scan performed. Of these, 85% were male and 15% were female with a median age of 33 years. The most common mechanism of injury was motor vehicle accidents (33.1%). The prevalence of orthopaedic injuries in polytrauma patients was 53.3%. A total of 1012 injuries were found. One hundred and ninety-six (196) spinal fractures were detected; a total of 137 pelvic/sacral fractures, 101 long bone fractures with 75% lower limbs and 25% were upper limb fractures. The most common non-orthopaedic injury sustained was a chest injury. The most common combination of orthopaedic and non-orthopaedic injuries identified in the study was a chest injury with an associated

pelvic/sacral fracture secondary to a PVA. Interpersonal and intentional injuries were significantly associated with a higher risk of thoracic spine fractures (RR 1.8, CI 1.1-2.9). Road traffic accidents were significantly associated with a higher risk of scapular/clavicular fractures (RR 2.0, CI 1.2-3.5) and a higher risk of tibial/fibula fractures (RR 3.5, CI 1.2-10.3)

Conclusion:

The majority of polytrauma patients seen at CMJAH were young males, who sustained injuries during road traffic accidents. Fractures accounted for 94% of all orthopaedic injuries. The most common orthopaedic injury detected in our cohort, overall, was a spinal fracture, most commonly involving the cervical spine. A patient involved in a road traffic accident is 3.5 times more likely to sustain a tibia/fibular fracture as opposed to any other fracture. The most common non-orthopaedic injury sustained was a chest injury. Importantly, 1 in 4 of these patients sustained an associated cervical spine injury and 1 in 3 a pelvic injury, similarly with head injuries. The most common combination of injuries is a chest injury with an associated pelvic/sacral fracture secondary to a pedestrian vehicle accident. The findings highlight the significant burden of orthopaedic injuries in polytrauma patients. In addition, the findings of this study, highlight injury patterns that should be anticipated in polytrauma patients.

Keywords

CT pan scan

Orthopaedic injuries

Polytrauma

Trauma

Whole body computed tomography

Level of evidence

Level of evidence = III (retrospective, observational analysis)

1. Introduction

Traumatic injuries represent a significant burden globally, accounting for ten percent of the global burden of disease (1). The burden of traumatic injuries is greater in low- to middle-income societies, with 90% of all global cases of trauma-related mortality occurring in these countries (2). South Africa represents one of these countries, being a middle income country, with the reported rate of trauma-related mortality being six times higher than the global rate (2).

In South Africa we commonly see patients who have sustained major trauma, often with multiple injuries. These patients are often described as polytrauma patients, which may be defined as a combination of injuries occurring in two or more major organ systems (3).

This significant burden of trauma necessitates the demand for a rapid diagnostic assessment of injuries for appropriate therapeutic intervention. The introduction and popularisation of whole body computed tomography (pan scan) allows for a rapid multisystem injury diagnosis of trauma patients. The definition of a pan scan is a computed tomography (CT) scan of the head/brain, spine, chest, abdomen, pelvis and extremities that occurs in a single series at the scanner; the administration of contrast is given as per the protocols (4).

The use of a CT pan scan has a unique role in the polytraumatised patient, as it is more sensitive for the detection of head, spinal, thoracic, abdominal and pelvic injuries compared to conventional radiography (4). In addition, a CT pan scan has been shown to be associated with a reduction in mortality rates; and has a proven benefit over targeted CT examination (5).

Despite the benefit of a CT pan scan, in the assessment of polytrauma patients, there is no international consensus or validated clinical criteria for the selection of trauma patients who should undergo this scan. Rather, as highlighted by Gunn et al., the decision to do a CT pan scan is based on one of three indications, these being: the mechanism of injury (MOI), the location of injury or the physical examination correlating to the injury severity scale (4)(6).

Despite the widespread acceptance for the use of a CT pan scan in the assessment of polytrauma patients, there is a scarcity of literature evaluating the extent of

orthopaedic injuries in polytrauma patients. Therefore, the aim of the study is to evaluate the local epidemiology of orthopaedic injuries in polytrauma patients who have undergone a CT pan scan.

2. Objectives

The objectives of the study are:

- To determine the prevalence of orthopaedic injuries in polytrauma patients.
- To identify the injuries sustained in polytrauma patients who underwent a CT pan scan.
- To evaluate the relationship between orthopaedic injuries sustained and other contributing factors.

3. Methods

3.1. Study design, setting, and population

This study was based at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), a quaternary level state hospital, in Johannesburg, South Africa. A retrospective, observational analysis of patients who underwent a CT pan scan at CMJAH, was done over a two-year period from 01 January 2018 to 31 December 2019. Polytrauma patients aged 18 years and older, who presented to the trauma unit at CMJAH, and required a CT pan scan were included in the study. For the purpose of this study, the polytrauma definition has been adapted and is defined as a combination of injuries occurring in two major systems: namely one trauma injury and one orthopaedic injury. Patients who had no reported injuries, an isolated system injury or no orthopaedic injuries were excluded from the study.

3.2. Data Collection

A database was compiled for the evaluation period 01 January 2018 to 31 December 2019. The data were retrieved from the picture archiving and communication system (PACS) by selecting “CT” as the modality of investigation, followed by using the descriptive term “CT pan scan”.

3.3. Ethics

Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (Clearance number: M201131), as well as the Hospital Research Committee and Management. Informed consent was waived by the Ethics Committee due to the retrospective nature of the study and lack of identifying data.

3.4. Statistical analysis

Statistical analysis was performed using Statistica, version 13.3. Non-normal data were described using medians and interquartile ranges (IQRs). The qualitative data were reported using frequencies and percentages. Categorical variables were analysed using the Chi-squared test (or Fisher's exact test).

3.4.1. Defining the study variables:

Demographic data:

- Age
- Gender

The orthopaedic injuries were categorised as follows:

- Spine fractures (subdivided into cervical, thoracic, and lumbar spine)
- Long bone fractures (subdivided into humerus, radio-ulnar, femur and tibia-fibula)
- Pelvic/sacral fractures (including acetabular fractures)
- Scapula/clavicle fractures
- Joint injuries – intra-articular fractures/dislocations
- Hand and foot fractures

Trauma injuries were divided into anatomical areas:

- Head injury
- Chest injury
- Abdominal injury
- Pelvic injury

- Vascular injury

3.4.2. Defining categories by mechanism of injuries:

Category A injuries included interpersonal and intentional injuries: assault, fall from a height (FFH), a gunshot wound (GSW) and injury from a heavy object. Category B injuries included road traffic accidents: motor vehicle accident (MVA), pedestrian vehicle accident (PVA), and train accidents, respectively. All unknown mechanisms of injury were excluded from these categories.

3.5. Sample size

The sample size was estimated based on a prevalence of between 30% and 50% of trauma patients who sustained orthopaedic injuries. Therefore, 300 - 400 CT pan scans, with a 95% confidence interval (CI) and a significance level of 5%, was required.

4. Results

4.1. Demographics

Over the two-year study period, a total of 21 466 patients attended the CMJAH trauma casualty. Of these patients, a total of 4 856 patients were deemed priority resuscitation patients. A total of 954 CT pan scans were found on PACS when the previously mentioned parameters were used. Of these, 64 CT pan scans were eliminated (see *Figure 1* below). After exclusions were applied; there were 296 polytrauma patients that had a reported CT pan scan. Therefore, the incidence of polytrauma patients identified by CT pan scan at CMJAH is 1.4%. Nevertheless, one-third (33%) of the trauma CT pan scans performed diagnosed patients with polytrauma injuries.

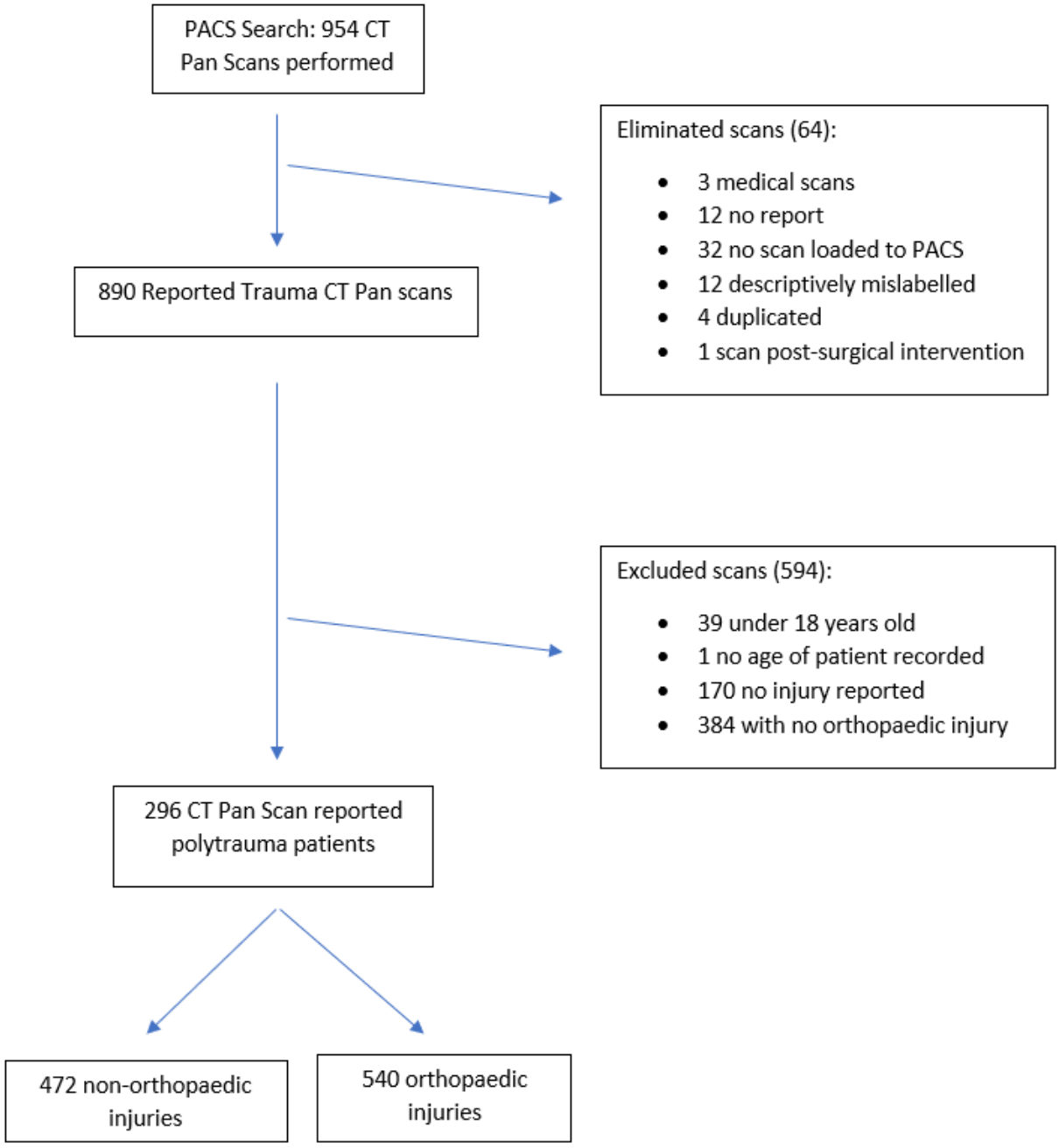

Figure 1: CT pan scan search flow chart

Of the 296 CT-reported polytrauma patients included, 85% were male (n=252) and 15% were female (n=44) with a male to female ratio of 5.6:1.0. *Figure 2* below shows the male and female gender distribution. The median age of the patients was 33 years (Interquartile range of 28-42years). The male age range was 18-79 years whereas the female age range was 18-68 years. *Figure 3* shows the age distribution of the study population.

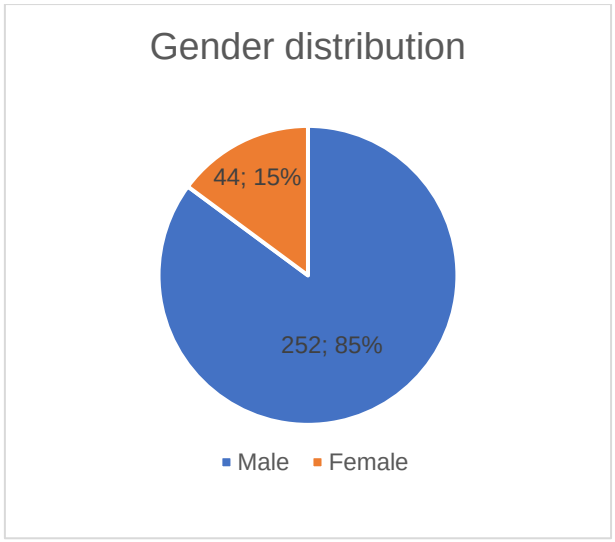

Figure 2: A pie chart showing the gender distribution of polytrauma patients (n=296)

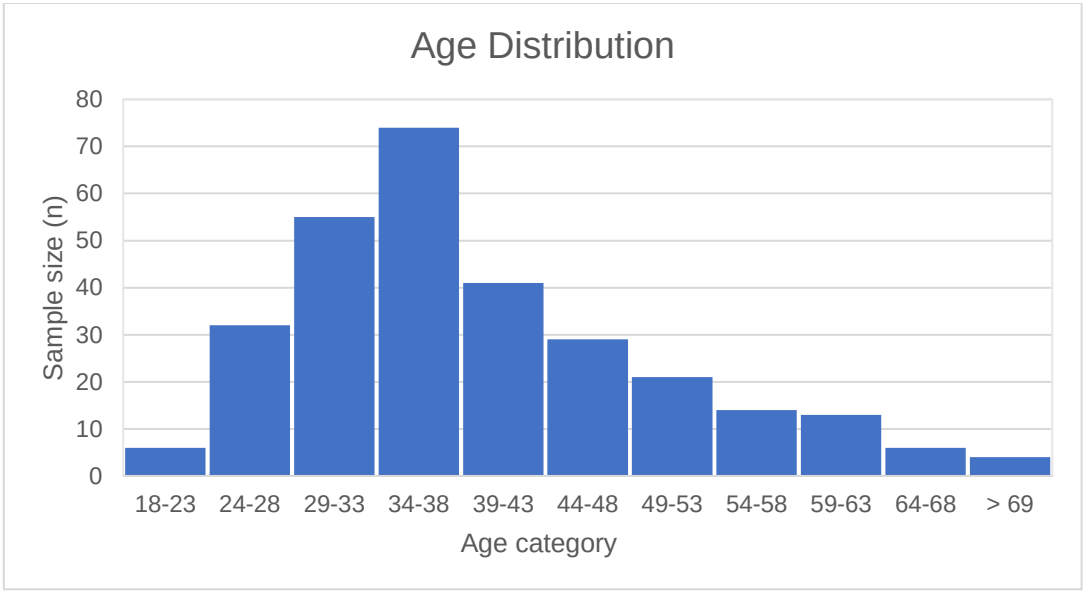

Figure 3: Age distribution of polytrauma patients (n=296)

The five most common mechanisms of injury were: MVA (33.1%), PVA (31.1%), FFH (21.6%), assault (4.4%) and unknown MOI (3%). *Figure 4* below shows the MOI frequencies based on gender.

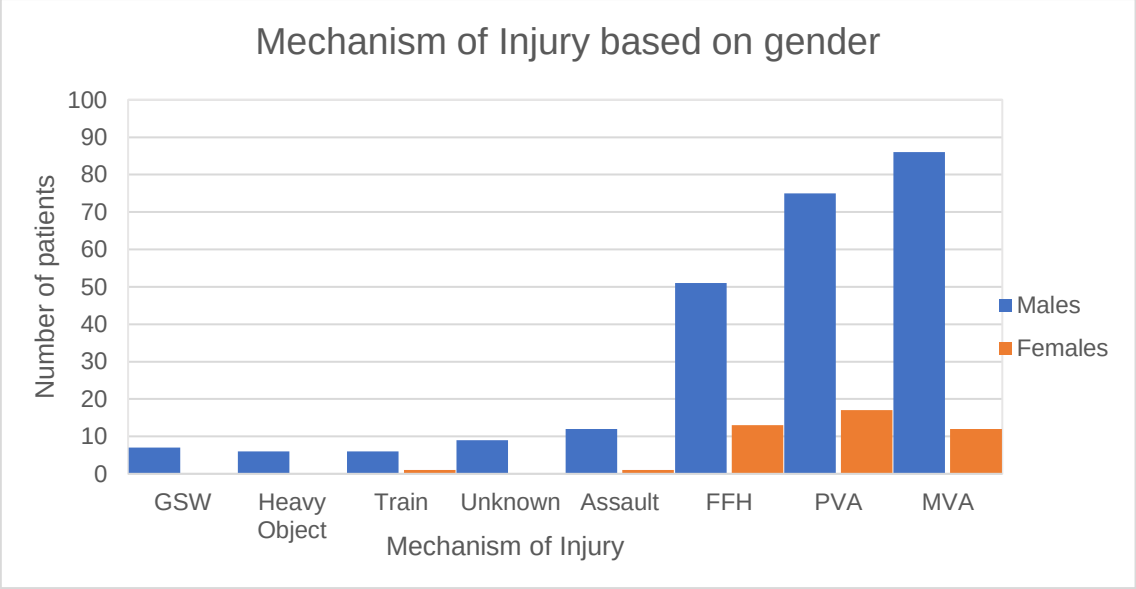

Figure 4: MOI based on gender

4.2. Polytrauma injuries

There were 1012 injuries found among the 296 patients included in the study. There was a total of 472 (46.6%) non-orthopaedic injuries and 540 orthopaedic injuries reported in this sample. The prevalence of orthopaedic injuries in polytrauma patients was 53.3% (95% CI 51.7% - 54.9%). Fractures accounted for 94% (n=508) of all orthopaedic injuries while joint injuries accounted for the remaining 6% (n=32) of orthopaedic injuries. *Figure 5* shows the frequency of each injury reported.

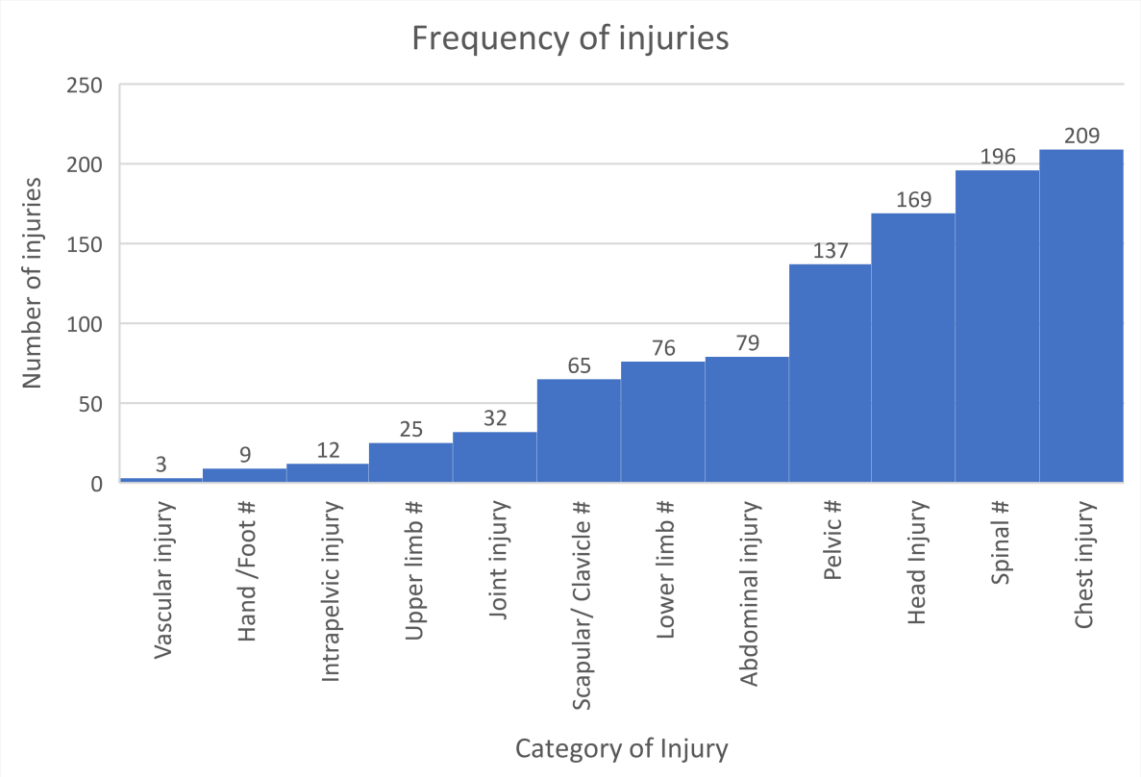

Figure 5: Frequency of all injuries sustained in polytrauma patients (# = Fractures)

4.3. Description of spinal injuries:

One hundred and ninety-six (196) spinal fractures were detected in 152 of the 296 patients on whom a CT pan scan was performed. The relative frequency of the different spinal fractures and combinations of injuries sustained is shown in *Figure 6*.

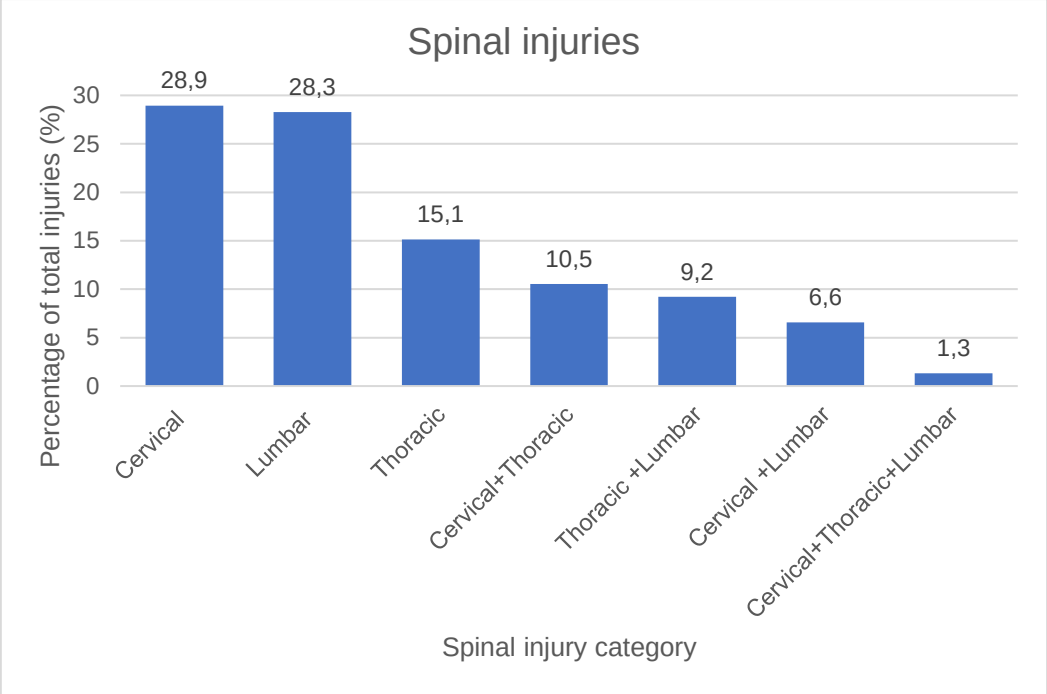

Figure 6: Spinal injuries

4.4. Description of pelvic/sacral fractures

There was a total of 137 pelvic/sacral fractures reported on CT pan scan. Forty-five (45) of these were acetabular fractures and two had associated posterior hip dislocations. There were 29 sacral fractures, including sacral alar fractures and sacro-iliac joint diastasis injuries. The remaining injuries included pubic rami or iliac blade fractures.

4.5. Description of upper and lower limb long bone fractures

Of the 296 patients included in the study, a total of 101 long bone fractures were sustained in 85 patients. The majority of long bone fractures involved the lower limbs (75%), while 25% were upper limb fractures. Of all long bone fractures, 78% were isolated long bone fractures while 22% were multiple long bone fractures. The relative frequency of the different long bone fractures and combinations of fractures is shown in *Figure 7*.

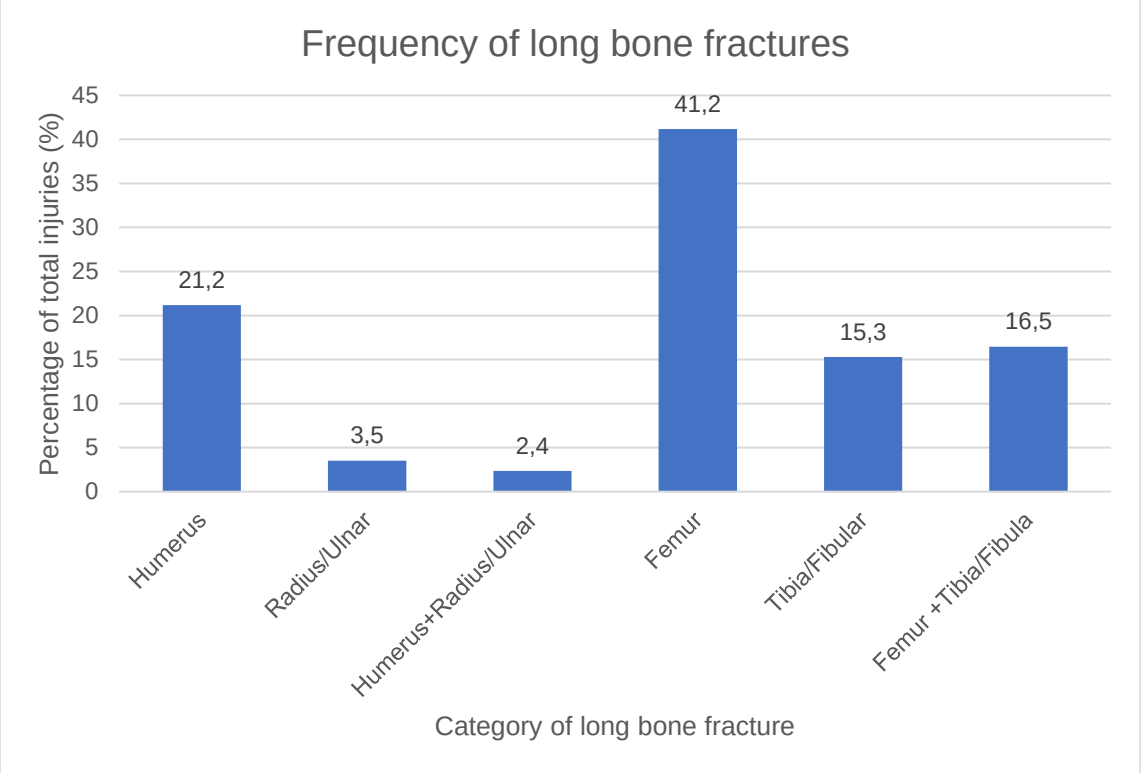

Figure 7: Relative frequency of long bone fractures

4.6. Description of joint injuries

The upper limb joints (shoulder and elbow) only represented 29% of joint injuries. The knee and ankle joint injuries represented 56% and 15%, respectively.

4.7. Associated vascular injuries sustained

There were only three reported vascular injuries among the 296 patients included. These were a thoracic aortic pseudo-aneurysm, a descending aorta intimal flap and a popliteal vessel injury after sustaining a Shatzker 6 tibial plateau fracture.

4.8. Frequency of multiple orthopaedic injuries

In our sample, 48% (n=142) of patients had sustained multiple fractures. There were 19 patients with 2 or more long bone fractures; of these, 13 patients had a combination of femur and tibia-fibula fractures. In addition, there were 25 patients that had sustained pelvic/ sacral fractures with an associated long bone fracture. Furthermore, 18 patients with spinal fractures had also sustained long bone fractures. Interestingly, 34% (48/142) of patients with multiple orthopaedic injuries had a scapula/clavicle

fracture. The most common orthopaedic injury in this group were pelvic/sacral fractures and 32% of these patients had an associated lumbar spine fracture.

4.9. Description of non-orthopaedic injuries

The most common non-orthopaedic injury sustained was a chest injury with 209 injuries reported. See *Table I* for the percentage of head and chest injuries which sustained various orthopaedic injuries. The most common combination of orthopaedic and non-orthopaedic injuries identified in the study was a chest injury with an associated pelvic/sacral fracture secondary to a PVA. The most common orthopaedic injury associated with either a head injury or chest injury or abdominal injury was a pelvic/ sacral fracture.

4.10. Frequency of different injuries by mechanism of injury

The majority of spine fractures were sustained during MVAs. Most of the long bone and pelvic fractures were sustained by PVAs. The majority of multiple orthopaedic injuries were sustained equally by MVAs and PVAs. *Figure 8* shows the mechanism of injury versus the frequency of injury.

Table I: Percentage of head and chest injuries associated with orthopaedic injuries

	Cervical spine injury	Pelvic/ sacral injury	Upper limb injury	Lower limb injury
Head injury	27%	34%	7%	26%
Chest injury	25%	33%	8%	22%

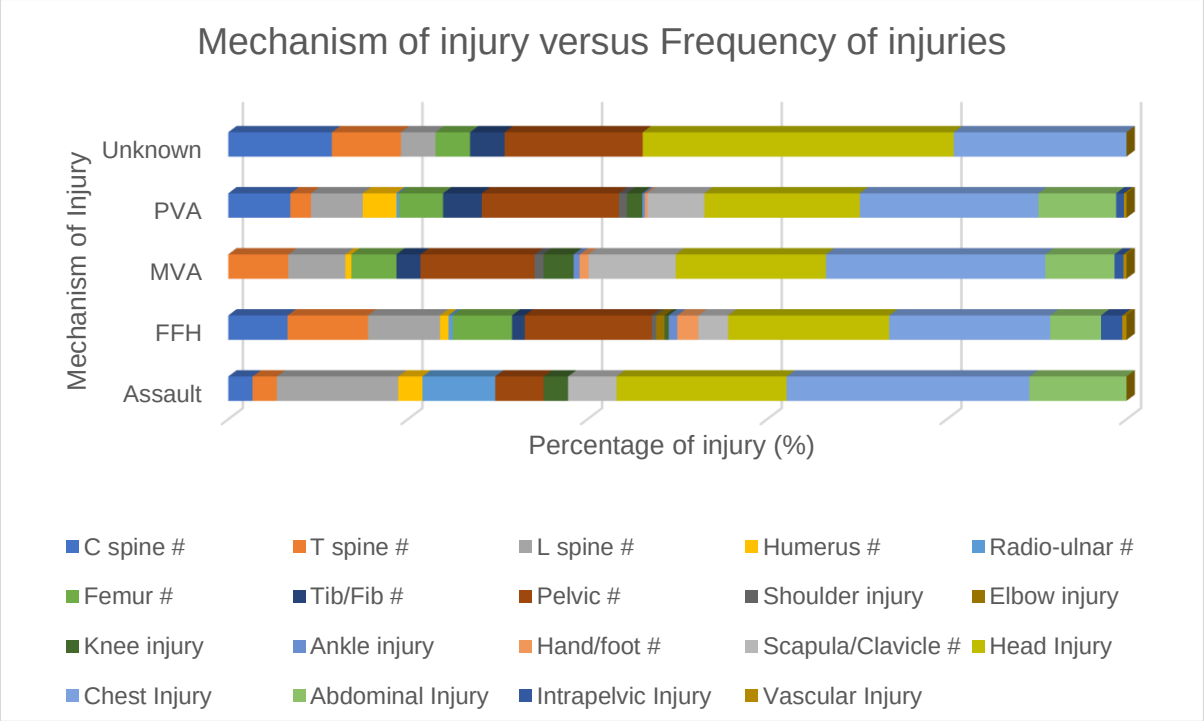

Figure 8: Mechanism of injury versus frequency of injury (# = Fracture)

4.11. Relationship between mechanism of injury and type of injury

Category A (interpersonal and intentional injuries) mechanisms included: assault, fall from a height, a gunshot wound and injury from a heavy object. Category A mechanisms were significantly associated with a higher risk of thoracic spine fractures (Relative Risk (RR) 1.8, CI 1.1-2.9). None of the assaulted patients, that were CT pan scanned, suffered a lower limb long bone fracture (femur of tibia/fibula).

Category B (road traffic accidents) injuries included: MVAs, PVAs and train injuries. Category B mechanisms were significantly associated with a higher risk of scapular/clavicular fractures (RR 2.0, CI 1.2-3.5) and a higher risk of tibial/fibula fractures (RR 3.5, CI 1.2-10.3).

5. Discussion

The aim of the study was to describe the epidemiology of polytrauma patients that underwent a CT pan scan at CMJAH. With a paucity of studies looking specifically at this subject, we compared the data obtained from the current study to the findings reported in similar studies however, it should be noted that the findings reported in the literature are not limited to only polytrauma patients who underwent a CT pan scan.

5.1. Gender

In the current study, we had a predominance of males (85%). This is comparable to the 83% male predominance reported by Donovan et al. at Grey Hospital (7), and the 80% male predominance described by Dhaffala et al. from the Mthatha Hospital Complex (8), both located in South Africa. However, when compared to the international burden of disease as estimated in the United States of America, they only have a 55.8% male predominance of patients seen in the emergency department (9). The difference in the findings when comparing South Africa to the United States of America may be attributed to the fact that young South African males make up a large proportion of the available workforce and are most frequently involved in interpersonal violence and road traffic accidents (10)(11).

5.2. Age

The median age of the population studied was 33 years. This is comparable to studies from Chris Hani Baragwanath Academic Hospital (CHBAH), Botswana and India reporting mean ages of 33.0, 33.5 and 35.2 years, respectively (3)(12)(13). In comparison to a local and an international study, the mean ages reported were 44.4 and 43.9 years, respectively (8)(14). The IQR of 28-42 years found in the current study is in keeping with the age ranges of polytrauma patients reported at an Indian tertiary care centre where 57.7% of their trauma patients were aged 21-40 years old and similarly at Grey's Hospital where 60.3% of their patients were aged 20-39 years old (7)(15).

5.3. Mechanism of injury

The mechanism of injury is an important aspect of trauma and orthopaedics, which relates to the severity of an injury and the number of injuries sustained. The most common MOI to cause polytrauma in patients seen at CMJAH is either high velocity injuries (MVA/PVA) or high energy trauma (FFH). *Table II* highlights and compares the five most common MOIs observed in the current study, as well as those reported in five other studies.

Table II: A comparison of MOIs reported in various studies

	Reference	Current Study	Leshoele (13)	Kalsotra et al. (15)	Manwana et al. (12)	Jarman et al. (9)	Donovan et al. (7)
	n	296	289	258	372	815 298	8 722
		%	%	%	%	%	%
Road Traffic Accident		64.2	86.9	76.4	25.5	29.2	28.17
	MVA	33.1	54.7	51.0			18.48
	PVA	31.1	32.2	25.4			9.69
FFH		21.6	6.0	10.5	39.0	47.9	2.42
Assault		4.4	4.5	10.9	15.3	7.2	18.06
Unknown		3.0	<1.0			11.6	1.63
GSW			32.0		1.1	1.2	
Miscellaneous				2.2	5.1		

Of note, road traffic accidents, are the most significant mechanism of injury in our study (64.2%). This is a similar trend reported by other similar studies; and highlights the deficiency in road safety awareness and practices, amongst pedestrians, passengers, and drivers. This finding highlights the need for improved road safety education, as well as improvements to public transport infrastructure to possibly reduce the number of traffic related accidents.

Falls from a height represented the second largest mechanism of injury in our study (21.6%). This in stark contrast to local studies; with CHBAH reporting only 6% injuries due to fall from a height. A possible explanation for this finding is that CMJAH is located in close proximity to the Johannesburg central business district, with a large number of residents living in high rise buildings. Thus, the large number of high-rise buildings is expected to be a significant contributor to the trauma burden due to falls from a height seen at CMJAH; unlike CHBAH where there are virtually no high-rise buildings. In comparison to two international studies by Jarman et al. (9) and Manwana et al. (12), the authors reported that falls were the most common MOI however, these studies included all types of falls in this category i.e. falls from a height and falls of the elderly.

In 2017, Pelonomi Hospital in Bloemfontein, South Africa reported that 50.64% of all hospital visits were due to interpersonal and intentional violence (16). In this study, only 4.4% of polytrauma injuries were due to interpersonal and intentional violence. However, upon review of the casualty statistics, it shows that 43.5% of patients seen at the CMJAH trauma unit was because of interpersonal and intentional violence.

Similar trends were seen in the Western Cape, with Groote Schuur Hospital reporting 38% of patients seen due to assault (10). This highlights the prevalence rates of interpersonal violence are similar across South Africa, but that the patients seen at CMJAH are less likely to be polytrauma patients. The burden of violence in South Africa is emphasised by the homicide rate of 64.8 per 100 000, which is seven times higher than the global average homicide rate (17).

5.4. Orthopaedic Injuries

In the analysis of spinal fractures (196/1012), these accounted for most of the orthopaedic injuries reported on a CT pan scan. The only other study to have also shown this was published by Shannon et al. (5). The authors also used CT pan scans which were compared to clinically suspected injuries. *Table III* compares the number of injuries observed in the current study compared to those reported in other studies. The most common spinal fracture was a cervical spine fracture (72/196) which had concomitant thoracic spine injuries 10.5 % of the time. This is comparable to Nelson et al. who reported a 9% non-contiguous cervicothoracic vertebral fracture rate (18). Thus, a high index of suspicion for thoracic spine trauma is required when a cervical spine fracture is identified in a polytrauma patient.

Table III: A comparison of the number of injuries reported in various studies

		Reference	Current Study	Sampson et al. (19)	Shannon et al. (5)	Kalsotra et al. (15)	Banerjee et al. (14)
		n	296	255	588	285	14 583
		Investigation	CT Pan Scan	CT Pan Scan	Pan Scan	X rays + CT	X rays + CT
Orthopaedic Injuries							
	Spinal Fractures						
		C spine	72	26	62	22	
		T spine	55	48	85		
		L spine	69		55		
	Long Bone Fractures						
		Upper limb	25			174	3 266
		Lower limb	76			461	5 381
	Pelvic/sacral		137	67	60	30	
	Hand/foot		9			163	1 487
	Scapula/clavicle		65			27	2 640
Trauma Injuries							
	Head injury		169	127	158	153	7 277
	Chest injury		209	311	399	81	9 319
	Abdomino-pelvic injury		91	89	78	89	3 281

When analysing the number of pelvic/sacral fractures, these represented 25% of the orthopaedic injuries sustained in the sample size. Pelvic/sacral fractures showed a proportionally higher prevalence in the study population when compared to other studies. However, the global prevalence of pelvic fractures is estimated at 2-8%, but in polytrauma patients this is reported to increase to 20-25%, which is comparable to our study (20). A reason for the high number of pelvic/sacral fractures seen in the study is based on the MOI (road traffic accidents and FFH); which tend to be high velocity and high energy injuries leading to increased incidence of pelvic fractures. In addition, CMJAH is a referral centre, thus more complex trauma cases may have been transferred to this hospital for further management.

The prevalence of long bone fractures is predominantly lower limb fractures, and this is comparable to the other studies cited in *Table III*. However, it is believed that the CT pan scans performed on the study population has under-reported on the total number of lower limb fractures due to where the scan sequence was terminated. The majority of the scans were performed to the level of the proximal femora which may result in injuries being missed distal to the point of termination. It is important to note that an extended scan should be requested if there is an index of suspicion for injury to the lower limb (vascular or fractures that would require a CT scan) (21).

The reported number of upper limb fractures in comparison to other studies is markedly lower, and this also raises the suspicion for under-reporting in the study population. The upper limbs are notorious for not being included in the CT field based on the position of the upper limb (14).

5.5. Non-Orthopaedic Injuries

Chest injuries are the most common non-orthopaedic injury, comprising of rib fractures, lung contusions and hemopneumothoraxes as the most common injuries reported. This is a similar finding to those reported in other studies (see *Table III*) which is to be expected since the chest is one of the largest body cavities that is often involved in both blunt and penetrating trauma (22). From *Table I*, the polytrauma patients that present with chest injuries also have a high incidence of orthopaedic injuries, similarly with head injuries. It is important to identify combined injuries, especially with chest and head injuries as these are critical factors in determining whether a patient is for early total care or damage control orthopaedics.

5.6. Correlations between orthopaedic injuries sustained and mechanism of injury

Based on the results obtained from this study, should a patient be involved in a road traffic accident they are 3.5 times more likely to sustain a tibia/fibular fracture as opposed to any other fracture. These road traffic accident patients are also twice as likely to sustain scapula or clavicle fractures compared to the other MOIs.

5.7. Study strengths, limitations, and future research

5.7.1. Strengths

The study is based on a large sample size for a select group of patients, over a two-year period. Thus, we have established a significant data bank on which further studies can be conducted. The study encompasses a wide spectrum of orthopaedic and non-orthopaedic injuries, identified, and confirmed objectively by a consultant radiologist.

5.7.2. Limitations

A limitation of the study was its retrospective nature and there was no follow up on the patient outcomes of the identified injuries. With regards to spinal fractures, there was no collection of data regarding the presence or absence of neurological dysfunction,

which may be a consideration for further research. The CT pan scan protocol includes patients who are deemed clinically stable to undergo a CT pan scan, thus those patients who were deemed to be too unstable were not pan scanned and thus may not reflect the injury patterns of these unstable polytrauma patients. In South Africa, there are periods of load shedding during which CT scans are performed offline. The CT scan images and reports are not transferred to the PACS once the servers are back online.

5.7.3. Future research

- To conduct a prospective study with a follow-up of polytrauma patients who will undergo a CT pan scan.
- To investigate the use of CT pan scan compared to other alternatives to establish the modality of choice to a standard of care.
- To evaluate the criteria of selection for the CT pan scan and the rationale for this intervention in polytrauma patients.

6. Conclusion

The majority of polytrauma patients seen at CMJAH are young males, who sustained injuries during road traffic accidents. Fractures accounted for 94% of all orthopaedic injuries. The most common orthopaedic injury detected in our cohort, overall, was a spinal fracture, most commonly involving the cervical Spine. A patient involved in a road traffic accident is 3.5 times more likely to sustain a tibia/fibular fracture as opposed to any other fracture. The most common non-orthopaedic injury sustained is a chest injury. Importantly, 1 in 4 of these patients sustained an associated cervical spine injury and 1 in 3 a pelvic injury, similarly with head injuries. The most common combination of injuries is a chest injury with an associated pelvic/sacral fracture secondary to a pedestrian vehicle accident. The findings highlight the significant burden of orthopaedic injuries in polytrauma patients. In addition, the findings of this study, highlight injury patterns that should be anticipated in polytrauma patients.

Declarations

Author contributions:

1. Wezley Laney. This author helped with report design, data collection, literature review and analysis, article drafting, final approval and submission.
2. Dharshen Naicker. This author helped with report design, literature review and analysis, article drafting and final approval
3. Brenda Milner. This author helped with report design, literature review and analysis, article drafting, final approval and submission.
4. Shahed Omar. This author helped with data analysis, article drafting, article review and final approval.

Ethics approval and consent to participate:

1. Ethics approval was obtained from Human Research Ethics Committee (Medical), University of the Witwatersrand.

Consent for publication:

1. Consent waived for retrospective research.

Availability of data and materials:

1. Data sharing applicable to this article as datasets were generated or analysed from CMJAH during the current study.

Funding:

1. No funding was required for the retrospective study.

Competing interests:

1. The authors declare that they have no competing interests.

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Appendices

Appendix A: Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R49 Dr W Laney

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M201131

NAME: (Principal Investigator)	Dr W Laney
DEPARTMENT:	School of Clinical Medicine Department of Surgery Division of Orthopaedic Surgery Medical School University
PROJECT TITLE:	*Analysis of orthopaedic injuries in polytrauma patients at Charlotte Maxeke Johannesburg Academic Hospital*
DATE CONSIDERED:	2020/11/27
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Drs D Naicker and B Milner
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2021/01/20

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. I agree to submit a yearly progress report. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **November** and therefore reports and re-certification will be due in the month of **November** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

25/01/2021
Date

Appendix B: CEO permission letter

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL (CMJAH)
Office of the Clinical Director

Enquiries: Ms. XF Dhlamini
Tel: (011) 488-3710
Email: Xolisane.dhlamini@gauteng.gov.za

Physical Address: Room 262A,17 Jubilee, Parktown 2193 Postal Address: Private Bag x39, Johannesburg 2000

10 February 2021

GP_202102_002

To: Dr. W Laney

RE: FINAL APPROVAL OF STUDY

TITLE: ANALYSIS OF ORTHOPAEDICS INJURY IN POLYTRAUMA PATIENTS AT CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL.

Permission is granted for you to conduct the above-mentioned study as described in your request provided:

1. Charlotte Maxeke Johannesburg Academic Hospital will not in any way incur or inherit costs as a result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall always be observed.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the HOD and Unit Manager or Sister in charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

Supported/Not Supported

Dr J Punwasi
Clinical Director
Date: 11/02/2021

Approved/Not Approved

Ms. G Bogoshi
Chief Executive Officer
Date: 19.02.2021

Appendix C: HOD Radiology permission letter

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL
Department of Diagnostic Radiology
Tel: (011) 488 3368

27 January 2021

Dear Dr Wezley Laney

Re: Request to conduct a retrospective study on Analysis of Orthopaedic Injuries in Polytrauma Patients at Charlotte Maxeke Johannesburg Academic Hospital.

Dr Wezley Laney is a registrar from the Department of Orthopaedic Surgery at CMJAH, he has requested to conduct a retrospective study on Analysis of Orthopaedic Injuries in Polytrauma Patients at Charlotte Maxeke Johannesburg Academic Hospital, he would like to access patients panscans computer tomography from the 01 January 2018 to 31 December 2019 from the Radiology department.

As the Head of the Department of Diagnostic Radiology, I hereby grant Dr Wezley Laney a permission to conduct the above study and to access the radiographs required, please note that Diagnostic Radiology department should be properly acknowledged in any publications and Journals. In addition we require six monthly reports on the progress of the project.

Please liaise with the relevant Consultant and Radiography department manager in charge with regards to the logistics and practical aspects of conducting the study.

Yours faithfully,

Prof. D.P. Ramaema
Clinical Head of Department
Department of Diagnostic Radiology
Charlotte Maxeke Johannesburg Academic Hospital

Appendix D: HOD Orthopaedics CMJAH permission letter

Division of Orthopaedic Surgery

Faculty of Health Sciences, 4M Room 12, Wits Medical School, 7 York Road, Parktown 2193
• Tel: +27 11 717-2538 • Fax: +27 11 717-2551

Dr. S Van Deventer

Head of the Trauma Unit, Orthopaedic Department

Division of Surgery

Charlotte Maxeke Johannesburg Academic Hospital

31/08/2020

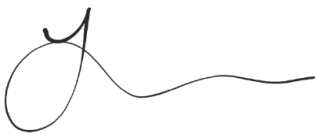
Re: **Retrospective analysis of orthopaedic injuries in polytrauma patients at Charlotte Maxeke Johannesburg Academic Hospital**

The Orthopaedic trauma unit of department of Orthopaedics at Charlotte Maxeke Johannesburg Academic Hospital supports the above-mentioned study. We give Dr. Wezley Laney permission to use our admission database to conduct this study. The goal of this research is for publication to a local or international journal and MMED submission.

We therefore accept that ethical clearance will be compulsory before commencement of the study. No costs will be borne by the Department, Unit or the Hospital for the study. It accepts that the anonymity of all patients; confidentiality will be strictly adhered to in this study will be ensured.

Please endorse this project and grant me permission to continue with it within the Division of Orthopaedics at Charlotte Maxeke Johannesburg Academic Hospital. We will submit all results to you as we seek to publish these results in an international or national journal.

Yours faithfully



Dr. S Van Deventer

Head of the Trauma Unit, Orthopaedic Department
Charlotte Maxeke Johannesburg Academic Hospital

University of the Witwatersrand

Appendix E: South African Orthopaedic Journal Guidelines

Abstract

A structured abstract (maximum of 350 words), summarising the most important points in the article is required.

The abstract consisting of four paragraphs with the subheadings:

- Background (must include the aim of the study)
- Patients and methods
- Results
- Conclusion

References should be avoided. Avoid uncommon abbreviations. If essential, they must be defined at their first mention in the abstract itself

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using standard searchable terms. These keywords will be used for indexing purposes.

Level of evidence

Level 1 to 5.

Please follow the level of evidence guidelines provided by the Oxford Centre for Evidence-Based Medicine (OCEBM); version 2.1.

Available from: OCEBM Levels of Evidence Working Group. “The Oxford Levels of Evidence 2”. Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653

Introduction

The introduction should contextualise the study by providing the background to the research; explain the problem that is to be addressed and provide the rationale for the study.

Briefly outline the relevance if the study in respect to the current literature. Avoid a detailed literature survey or a summary of the results.

The last sentence should outline the research question or hypothesis.

Patients (or Materials) and Methods

State the methods, outcome measures, and selection criteria. The following aspects needs to be described:

- The study design and research methodology.
- Whether randomization (with methods) was applied.
- If case controlled, how the controls were selected.
- The time period under review.
- Number of patients/subjects under investigation and why this number was chosen.
- Inclusion and exclusion criteria.
- Case and outcome definitions.
- Description of procedure or intervention, including post-operative protocol.
- The outcome measures or scores were used.
- The minimum follow-up period.
- A statistical analysis section should be included at the end of this section to detail statistical tests and package used, the reasons why these tests were used, and what p-value was considered statistically significant. A power analysis is recommended for studies comparing two or more groups.
- Provide sufficient detail so that another researcher can replicate the study.
- The reader should understand from this description all potential sources of bias such as referral, diagnosis, exclusion, recall, or treatment bias. This includes the manner in which investigators selected the patients. Consecutive inclusion implies all patients with a given diagnosis are included, while

selective implies patients with a given diagnosis but selected according to certain explicit criteria (e.g., state of disease, choice of treatment).

- Do not describe standard procedure for common operations. Only include new procedures or adaptations to standard procedure.
- If you name any specific product, then it requires the name, city, and state/country of the manufacturer.
- Present in narrative format and use past tense.
- Where relevant, tables or figures may be included to provide information more clearly.
- Generally, no data should normally be presented in this section.

Results

- Describe the relevant results and analysis thereof.
- Provide details of the number of patients included and excluded, as well as the reason for exclusion.
- It is important to state the follow-up period (mean and range).
- The results can be broken down into separate sections, e.g., Treatment, Functional outcome, Complications, etc.
- Tables may be used but avoid repeating data reported in the text in the tables.
- All appropriate data should be presented as means with ranges, not with standard deviations (SDs). Medians should only be used when the data is skewed, accompanied by an interquartile range (IQR).
- Avoid using percentages in studies involving well under 100 subjects.
- All results must be backed-up with p-values or survivorship analysis. All Kaplan-Meier data should be presented with the confidence intervals. Always present exact absolute p-values, whether significant or not, unless $p < 0.001$.
- However, p-values do not always convey the entire picture and where relevant the confidence interval will also be required (in addition to the power of the study reported in the methods section).

Discussion

- The question or hypothesis stated at the end of the introduction should be discussed and supported or rejected.
- The results must be interpreted clearly, and any deficiencies expressed. All possible confounding factors, sources of bias, weaknesses in the study should be identified.
- Explore the significance of the results of the work, rather than repeating the results.
- The discussion must point out the relevance of the work described in the paper and its contribution to current knowledge.
- Explain what can be deduced from the results and how will it affect clinical practice should be clearly stated
- Should include a review of the relevant literature, placing the results of the study in the context of previous work in this area.
- Discussion of relevant prior research and references must be concise. Avoid extensive citations and discussion of published literature but put emphasis on previous findings that agree (or disagree) with those of the present study.
- Do not repeat the introduction.
- The limitations of the study must be presented and suggest how the study could have been improved for a future study.
- Authors should avoid making inferences from non-significant trends unless they believe their study is adequately powered to answer the question; in that case, provide a power analysis.

Conclusion

Summary statement which conveys the conclusions of the findings. Do not draw conclusions not supported by the data obtained from the specific study presented.

Appendix F: Student's contribution to the research and writing of the "submissible" paper

Division of Orthopaedic Surgery

Faculty of Health Sciences, 4M Room 12, Wits Medical School, 7 York Road, Parktown 2193
• Tel: +27 11 717-2538 • Fax: +27 11 717-2551

14 October 2021

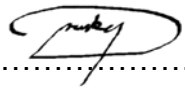
Faculty of Health Sciences, University of the Witwatersrand

RE: WEZLEY LANEY'S CONTRIBUTION TO THE RESEARCH AND WRITING OF THE "SUBMISSIBLE" PAPER

To whom it may concern,

This letter serves to confirm that the co-authors of the "submissible" research paper have agreed to its use by Wezley Laney, student number 361419, as part of his MMed research report. Wezley Laney made a substantial contribution to conducting the research study and writing the manuscript.

Yours sincerely,



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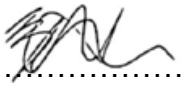
Dr Dharshen Naicker

Supervisor



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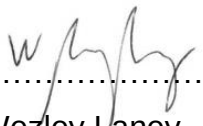
Dr Brenda Milner

Supervisor



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Dr Wezley Laney

MMed Candidate