

**COMPUTED TOMOGRAPHY AND X-RAY PATTERNS OF PELVIC FRACTURE IN
ADULTS IN TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA
UNIVERSITY, ADDIS ABABA, ETHIOPIA**

INVESTIGATOR: DR HAILE HAGOS, MD (RADIOLOGY RESIDENT)

**A RESEARCH REPORT TO BE SUBMITTED TO RADIOLOGY
DEPARTMENT, COLLEGE OF HEALTH SCIENCES, ADDIS ABABA
UNIVERSITY IN PREPARATION FOR PARTIAL FULFILMENT OF THE
REQUIREMENT FOR THE POST GRADUATE STUDY IN RADIOLOGY.**

JULY, 2019

ADDIS ABABA, ETHIOPIA

**COMPUTED TOMOGRAPHY AND X-RAY PATTERNS OF PELVIC FRACTURE IN
TIKUR ANBESSA SPECIALIZED HOSPITAL IN ADULTS, ADDIS ABABA
UNIVERSITY, ADDIS ABABA, ETHIOPIA**

INVESTIGATOR: DR HAILE HAGOS, MD (RADIOLOGY RESIDENT)

ADVISORS

PRF.DANIEL ADMASSIE (CONSULTANT RADIOLOGIST)

DR HIWOT GEZAHEGN (RADIOLOGIST)

DR MOGES ZENEBE (RADIOLOGIST)

JULY, 2019

ADDIS ABABA, ETHIOPIA

ACKNOWLEDGEMENT

I would sincerely like to thank my advisors professor Daniel Admassie, Dr. Hiwot Gezahegn and Dr. Moges Zenebe for their continuous support and constructive comments on the study of the material and throughout preparation of the study.

I am grateful to the workers of the archive room specially W/ro Wesene Beklle, Ato Shewangizaw Zergaw and W/ro Getenesh Asegid for their unreserved cooperation and assistance for assessing the charts of the patients.

I would also like to thank the Faculty for giving me the opportunity to do this research.

Last but not least my deepest gratitude goes to my family for their generous support especially my wife W/ro Hiwot G/her being with me throughout the course of the preparation of the study and the completion of this paper.

Table of Contents

| | |
|--|------|
| List of abbreviations and Acronyms | IV |
| List of tables..... | v |
| List of Figures..... | vi |
| Abstract..... | viii |
| 1. Introduction..... | 1 |
| 1.2. Statement of the problem | 2 |
| 2. Literature review..... | 3 |
| 3. Objectives..... | 12 |
| 3.1 General objectives..... | 12 |
| 3.2 Specific objectives..... | 12 |
| 4. Methodology..... | 12 |
| 4.1 Study area..... | 12 |
| 4.2 study design..... | 12 |
| 4.3. Source and study population..... | 13 |
| 4.3.1 Source population..... | 13 |
| 4.3.2 Study population..... | 13 |
| 4.5. Inclusion and exclusion criteria..... | 13 |
| 4.5.1 Inclusion criteria..... | 13 |
| 4.5.2 Exclusion criteria..... | 13 |
| 4.6 Sample size and sampling procedures..... | 13 |
| 4.6.1 Sample size determination..... | 13 |
| 4.6.2 Sampling method..... | 13 |
| 4.7. Study variables..... | 13 |
| 4.8 Data collection procedures..... | 14 |
| 4.8.1 Data collection..... | 14 |
| 4.8.2 Data quality control..... | 14 |
| 4.8.3 Data processing and analysis..... | 14 |
| 4.9 Ethical clearance | 14 |

| | |
|---|----|
| 4.10 dissemination plan..... | 14 |
| 5. Operational definition..... | 15 |
| 6. Result..... | 17 |
| 6.1 Demographic status of patients with pelvic ring fracture. | 17 |
| 6.2 Mechanism of injury of pelvic ring fracture..... | 18 |
| 6.3 CT pattern of pelvic ring fracture(Tiles classification pattern)..... | 20 |
| 6.4 X-ray Patterns of pelvic ring fracture(Tiles classification) | 21 |
| 6.8. Correlation of the variables..... | 22 |
| 7. Discussion | 24 |
| 8. Conclusion..... | 26 |
| 9. Recommendation..... | 26 |
| 10. Limitation of the study..... | 27 |
| References..... | 28 |

List of abbreviations and Acronyms

| | |
|--------|---|
| AAU | Addis Ababa University |
| APC | Anteroposterior compression |
| CT | Computed tomography |
| DALYs | Disability adjusted life year (1 DALY = loss of 1 year of healthy life) |
| GNP | Gross National Product |
| LC | Lateral compression |
| MSK | Musculoskeletal |
| IRB | Institutional review board |
| RTA | Road traffic accident |
| RTI | Road Traffic Injuries |
| AO/OTA | (Arbeitsgemeinschaft für Osteosynthesefragen/ Orthopedics Trauma Association) |
| SD | Standard Deviation |
| SPPS | Statistical Package for Social Science |
| TASH | TikurAnbesa Specialized Hospital |
| US | United States of America |
| VS | Vertical shear |

List of tables

| | |
|--|----|
| Table 6.1: Percentage of gender and mean age of pelvic ring fracture in TASH, Addis Ababa, Ethiopia..... | 17 |
| Table 6.2: Mechanism of injury in pelvic ring fracture in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 19 |
| Table 6.3: CT pattern of pelvic ring fracture(Tiles classification) in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 20 |
| Table 6.4: X-ray patterns of pelvic ring injury (Tiles classification) in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 22 |
| Table 6.5: Mechanism of injury vs CT Tiles classification in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 22 |

List of figures

| | |
|--|----|
| Figure 6.1: Age category distribution of patients with pelvic ring fracture in TASH, Addis Ababa, Ethiopia (n=80), April 2018 to June 2019 | 18 |
| Figure 6.2: Mechanism of injury in pelvic ring fracture in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 19 |
| Figure 6.3: CT patterns of pelvic ring injury in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019 | 21 |

**COMPUTED TOMOGRAPHY AND X-RAY PATTERNS OF PELVIC FRACTURE IN
TIKUR ANBESSA SPECIALIZED HOSPITAL IN ADULTS, ADDIS ABABA
UNIVERSITY, ADDIS ABABA, ETHIOPIA**

Abstract

Background

Trauma is a public health burden resulting in increased morbidity, mortality and disability for the survivors. Musculoskeletal injury results in dramatic, destructing and life-threatening injuries. Of these pelvic fracture accounts approximately to 3% of the overall injuries and is one of the major causes of morbidity and mortality. Classification of pelvic fracture is useful in describing injury and also helps in guiding both the initial treatment and definitive fixation. But pelvic fractures have presented a great challenge to orthopedic surgeons and radiologists over the years in that multiple classification system exists to attempt to standardize care and no consensus exists in the classification method of such fractures. The classification scheme of Young and Burgess and Tiles described the severity of injury by the mechanistic process involved and by grading the stability of the injury respectively. However, the most current classification method is that developed by the AO and OTA and is a composite of these two earlier methods. In addition, an understanding of the mechanism of injury that leads to pelvic fractures is useful to guide treatment and understand patterns of injury and cause of mortality.

Objective

The objective of the study is determining the CT and X-ray pattern of pelvic fracture in TASH.

Method

The study is a hospital based retrospective cross sectional study done on 80 patients who have pelvic ring fracture who have CT scan and Pelvic X-ray (AP, Inlet and outlet views) in the department of radiology. The CT scan was examined by senior radiology residents and revised by radiologist, with these finding the Tiles classification of pelvic ring fracture was assessed by the principal investigator initially by X-ray alone and later by CT scan alone blindly.

Result

A total of 80 patients with pelvic ring fracture were included in the study of which 58 (72.5%) were males and 22 (27.5%) were females. Road terrific accident was the major cause of pelvic fracture accounting for 76.3% of cases followed by fall from a height. Of those involved in RTA the most affected people were both passengers and pedestrians (30%) each followed by drivers(16.3%).The most commonly affected age group was those found in between 15-25 years of age (43.8%) and followed by those in between 26-35 years (35%). The most common pattern of pelvic ring fracture was Tiles B2 (25%) followed by C1 (22.5%) and B3 (20%). Over all Tiles B accounts 45% and Tiles C accounts 38.8%.

Conclusion

In this study trauma commonly affects males and RTA is the most common type of trauma causing pelvic ring fracture affecting males in the productive age groups between 15-35 years. Tiles B pattern of pelvic ring fracture is the most common pattern followed by Tiles C pattern. Further study is recommended in the value of CT and X-ray in the evaluation of pelvic fracture.

1. Introduction

1.1 Background

Trauma is a public health burden resulting in increased morbidity, mortality and disability for the survivors. Musculoskeletal injury results in dramatic, destructing and life-threatening injuries. Musculoskeletal trauma principally includes injuries occurring to the neck, spine, pelvis and extremities. They include fractures, dislocations, sprains and strains, contusions, crush injuries, joint injuries, soft tissue trauma, open wounds, and traumatic amputations. The cause of musculoskeletal injuries are sport injuries, playground accidents, motor vehicle crashes, falls , assaults, war injuries, stress injuries , overexertion, and occupational or workplace injuries. Among the listed causes road traffic accidents are reported to be the main cause of injury to the musculoskeletal system. And pelvic fracture accounts approximately 3% of all skeletal injury. Pelvic fractures have presented a great challenge to orthopedic surgeons and radiologists over the years. Multiple classification system exists to attempt to standardize care. However, no consensus exists in the classification method of pelvic fracture. Classification of pelvic fracture is useful in describing injury and also to help guide both initial treatment and definitive fixation. The classification scheme of Young and Burgess and Tiles described the severity of injury by the mechanistic process involved and by grading the stability of the injury respectively. However, the most current classification method is that developed by the AO and OTA and is a composite of these two earlier methods. Currently, the classification of a pelvic ring injury is based on evaluation of conventional plain radiography, specifically the AP, inlet and outlet views. Although plain radiography has been the mainstay of classifying pelvic ring disruptions, plain radiography are subject to factors, such as obesity and the presence of bowel gas or contrast media, that can impair diagnostic accuracy. In addition, accurate positioning of the X-ray tube angle to obtain proper views of the pelvis may be difficult to achieve, depending on the patients position and the technicians precision in obtaining these films. In addition, an understanding of the mechanism of injury that leads to pelvic fractures is useful to guide treatment and understand patterns of injury and cause of mortality.

1.2. Statement of the problem

Worldwide trauma is considered a public health burden as it results to increase in morbidity, mortality and disability. This translates to increase in health care expenses and reduced productivity due to suboptimal functional outcome. Road traffic accidents are reported to be the main cause of injury (6). These has been largely attributed to by rapid motorization and advanced industrialization.

In young patients displaced pelvic ring fracture results from the transfer of substantial kinetic energy to the body. They most commonly result from trauma such as motor vehicle accidents (60% of cases), falls from a height (30% of cases), and crash injuries (10% of cases) [1]. Thus displaced pelvic ring fractures are marker for high energy trauma and are often associated with other life threatening injuries. Although the mortality rate in patients with pelvic fracture has declined in the recent years, the incidence of pelvic fractures is increasing because of the increased incidence of high speed motor vehicle accidents and increased survival after these incidents [2].

Pelvic fractures increase the risk for mortality primarily because of hemorrhage caused by direct injury to adjacent vasculature (venous and arterial) from osseous fragments, disruption of vessels by shear forces, and osseous bleeding [3]. After displaced pelvic fracture, mortality is most often related to acute hemorrhage in patterns that increase the pelvic volume, such as anteroposterior compression and vertical shear, but it may also result from associated injuries in patterns such as lateral compression, which reduces the pelvic volume.

1.3. Justification of the study

The incidence of pelvic fracture is thought to be rising in recent years. This in Ethiopia is attributable to high speed motor vehicle accidents due to improved road networks. The approach to evaluation and management of these pelvic fractures has also evolved in the local setup. There are tools specifically X-ray and CT scans for the evaluation of pelvic fractures. Classification of pelvic fracture is useful in describing injury and also to help guide both initial treatment and definitive fixation.

An understanding of the mechanism of injury that leads to pelvic fractures is useful to guide treatment and understand patterns of injury and cause of mortality. Up to my knowledge is concerned no study on patterns of pelvic fracture and severity exists in Ethiopia. This study will give a baseline for further study and highlight the severity of pelvic fracture in our country.

2. Literature review

Global burden of disease in 1990 estimated 50.5 million deaths occurred annually worldwide. Of these, 5.1 million people died following injury [4]. Worldwide, 1.2 million people die in road crashes annually and 20-50 million more people survive with injuries. For every death from trauma, three victims suffer permanent disability [5].

By 2020, WHO projects 8.4 million people will die annually following injury. Road traffic accidents being third to ischemic heart disease and unipolar major depression as the commonest causes of mortality and morbidity world-wide. Fifth in the developed countries for mortality and second in the developing countries [4, 6, 7, 8].

Low and middle income countries account for 85% of deaths and 90% of disability adjusted life-years lost annually [7]. The major unintentional injury-related causes of DALY's lost annually include road traffic injuries and falls [6]. The worldwide burden of injuries is disproportionately concentrated in the low and middle-income countries with unintentional injuries accounting for over 9% total DALY's, often occurring in countries with the weakest evidence to guide intervention strategies, the fewest resources and least developed infrastructure to effect change [9-11]. World health organization (WHO) 2004 region estimates Africa DALY's 2743 per 100, 0000 [10].

Annually, the average number of injuries resulting in restriction of activities is 30.6 million. 13.4 million Of these are severe enough to require bed rest. This translates into 1.54 million acute hospitalizations for an average duration of 7.1 days and about 45000 deaths over one year period [12, 13]. The overall fracture incidence in the Scottish population over 12 years is 11.13 in 1000 per year (14). In the USA 15.3 million fractures occur annually. Fractures account for 53% of all hospital discharges in the United States [15]. These figures are less than those recorded in Norway and England [16].

Among the Scottish population above 65 years of age, the fracture incidence is 23.3 per 1000 per year, which compares to results in England and Australia [17, 18]. In a review on adult fractures by Charles and Ben, there was a wide variation in England and Wales fracture incidence for reasons not fully understood. There was also over diagnosis of fractures by inexperienced doctors who cover the accident and emergency department and an underestimate from the orthopedic clinic as most fracture patients referred for follow up, default. The data from having been from a single hospital could explain the skewed results [19].

Pelvic fracture constitutes 3% of all skeletal injuries [23, 27]. Its incidence amongst polytrauma patients ranges from 25% to 30%, it is one of the most common causes of mortality in polytrauma patients and these rates have been found to be in the range of 16-19% in such patients [23,27]. The most common cause of death in these patients is hemorrhagic shock or coagulopathy (60-65%), thus control of hemorrhage is of utmost importance. Additional causes of death are sepsis in pelvic hematoma and acute renal failure [52].

In young patients displaced pelvic ring fracture results from the transfer of substantial kinetic energy to the body. They most commonly result from trauma such as motor vehicle accidents (60% of cases), falls from a height (30% of cases), and crash injuries(10% of cases) [1]. Thus displaced pelvic ring fractures are marker for high energy trauma and are often associated with other life threatening injuries. Although the mortality rate in patients with pelvic fracture has declined in the recent years, the incidence of pelvic fractures is increasing because of the increased incidence of high speed motor vehicle accidents and increased survival after these incidents [2].

The incidence of pelvic fractures has been reported in literatures as ranging from 29:100,000 in women and 20:100,000 in men. The male to female ratio in those above 49 years was 1:2.9 and 1:0.5 for those below 49 years [24, 25]. There has been reported far less for pediatric patients [26]. There has been increased association of severe pelvic fractures with motor vehicle collision especially side lateral collision [27].

Pelvic fractures increase the risk for mortality primarily because of hemorrhage caused by direct injury to adjacent vasculature(venous and arterial) from osseous fragments, disruption of vessels by shear forces, and osseous bleeding [3]. After displaced pelvic fracture, mortality is most often related to acute hemorrhage in patterns that increase the pelvic volume, such as anteroposterior compression and vertical shear, but it may also result from associated injuries in patterns such as lateral compression, which reduces the pelvic volume.

Plain radiographic films (X-rays) are a simple and convenient two-dimensional means of imaging osseous anatomy with variable soft tissue definition. The use of anteroposterior (AP) pelvic X-rays in blunt pelvic trauma is widely established, for example as adjunct to the primary survey in advanced trauma life support (ATLS) principles [40]. The antero-posterior pelvic X-ray alone however has a limited sensitivity in blunt trauma with reported false negative rates of 32% [41]. It most commonly fails to detect sacral and iliac fractures. Despite this, their use is still advocated in the following groups [42]: haemodynamically unstable patients, suspicion of hip dislocation (as urgent relocation is required) and in patients who are being transferred directly to theatre for other indications (such as head injury)without time for CT imaging. It has been suggested that CT should be the primary investigation in blunt trauma for all haemodynamically stable patients with the initial pelvic x-ray being omitted completely [43]. Tilting the x-ray tube 45° –cranial and caudal achieves the angled inlet and outlet views, respectively. These views give additional information about the sacrum, sacro-iliac joints and any suspected vertical displacement of the hemipelvis becomes more apparent. These additional plain film views are seldom used in the acute setting, as significant or complex pelvic fractures are likely to require CT to assess for associated injuries. If needed, retrospective reconstructions may be performed on the CT to offer the trauma surgeon simulations of the above additional views[44].

Because of the complexity of pelvic fractures precise pathological anatomy is not easily demonstrated by routine radiographs and in many cases details of fractures are not visible. Moreover, the insufficient co-operation of the patient or the difficulty of maintaining special positions can be overcome by using CT.

Spiral CT provides information regarding the extent of the fractures and is complementary to radiograph for ascertaining the spatial arrangement of fracture fragments. Spiral CT is an effective tool for understanding complex fracture patterns, particularly when combined with multiplanar reconstruction two-dimensional (MPR 2D) reformatted images or three-dimensional (3D) images. Including these techniques of reconstruction in routine pelvic imaging protocols can change management in a significant number of cases. Subtle fractures, particularly those oriented in the axial plane, are seen on MPR images or 3D volume –rendered images. Complex injuries can be better demonstrated with 3D volume –rendered images, and complicated spatial information about the relative position of fracture fragments can be easily demonstrated to the orthopedic surgeons. The use of intravenous contrast material allows simultaneous evaluation of osseous and vascular structures within the affected area. Postoperative studies in patients with orthopedic hardware also benefit from volume-rendered imaging. Volume rendering eliminates most streak artifact and produces high-quality images on which the relationship among hardware, bones, and bone fragments are well demonstrated [30].

Magnetic resonance imaging (MRI) has a limited role in assessing most pelvic fractures. With high resolution spiral CT performed on arrival of most traumatically injured patients there is little use for further imaging. There is some value for MRI in delineating some acute pelvic disruption and providing accessory information regarding the nature of ligamentous injury [46]. However, there is one scenario in which MRI may be beneficial. MRI has a role for detecting undisplaced pelvic fractures in osteoporotic bone where an elderly patient has had a low energy injury and pelvic pain [45]. These fractures may be undetectable on CT images due to the patient’s low bone density thus MRI is warranted.

The utility of radiology in formulating classification systems has also been studied. In his paper Young, used plain radiography to delineate four basic patterns of injury lateral compression, anteroposterior compression, vertical shear and combined mechanical injury [28].

There are few studies to validate the myriad classification system of the pelvis. One of them demonstrates moderate intraobserver and interobserver agreement in both the Tiles and Young and Burgess Systems. In this study the Tiles classification system of pelvic fracture was used. It has moderate interobserver and intraobserver variability. It has been adopted by AO, and it is easy to use.

To aid in rapid and appropriate treatment of pelvic ring injuries, numerous attempts to classify these injuries have been made. In 1938 Watson-Jones proposed a schema based primarily on fracture location[51]. Huittinen and Slatis noted the relationship between the directions of impact and the resulting pelvic injury pattern[47] and Trunkey et al [50] introduced the concept of stability. Location and magnitude of the applied force, either high or low energy, have been recognized as important factors responsible for pelvic injuries [47,48]. Stability of the ring also was identified as a critical component of pelvic ring management (49). Pennalet al [29] were the first to systemically describe the force vector responsible for pelvic ring injury as AP compression (APC, lateral compression (LC), or vertical shear (VS). Tiles et al. [21] added the concept of stability (i.e, stable, vertically stable but rotationally unstable, vertically and rotationally unstable). Acetabular fractures were considered separately in the classification of Tile et al. (comprehensive classification) [21] and young et al. (Young and Burgess Classification) [27].

Tiles modified the Pennel classification, and categorized the injuries as stable and unstable. Stability is the ability of pelvic ring to withstand physiologic forces without abnormal deformation. Forty percent of the pelvic stability is provided by the anterior ring and 60% by posterior ring. Stability of the pelvis following trauma is assessed by clinical and radiological parameters [23]. Clinically stability is examined by pelvic compression and distraction test. Radiologically the criteria for instability are , sacroiliac joint displacement of 5 mm in any plane, posterior fracture gap(rather than impaction, and avulsion of fifth lumbar transverse process, lateral border of sacrum (sacrospinous ligament), or ischial spine (sacrospinous ligament) [23,27].

According to Tiles classification, pelvic ring fracture was classified in to three types

Tiles type -A are stable fractures with intact soft tissue around the pelvis, not disrupting the ligaments. It includes avulsion fractures and transverse fracture of sacrum and coccyx.

Tiles type B pelvic fractures are rotationally unstable, but vertically stable; there is less than 1 cm rotation of the hemipelvis. These types of injuries are caused by external or internal rotational forces. The external rotational forces produce “open book” injury pattern. There is disruption of symphysis pubis associated with unilateral or bilateral sacroiliac joint disruption. The posterior sacroiliac ligaments remain intact, thus the pelvis is vertically stable.

Tiles type C pelvic fractures are rotationally and vertically unstable, characterized by disruption of posterior sacroiliac ligaments as well as pelvic floor, this result in gross displacement of pelvis. These injuries are due to vertical shear forces, resulting in the mark displacement of the sacroiliac joint. There is complete disruption of both sacroiliac and sacrotuberous ligament leading to rotationally and vertically unstable fracture pattern.

The OTA classification is further modification of the Tiles classification and thus type A is lesion sparing (or with no displacement of) the posterior arch, A-1 is fracture of innominate bone; avulsion, A-2 is fracture of innominate bone; direct blow, and A-3 is transverse fracture of sacrum and coccyx. Type B pelvic fractures are incomplete disruption at posterior arch; partially stable B-1, is unilateral partial disruption of posterior arch, external rotation (“open book”), B-2 is unilateral, partial disruption of posterior arch, internal rotation (LC injury), and B-3 is bilateral, partial lesion of posterior arch. Type C pelvic fractures are complete disruption of posterior arch with C-1 being unilateral, disruption of posterior arch, C-2 is bilateral, ipsilateral complete with contralateral incomplete posterior arch disruption, and C-3 is bilateral, complete disruption. In 1986, Young et al. described 142 patients with pelvic ring injuries and classified their injuries mechanistically [27]. Using AP pelvic radiographs, pelvic injuries (fractures and joint disruptions from ligamentous injuries) were identified. These injuries appeared in patients correlating with the direction and location of applied force. The authors cited the necessity for rapid and accurate diagnosis of pelvic injuries and correction of pelvic deformity as essential aspects of the resuscitation and treatment of patients with pelvic ring injuries.

By understanding that APC injuries result in external rotation of the hemi-pelvis and learning to identify this deformity on rapidly obtained AP pelvic radiographs, providers learned to apply circumferential resuscitative splints (pelvic binders or pelvic sheets) to correct this deformity, decrease intra-pelvic volume, and aid in patient resuscitation. Additionally, by recognizing vertical shear injuries, traction can be applied to reduce the proximally displaced hemi-pelvis. These concepts were articulated by Young et al [27] and continue to be a cornerstone in the evaluation and treatment of patients with pelvic ring injuries.

APC I injuries show less than 2.5 cm of symphyseal widening and have no posterior instability either clinically or radiographically [27]. APC II injuries show widening of the symphysis pubis and instability of the posterior pelvis resulting from disruption of the anterior sacroiliac complex [27]. Tile et al. [21] found that division of the anterior structures of the symphysis pubis without disruption of the posterior structures allowed the symphysis pubis to widen as much as 2.5 cm. After this point, division of the sacrospinous, sacrotuberous and anterior sacroiliac ligament is required for additional widening. APC III injuries can be challenging to classify and difficult to diagnose, especially in the current era of pelvic wraps where radiographic evidence of posterior injury may be difficult to see on AP images of the pelvis but are more clear on axial CT scans. In the original description by Young et al. [27], eight of the ten APC III injuries had widening greater than 2.5 cm at the symphysis pubis, whereas the two with widening less than 2.5 cm had radiographic evidence of anterior sacroiliac joint disruptions. APC type III injuries are those associated with complete posterior ligamentous disruption. While fractures are less common in APC- type injuries, when they occur, they often involve the pubic rami and are vertically oriented [27].

LC injuries result when a force, laterally based and directed medially, is applied to the pelvis. Based on the location and magnitude of the applied force, different injury patterns result [27]. Fracture is more common with LC injuries than with APC injuries. In the original description by Young et al. [27], 100% of the LC injuries had ramus fractures, 88% had sacral fractures, 19% had iliac wing fractures, and 19% had central hip dislocations.

Rami fractures in LC patterns are more horizontal or coronal in orientation than with APC injuries, where vertical fractures are expected [27]. LC I injuries result from a lateral force delivered over the posterior aspect of the pelvis and represents a spectrum of injury. Sacral injury severity ranges from an incomplete anterior buckle fracture to complete sacral fracture based on the amount of energy applied to the pelvis at the time of injury. The degree of pelvic instability correlates with the severity of injury [27] and there may be a role for stress radiographs in classifying this instability. LC II injuries result from a more anteriorly directed force. This causes internal rotation of the anterior hemipelvis with possible external rotation of the posterior hemipelvis with the anterior sacroiliac joint serving as a fulcrum. The resulting posterior pelvic injury in LC II patterns may be a sacral fracture, sacroiliac ligament and joint disruption, or crescent fracture-dislocation of the ilium. LC III injuries result from greater force. The internal rotation of the ipsilateral hemipelvis causes injury to the contralateral hemipelvis in the form of anterior sacroiliac ligament disruption and sacrospinous and sacrotuberous ligament injury [27].

VS injuries result from an axially loaded force delivered over one or both hemipelvis lateral to the midline. Significant force, such as being struck by falling trees on the head or upper torso or a jump or fall from a height, is required to generate a VS pelvic injury [27]. The sacrum is driven down, relative to the iliac wing, resulting in complete ligamentous injury and disruption of the sacrospinous, sacrotuberous, anterior, and posterior sacroiliac ligaments on the injured side. Fractures of the pelvic ring may be present instead of ligamentous injury [27].

Complex (combined mechanism) injury patterns are a combination of any three primary patterns (APC, LC, or VS). The majority of the complex injury patterns originally described by Young et al. [27] resulted from LC injuries being combined with AP or VS patterns.

In addition to describing injury patterns, the Young and Burgess classification correlates with extra pelvic injuries. Dalal et al [46] showed that death in patients with pelvic ring injuries often is attributable to other, extra pelvic injuries and highlighted that the mechanical force type and resulting pelvic deformity can indicate expected organ injuries, resuscitation needs, and mortality rates.

The pattern of pelvic fracture differs in the classification method used. In a study in Kenya, the Kane modification of the Key and Conwell system was used. The commonest type of fracture was type 2 accounting 51% followed by type 1 that accounts to 27% [20]. In his paper, Tiles noted that type A and type B fracture makes up 70-80% of all pelvic fractures. The pelvic ring is stable in type A fracture and partially stable in type B fracture such as “open book” and “bucket handle” fractures. The type C fractures have complete disruption of the posterior sacroiliac complex and unstable [21]. In another study of 58 patients with pelvic fractures, Tiles type B and C comprises 46% of all pelvic fractures [22].

The three views of the pelvis namely anteroposterior, inlet view and outlet view have been validated to accurately pick up pelvic fracture [29]. The CT scan was shown to be superior to the plain radiography in detecting pelvic fractures [30,31]. The role of CT scan is affirmed as an effective tool for evaluating the pelvis. Its limitations arising from time consumption and difficulty in certain selected patients with severe injuries. It is also not available in certain setups.

In a study done in Kenya national hospital, in 2016 that includes 46 patients in patterns of pelvic fracture majority (82.6%) were male, the mean age of patients was 36.6 (SD 10.7) years within the range of 20-67 years. The main mechanism of injury of the pelvic fracture was motor vehicle accidents (60.9%), most of them was pedestrians and the main pattern of pelvic fracture were Tiles B. Acetabular fracture were reported in 26.1 % of cases [31].

There are many other classification systems but there is no consensus in one system. One system favors the mechanism of injury as the key to relating the pattern of organ injury, the resuscitative requirements and eventual mortality incidence in these injuries. There is demonstrable correlation between the organ injury and the four categories of lateral compression, anteroposterior compression, vertical shear and combined mechanical injury [23].

In a study done in Tikur Anbesa specialized hospital, Ethiopia, in 2013 including 230 patients in injury characteristics and road traffic accidents, majority of patients were males (71.7%). The mean age was 32.15 (SD 14.38) years within the range of 14-80 years. The main mechanism of injury was motor vehicle accidents (pedestrian) 36.1 % and pelvic fracture was seen in 5.1 % of patients but no study on the patterns of pelvic fracture done (38).

In this study the CT and X-ray patterns of pelvic ring fracture, severity, the agreement between CT and pelvic X-ray on Tiles classification of pelvic ring fracture and mechanism of injury will be described.

3.Objectives

3.1.General objective

- To determine the CT and X-ray patterns of pelvic fracture in TASH

3.2. Specific objectives

- To determine CT and X-ray patterns of pelvic ring fracture
- To determine the severity of pelvic ring fracture based on the Tiles classification
- To determine the agreement of CT and X-ray in Tiles classification of pelvic ring fracture.
- To determine mechanism of injury in pelvic ring fracture.

4. Methodology

4.1. Study area

- The study was conducted at TASH, College of health science, Addis Ababa University, Addis Ababa, Ethiopia. TASH is located in Addis Ababa, and is the largest referral as well as the main teaching hospital in the country.

4.2. Study design

- Institutional based retrospective cross-sectional study was conducted at department of radiology, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia to meet the study objectives.

4.3. Source and study Population

4.3.1. Source population

The source populations are all those patients who had Pelvic fracture and evaluated in emergency department at TASH.

4.3.2. Study population

The study populations were all patients who sustained pelvic injury and who have CT and /or X-ray finding of pelvic fracture at radiology department at TASH.

4.4. Study participants

All patients aged 14 years and older who have pelvic fracture during the study period.

4.5. Inclusion and exclusion criteria

4.5.1. Inclusion criteria

All patients aged 14years or above who have pelvic fracture.

4.5.2. Exclusion criteria

- Patients with pelvic fracture whose clinical data and chart could not retrieved.
- Patients whose chart is retrieved but no relevant clinical information available.

4.6. Study period

- Study period was from April 2018 to June 2019 and data was collected from March 01, 2019 to April 30, 2019.

4.7. Sample size and sampling procedures

4.7.1 Sample size determination

It is estimated that fracture of the pelvis constitute 5 % of all trauma patients. Using Cochran formula to estimate sample size when the population size is infinite.

$$N = \frac{(Zc)^2(P)(1-P)}{d^2}$$

N = required sample size, Zc = standard normal deviate corresponds to a confidence level of 95%, P = prevalence: 5%, d = precision of confidence interval: 0.05

$$\frac{3.8416 \times 0.05 \times 0.95}{0.0025} = 72.99 \text{ rounded off to } 73 \text{ with } 10\% \text{ contingency} = 80$$

4.7.2 Sampling method

- The study were nonrandom convenient sampling method and Every patient who have pelvic ring fracture which fulfills the inclusion and exclusion criteria was included in the study until the sample size fulfilled.

4.8 Study variables

4.9 Data collection procedures

4.9.1 Data collection

Relevant clinical information such as socio- demographic data, mechanism of road traffic injury, and patterns of pelvic bone fracture had been filled on questionnaire paper with reading finding of the CT by senior radiology resident and MSK radiologist. Data were collected retrospectively by the principal investigator from patient record chart and reviewing reports of CT in the card room and patient X-ray and CT scan images from the PACS for the purpose of legal issues.

4.9.2 Data quality control

Data was collected by the principal investigator and case by case consultation will be done for MSK radiology subspecialist

4.9.3 Data processing and analysis

The collected data on prepared questionnaire was entered, after being encoded and analyzed using SPSS version 24 statistical package. Data cleaning was performed to check accuracy, consistency and missed values. Any logical and consistency error identified during data entry was corrected after revision of the original completed questionnaire. The cleaned and edited data was analyzed by the SPSS version 24 to generate results in frequencies, tables and figures of different variables.

4.10 Ethical clearance:

Data collection was taken after getting permission from ethical committee of the department of radiology and Addis Ababa University. Approval from IRB was obtained and formal letter were written from radiology department to the card archive before commencing the data collection process. Then, for legal purpose data collection of individual record had taken place in the chart room. After completion of data collection the charts were returned back to their original place properly.

4.10. Dissemination plan

After finalization of the analysis and interpretation of the result, the finding will be defended and the report will be submitted to Addis Ababa University School of graduate studies. The finding of this study will be communicated to department of radiology and department of orthopedics. Ways of disseminating the finding may be through printing the result and distributing to the respective department.

4.11. Operational definition

Pelvic Fracture Tiles Classification

Anterior Arch: anterior to the acetabulum

Posterior Arch (Sacroiliac complex): posterior to the acetabulum

Stability is the ability of pelvic ring to withstand physiologic forces without abnormal deformation.

Forty percent of the pelvic stability is provided by the anterior ring and 60% by posterior ring. Stability of the pelvis following trauma is assessed by clinical and radiological parameters [23]. Clinically stability is examined by pelvic compression and distraction test.

Radiologically the criteria for instability are,

- sacroiliac joint displacement of 5 mm in any plane,

- posterior fracture gap (rather than impaction),

- and avulsion of fifth lumbar transverse process, lateral border of sacrum

(sacrospinous ligament), or ischial spine (sacrospinous ligament

Tiles Type A: stable

A1: -Avulsion Fractures Pelvic ring not involved.

A2: - Iliac wing fractures or.

-Stable minimally displaced anterior arch fractures.

A3: -Transverse fractures of the sacrum or coccyx.

Tiles B: Partially Stable, vertically stable but rotationally unstable

B1: - disruption of the anterior pelvic arch through the symphysis pubis or through the rami

B2:- Anterior and posterior arch fractures.

B3: Bilateral open book (vertically oriented pubic rami fracture) , bilateral lateral compression(horizontally oriented pubic rami fracture) or combined.

Tiles C: unstable both rotationally and vertically, due to complete disruption of the anterior arch, posterior arch, and pelvic floor.

C1: -Unilaterally unstable

C2: -Unstable in one side and partially stable in the other side.

C3: -Bilaterally unstable.

6. Results

6.1 Demographic status of patients with pelvic ring fracture.

In this study, a total of 80 cases with pelvic ring fracture were reviewed. From all of the cases evaluated in the study 58(72.5) were male and 22(27.5) were female with male to female ratio of 2.64:1. The mean age of affected individuals was 30.61 years with standard deviation of 12.8. As showed in figure 6.1, the most common age group affected by pelvic ring fracture was between 15-25 years (43.8%) followed by 26-35 years(35%). The minimum age in the study was 17 years and the maximum age was 73 years and those between 46-55 years were found to be the least (2.5%). Those of patients who were between 36-45 years and those above 65 years were 12.5% and 6.3% respectively.

| Gender | Frequency | Percentage (%) | Mean age | Std.deviation |
|--------|-----------|----------------|----------|---------------|
| Male | 58 | 72.5 | 28 | 8.997 |
| Female | 22 | 27.5 | 31.6 | 13.918 |
| Total | 80 | 100 | 30.61 | 12.80 |

Table 6.1: Percentage of gender and mean age of pelvic ring fracture in TASH, Addis Ababa, Ethiopia .April 2018 to June 2019.

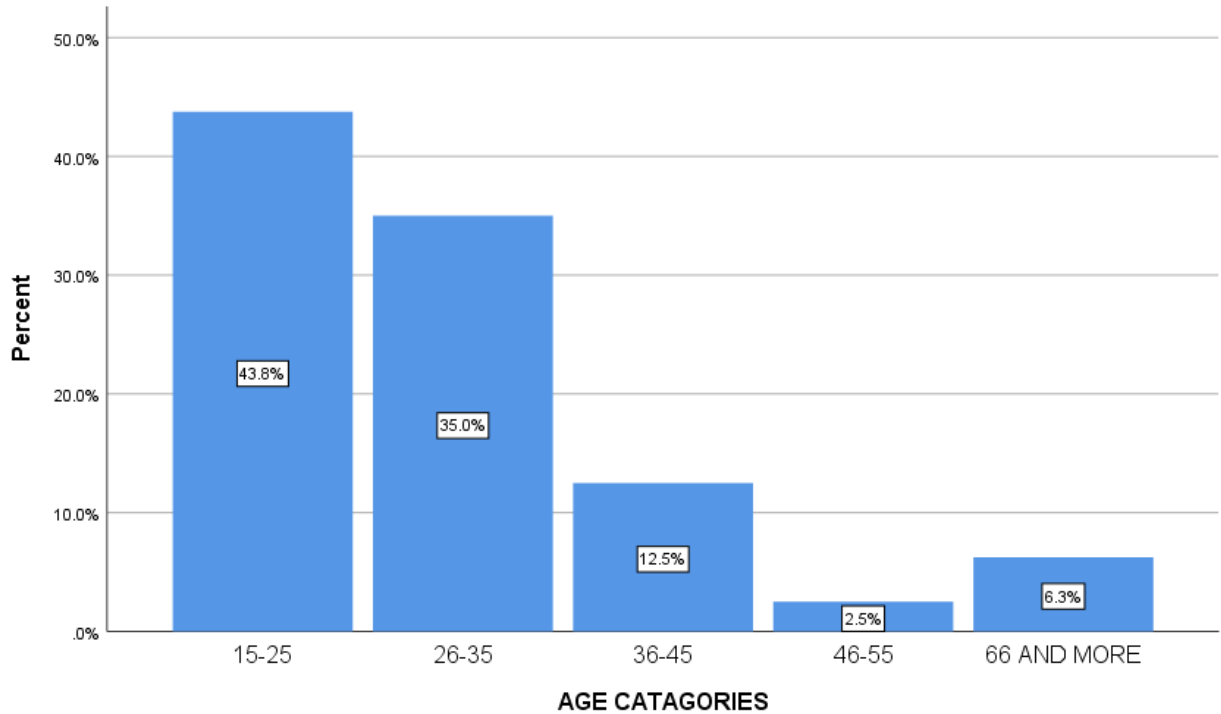


Figure 6.1: Age category distribution of patients with pelvic ring fracture in TASH, Addis Ababa, Ethiopia (n=80) , April 2018 to June 2019.

6.2: Mechanism of injury.

Road terrific accident was the major cause of pelvic fracture accounting for 76.3% of cases followed by fall from a height. Of those involved in RTA the most affected people were both passengers and pedestrians (30%) each followed by drivers (16.3%). The least mechanism of Injury was found to be others 8.8% including tree fall on them while cutting (two patients), house fall on them (three patients) ,stone injury in fighting accident (one patient), and fall from standing height (one patient).

Table 6.2: Mechanism of injury in pelvic ring fracture in TASH, Addis Ababa, Ethiopia , April 2018 to June 2019.

| | Frequency(N) | Percent(%) |
|-------------------------|--------------|------------|
| RTA | 61 | 76.0 |
| Fall down from a height | 12 | 15 |
| Others | 7 | 8.8 |
| Total | 80 | 100 |

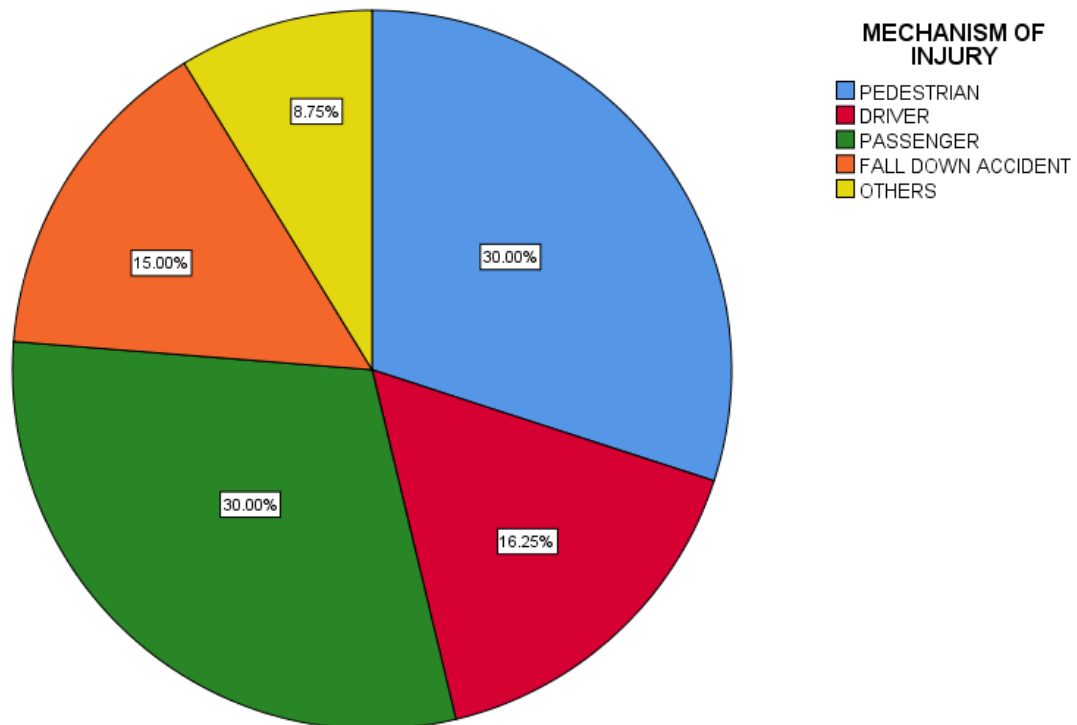


FIGURE 6.2: Mechanism of injury in pelvic ring fracture in TASH, Addis Ababa, Ethiopia.

6.3. CT Patterns of pelvic ring fracture(Tiles classification)

In this study involving 80 cases with pelvic ring fracture B2 Tiles classification was the most common fracture pattern accounting 25% followed by C1 22.5%. Tiles B3 accounts for 20% and Tiles A2 accounts for 11.3%. Tiles C3 accounts for 6.3% and the least Tiles pattern was Tiles A1 and A3 which accounts 2.5% each. In this study no Tiles B1 pattern was detected. In general classification Tiles B was the most common pattern accounting for 45% followed by Tiles C accounting 38.8%. Tiles A was least pattern accounting 16.3%.

Table 6.3: CT patterns of pelvic ring injury (Tiles classification) in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | A1 | 2 | 2.5 | 2.5 | 2.5 |
| | A2 | 9 | 11.3 | 11.3 | 13.8 |
| | A3 | 2 | 2.5 | 2.5 | 16.3 |
| | B2 | 20 | 25.0 | 25.0 | 41.3 |
| | B3 | 16 | 20.0 | 20.0 | 61.3 |
| | C1 | 18 | 22.5 | 22.5 | 83.8 |
| | C2 | 8 | 10.0 | 10.0 | 93.8 |
| | C3 | 5 | 6.3 | 6.3 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

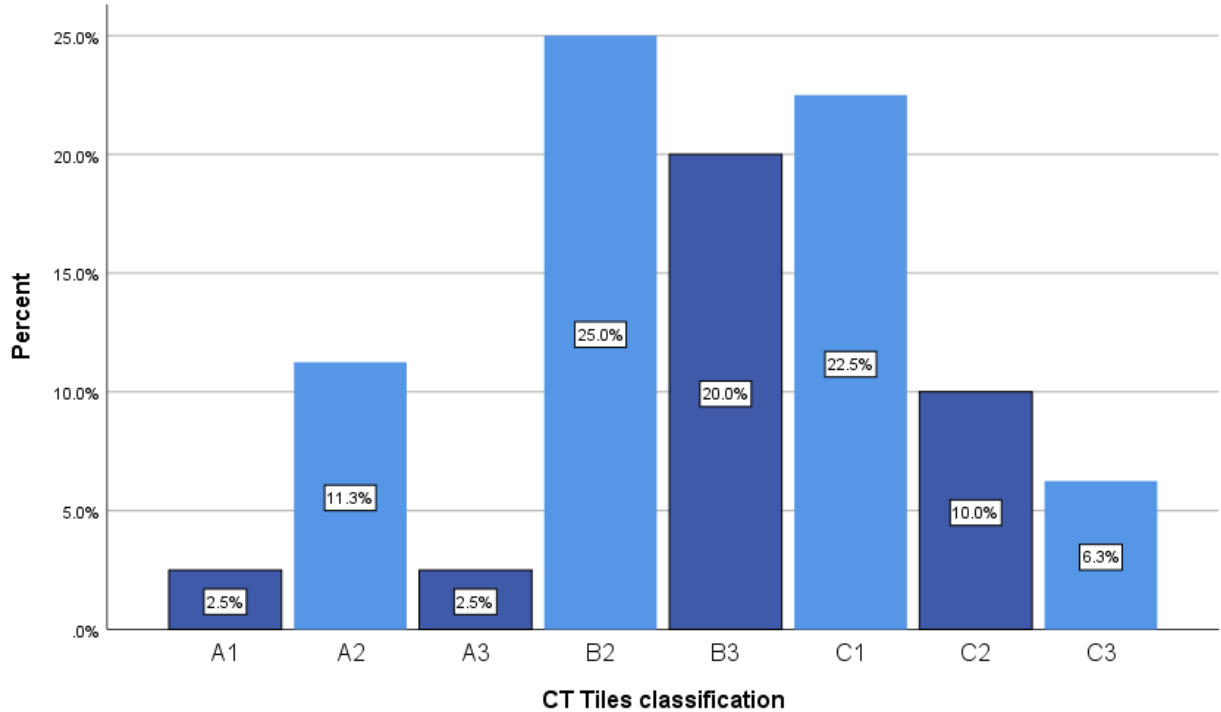


Figure 6.3: CT pattern of pelvic ring fracture (Tiles classification) in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019.

6.4. X-ray pattern of pelvic ring fracture(Tiles classification pattern)

Out of the 80 cases evaluated only 68 cases were found to have pelvic X-rays in radiology department. Out of this B2 Tiles pattern accounts for 29.4% followed by B3 26.5%. Tiles A2 accounts for 14.7% and 10.3 cases were found to have normal X-ray findings. 8.8% were Tiles C1 and A1,A3 and C3 accounts for 2.9% equally. The least X-ray Tiles pattern of pelvic ring fracture was found to be C2 accounting to only 1.5%. In this study no B1 Tiles pattern was found.

Table 6.4: Percent of X-ray patterns of pelvic ring injury in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--------|-----------|---------|---------------|--------------------|
| Valid | NORMAL | 7 | 8.8 | 10.3 | 10.3 |
| | A1 | 2 | 2.5 | 2.9 | 13.2 |
| | A2 | 10 | 12.5 | 14.7 | 27.9 |
| | A3 | 2 | 2.5 | 2.9 | 30.9 |
| | B2 | 20 | 25.0 | 29.4 | 60.3 |
| | B3 | 18 | 22.5 | 26.5 | 86.8 |
| | C1 | 6 | 7.5 | 8.8 | 95.6 |
| | C2 | 1 | 1.3 | 1.5 | 97.1 |
| | C3 | 2 | 2.5 | 2.9 | 100.0 |
| | Total | 68 | 85.0 | 100.0 | |
| Missing | System | 12 | 15.0 | | |
| Total | | 80 | 100.0 | | |

6.5. Mechanism of injury and pattern of pelvic fracture

There was no significant relationship between mechanism of injury and pattern of pelvic ring fracture (likelihood p value =0.325) . see table 4.6 for cross tabulation

| | | MECHANISM OF INJURY | | | | | Total |
|-------------------------|----|---------------------|--------|-----------|--------------------|--------|-------|
| | | PEDESTRIAN | DRIVER | PASSENGER | FALL DOWN ACCIDENT | OTHERS | |
| CT Tiles classification | A1 | 1 | 0 | 0 | 1 | 0 | 2 |
| | A2 | 1 | 1 | 3 | 1 | 3 | 9 |
| | A3 | 1 | 1 | 0 | 0 | 0 | 2 |
| | B2 | 6 | 3 | 5 | 6 | 0 | 20 |
| | B3 | 6 | 2 | 7 | 0 | 1 | 16 |
| | C1 | 6 | 3 | 5 | 3 | 1 | 18 |
| | C2 | 2 | 1 | 3 | 1 | 1 | 8 |
| | C3 | 1 | 2 | 1 | 0 | 1 | 5 |
| Total | | 24 | 13 | 24 | 12 | 7 | 80 |

Table 6.5: Mechanism of injury vs CT Tiles classification in TASH, Addis Ababa, Ethiopia, April 2018 to June 2019.

6.6. Agreement of CT and X-ray in Tiles classification of pelvic ring fracture.

In this study comparing 68 cases who had both Pelvic X-ray and Pelvic CT ,independent classification with Tiles classification was done and there was agreement in 50% and no agreement in the rest 50%of cases was seen. Out of this 34 cases (50%), the X-ray being normal in 7 cases(20.6%) and there was under classification in 27 cases (79.4%) with X-ray. On statistical analysis the kappa value was 0.329 which showed poor agreement.

6.7. Correlation of the variables

There is no significant correlation seen with in the variables in 95% confidence interval and significance level of 0.05.

7. Discussion

There have been several fracture classification systems that have been studied in the past with somewhat disappointing results. If agreement among radiologists and surgeons is poor, then it is difficult to determine the best treatment and prognosis for patients with any certainty [33]. In addition, the credibility of various clinical studies that use these classification systems becomes suspect [33]. There have been no clinical studies determining the pattern of pelvic ring fracture and measuring the interobserver reliability of the Tile classification system for fracture of the pelvic ring in Ethiopia. The purpose of this study was to determine the pattern of pelvic ring fracture and to measure the intraobserver reliability of this commonly used classification system from pelvic CT and plain radiograph.

The three views of the pelvis namely anteroposterior, inlet view and outlet view have been validated to accurately pick up pelvic fracture [29]. The CT scan was shown to be superior to the plain radiography in detecting pelvic fractures [30,31]. The role of CT scan is affirmed as an effective tool for evaluating the pelvis. Its limitation is arising from time consumption and difficulty in certain selected patients with severe injuries. It is also not available in certain setups.

This study reviewed eighty cases with pelvic ring fracture. Out of those who had pelvic ring fracture, pelvic ring fracture were more occurred in males (72.5% and 27.5% in females). This result is relatively comparable with similar study in Kenya (occurring 86.2% in males and 13.8% in females and 71.3% in males and 28.3% in females), Wollaita (77.6% in males and 22.8% in females) and TASH (74.8% in males and 25.2% in females). In addition, other study done in Oman showed 88% were males and 12% were females. This could be due to working habit, as male more works in the field and are more mobile than females [20,31,32]. The study also showed the commonest age range involved was between 15-25 years 43.8% of the cases. Most of the accidents occur in the productive age groups (15-35 years) accounting 78.8% of the total pelvic ring fracture. This result is relatively similar with similar study done in Kenya (75%), India (73%) and TASH (69.7%).

This result shows most of the affected patients are in the productive age groups which is a burden for the family and the country. The study also compares with other study done on Wollaita which shows (65%).

The commonest mechanism of injury for pelvic ring fracture was RTA where both pedestrians and passengers each accounted for 30% followed by driver's (16.3%). This result is relatively similar with study done in Wollaita which showed passengers (45.8%), pedestrians (33.8%), and driver's (18.8%). Similar study in Kenya showed pedestrians account for (46.5%), passengers and drivers account for 37.5%. In this study fall down accident accounts for 8.8% of causes of pelvic ring fracture with similar study in Kenya showed 10% and 10.8%. One unusual case of assault is recorded in this study. There are three cases of patients who had pelvic ring fracture after a house fell on them and another two patients who sustained trauma while cutting a tree and the tree fell on them. There was also another old age patient who had osteoporotic pelvic ring fracture after fall down accident from standing height.

The commonest type of pelvic ring fracture pattern in this study was the Tiles B2. This is a rotationally unstable but vertically stable injury. In this study B2 represents 25%. Similar study in Kenya showed B2 accounting for 34.7%. This is relatively similar to Tiles et al and young and Burgess of result of earlier time [21, 27]. In this study Tiles type C1 pattern accounts for 22.5% and B3 accounts 20% and A2 accounts 11.3%. Over all categories Tiles type B pattern is the most common type accounting for 45% and type C accounts for 38.8%. There was no type B1 pattern showed in this study. Similar study in Kenya showed Tiles B accounting for 67% and C1 19.5%. Other study by Furey et al showed Tiles B accounting for 54%, Tiles A 28% and Tiles C 18% (28). Other study by Gabbe et al and Koo et al showed variable results [33, 34].

In this study, the Tiles classification was made by X-ray alone and CT alone independently, there was under classification by the X-ray and the agreement was assessed and showed poor agreement with kappa value of 0.329. No similar study found which compares the agreement between X-ray and CT scan for the Tile's classification of pelvic ring fracture.

8. Conclusion

According to this study the most commonly affected with pelvic ring fracture was male with M:F ratio of 2.6:1. In addition to this the commonly affected population seen was in their productive age groups (15-35 years) and most of the Victims were due to road traffic accidents and more so pedestrians and passengers. Fall down from a height accounts also significant number.

This study also shows that there was under classification of pelvic ring fracture based on Tiles classification by X-ray.

The CT scan may be valuable in improving the reliability of assessment of pelvic stability because of its potential ability to more clearly identify anatomical features of injury. More extensive work would be required in the future to determine how and whether these observations should be implemented clinically.

9: Recommendation

1. Have consensus to use Single classification system of pelvic ring fracture consistently.
2. Relevant authority should institute robust road safety campaign especially for pedestrians and drivers.
3. Preventive policy formulation and enforcement in road safety.
4. Further study is recommended in the clinical relevance and value of X-ray in classifying pelvic ring fractures.
5. Further study in the agreement of classifying pelvic ring fracture with the participation of senior radiologists.

10. Limitation of the study.

1. Difficulty of getting patient card in the card room.
2. Difficulty of getting X-ray in some of the patients.
3. Poor recording system of the patient chart that makes difficulty of getting relevant information
4. Relatively small number of the study sample size.
5. Absence of using consistent single classification system in the radiology department.
6. Using the principal investigator himself for classifying the Tiles CT and X-ray patterns of pelvic ring fracture.

References

1. Schmal H, Markmiller M, Mehlhorn AT, Sudkamp NP. Epidemiology and outcome of complex pelvic injury. *Acta Orthop Belg* 2005;71(1):41–47.
2. McCormack R, Strauss EJ, Alwattar BJ, Tejwani NC. Diagnosis and management of pelvic fractures. *Bull NYU Hosp Jt Dis* 2010;68(4):281–291.
3. Ben-Menachem Y, Coldwell DM, Young JW, Burgess AR. Hemorrhage associated with pelvic fractures: causes, diagnosis, and emergent management. *AJR Am J Roentgenol* 1991;157(5):1005–1014.
4. Murray CJ, Lopez AD. Mortality by cause in eight regions of the world: Global Burden of Disease Study. *Lancet* May 1997;349(9061):1269-76.
5. Peden M, Scurfield R, Sleet D, et al. World report on road traffic injury prevention. Geneva: World Health Organization; 2004.
6. Aruna C, Hyder AA, Corinne P.A. The global burden of unintentional injuries and an agenda for progress. *Epidemiologic Reviews* 2010 April 22;32(1):110-20.
7. World Health Organization. Preventing death and disability due to injuries is both an economic imperative and a health priority. In. Montreal, Canada: World health Organization; 2002 May Press release.
8. World Health Organization. A 5 -year WHO strategy for road traffic injury prevention. Geneva, Switzerland; 2001.
9. World Health Organization. Violence, injuries and disability: biennial report 2006-2007. Geneva, Switzerland: World Health Organization; 2008.
10. Peden M, Oyegbite K, Ozanne-Smith J, et al. World report on child injury prevention. Geneva, Switzerland: World Health Organization unicef; 2008.
11. Krug E.G, Sharma G.K, Lozanor. The Global Burden of Injuries. *American Journal of Public Health* 2000;90(4):523-526.
12. Wilson LJ, Segal AB, Carvalho DEd, et al. Statistical analysis of infantile-juvenile orthopaedic

trauma in a tropical metropolis' orthopaedic emergency room. *Acta Orthopeda brasileira* 2005;13(4):179-82.

13. Back O, Klinik F. Musculoskeletal trauma in East africa public hospital. *Injury* 2004;35(4):401-6.

14. Court-Brown CM, Koral KJ. *The epidemiology of fractures*. 6th ed. Philadelphia: Lippincott; 2006.

15. Bergen G CL, Warner M, Fingerhut LA. *Injury in the United States 2007 Chartbook*. In. Hyattsville, MD: National Center for Health Statistics; 2008.

16. Bucholz RW, James D et al. *Rockwood & Green's fractures in Adults*. 6 ed; 2009.

17. Jones G NT, Sambrook PN, Kelly PJ, et al. Symtomatic fracture incidence in elderly men and women: the Dubbo Osteoporosis Epidemiology Study (DOES). *Osteoporosis int* 1994 sept;4(5):277-82.

18. O'Neill TW, Cooper C, Finn JD, et al. Incidence of distal forearm fracture in British men and women. *Osteoporosis international* 2001 February;12(7):555-8.

19. Charles M C-B, Ben Caesar. Epidemiology of adult fractures: a review. *Injury international Journal of Care injured* 2006 April;37:691-697.

20. Mutiso.V.M.Patterns Of Pelvic Fracture As Seen In Kenyata National Hospital. *East A frican J.S.*2008:1(1)

21. Tile M. Acute Pelvic Fractures :Causation And Classification.*J.Am Acad Orthop Surg*. 1996;4(3):143-51.

22. Thomas P.Outcome After Pelvic Ring Injuries. *Inj J.*1996;27(3):31-8.

23. Samir D. Pelvic Fracture in Multiple Trauma :Classification by Mechanism is Kye to Pattern of Organ Injury, Resuscitative Requirements, and Outcome.*J Trauma*. 1989;29(7).

24. Peltier L.Complications Associated with Fractures of the Pelvis.*J Bone Jt Surg Am.*1965:dx.doi.org (47(5)):1060-9.

25. Jacobson B. Epediomology of Pelvic Fractures. *Acta Orthopeda Scandinivica.*1991:63(3).

26. Holdsworth FW.Dislocations and Fracture Dislocations of the Pelvis .*Bone Jt J.*1948:45(4).

27. Young J. Pelvic Fractures : value of plain radiography in early assesment and management. *Radiology*.1986;160(2).
28. Furey AJ. Classification of Pelvic Fractures. Anaysis of Inter-and Intra-obserevr Variability Using the Young-Burgess and Tile Classification Systems. *Orthopedics*.2009;32(6).
29. Pennal G. Pelvic Disruption. Assessment and Classification. *Curr Orthop Pract*. 1980;151:12-21.
30. Falchi M. CT of Pelvic Fracture. *Eur J Radiol*.2004;50(1):96-105.
31. Wachira V. Patterns of pelvic fractures, associated injuris and early complications as seen in adults at kenyata national hospital, Kenya.2017, Unpublished study.
32. Mohammed S, Aklilu A, Fikre E, Etal. Injury Charecterstics and Outcome of Road Traffic Accidents. *BMC Emergency Medicine*:2015;15(10):3-9.
33. Koo H, Leveridge M, Thopson C, et al. interobserver reliability of the Young-Burgess and Tile classification systems for fractures of the pelvic ring. *J. Orthop Trauma* 2008;22:379-384.
34. Gabbe BJ, Esser M, Bukhnil A, et al. The imaging and classification of severe pelvic ring fractures, experience from two level I trauma centers. *Bone Joint J* 2013;95-B:1396-1401.
34. Weitru PN. Pattern of adult appendicular skeletal fractures at teaching and refferal hospital, KNH, Keya.2015. Unpublished study.
35. Woldemichael, Kifle, Negalign Berhanu, "Magnitude and pattern of injury in Jimma university specialized hospital, South West thipia. " *Ethiopian journal of health sciences* 21.3 (2011).
36. Asefa. Fekede. Demeke Assefa. and Gezahegn Tesfaye. " Magnitude of, trends in, and associated factors of road traffic collision in central Ethiopia. " *BMC public health* 14.1 (2014):1072.
37. Hailemichael, Feleke, Mohammed suleiman, and Wondimagegn Pauolos. "Magnitude and outcomes of road traffic accidents at Hospitals in Wolaita Zone, SNNPR, Ethiopia. " *BMC research notes* 8.1 (2015): 135.
37. Admassie, Daniel, Tekle Yirga, and Biruk L. Wamisho. "Brief communication: Adult limb fractures in Tikur Anbessa Hospital caused by road traffic injuries : Half year plain radiographic pattern. " *Ethiopian Journal of Health Development* 24.1 (2010).
38. Tiruneh, Bewket Tadesse, Berihun Assefa Dachew, and Berhanu Boru Bifftu. " incidence of road traffic injury and associated factors among patients visiting the emergency department of Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia. " *Emergecy medicine international* 2014 (2014).

39. Seid et al. Injury characteristics and outcome of road traffic accidents among victims at Adult Emergency Department of Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia: a prospective hospital based study. *BMC Emergency Medicine* (2015) 15:10.
40. American College of Surgeons. *Advanced trauma life support, ATLS, 9th edn*, Chicago, IL; American College of Surgeons, 2012.
41. Cooper J. Pelvic ring injuries. *Trauma* 2006;8(2):95-110.
42. Guillaumondegui OD, Pryor JP, Gracias VH, et al. Pelvic radiography in blunt trauma resuscitation: A diminishing role. *J Trauma* 2002;53(6):1043-1047.
43. Obaid AK, Barleben A, Porral D, et al. Utility of plain radiographs in blunt trauma patients in the emergency department. *Am Surg* 2006;72(10): 951-954.
44. Shenton A, Choudhary S et al. The emergency radiology of pelvic trauma. *Trauma* 2014;16(4):279-291.
45. Cabarrus MC, Ambekar A, Lu Y, Link TM. MRI and CT of insufficiency fractures of the pelvis and the proximal femur. *AM J Roentgenol* 2008;191:995e1001.
46. Garala K, Patil S. Radiography anatomy and imaging in pelvic fractures. *Orthopaedics and Trauma* 2018;01:004.
46. Dalal SA, Burgess AR, Siegel JH, Young JW, Brumback RJ, Poka A, Dunham CM, Gens D, Bthon H. pelvic fracture in multiple trauma: classification by mechanism is key to pattern of organ injury,, resuscitative requirements, and outcome. *J Trauma* 1989;29:981-1000; discussion 1000-1002.
47. Huittinen VM, Slati P. Fractures of the pelvis: trauma mechanism, types of injury and principles of treatment. *Aceta Chir scand.* 1972;138:563-569.
48. Huittinen VM, Slati P. Nerve injury in double vertical pelvic fractures. *Aceta Chir scand.* 1972;138:571-575.
49. Looser KG, Crombie HD jr. Pelvic fractures: an anatomic guide to severity of injury. Review of 100 cases. *Am J Surge*, 1976;132:638-642.
50. Trunkey DD, Chapman MW, Lim RC jr, Dunphy JE. Management of pelvic fractures in blunt trauma injury. *J Trauma.* 1974;14:912-923.
51. Watson-Jones R. Dislocations and fracture-dislocations of the pelvis. *Br J Surg.* 1938;25:773-781.
52. Patterson FP, Morton KS. The causes of death in fracture of pelvis: with a note on treatment by ligation of the hypogastric (internal iliac) artery. *J Trauma* 1973;13:849-856.

Annex

Data collection sheet

1. Participants assigned code

a. MRN

X-ray/CT Scan no

2. Age in year's _____

3. Sex. a. Male b. Female

4. Mechanism of injury

a. RTA: 1. pedestrian 2. Driver 3. passenger

b. Fall down accident

c. others, specify-----

6. CT Patterns of pelvic fracture (Tiles Classification)

Type's subtypes

| | | | |
|---|---|---|---|
| A | 1 | 2 | 3 |
| B | 1 | 2 | 3 |
| C | 1 | 2 | 3 |

6. X-ray patterns of pelvic fracture (Tiles classification).....

- **Tile classification** 📷

- **A: stable**

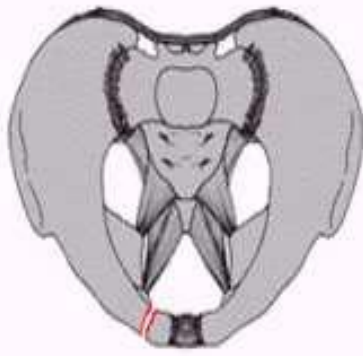
- A1: fracture not involving the ring (avulsion or iliac wing fracture)
- A2: stable or minimally displaced fracture of the ring
- A3: transverse sacral fracture (Denis zone III sacral fracture)

- **B - rotationally unstable, vertically stable**

- B1: open book injury (external rotation)
- B2: lateral compression injury (internal rotation)
 - B2-1: with anterior ring rotation/displacement through ipsilateral rami
 - B2-2: with anterior ring rotation/displacement through contralateral rami (bucket-handle injury)
- B3: bilateral

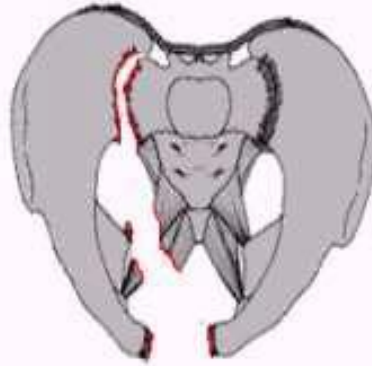
- **C - rotationally and vertically unstable**

- C1: unilateral
 - C1-1: iliac fracture
 - C1-2: sacroiliac fracture-dislocation
 - C1-3: sacral fracture
- C2: bilateral with one side type B and one side type C
- C3: bilateral with both sides type C



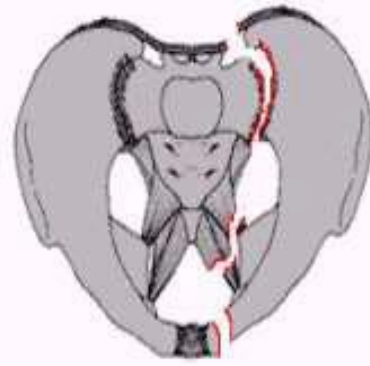
A

Stable



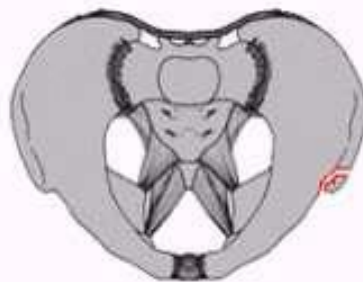
B

Rotational Instability
Vertically and Posteriorly Stable



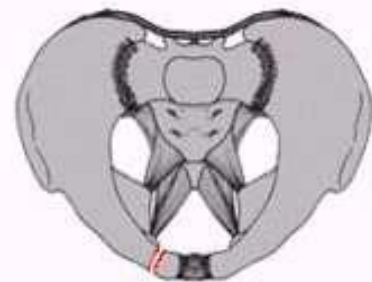
C

Rotational, Vertical & Posterior
Instability



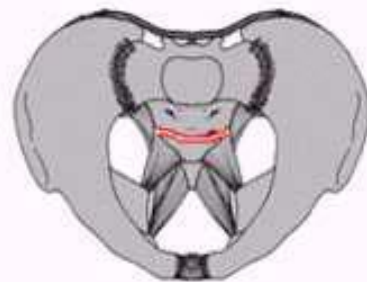
A1

Avulsion Injuries
Not involving the ring



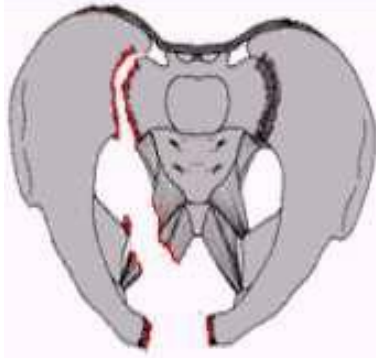
A2

Stable, minimal displacement



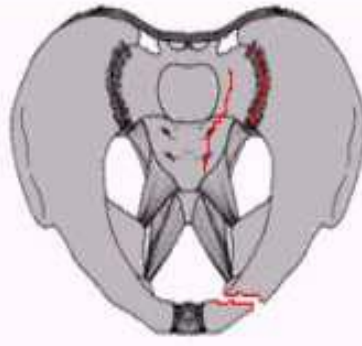
A3

Transverse fractures of
Sacrum or Coccyx



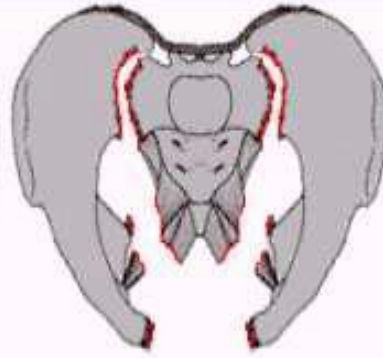
B1

Unilateral



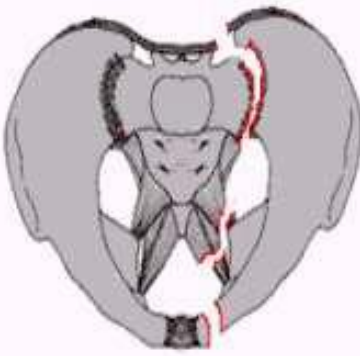
B2

Lateral Compression Injury
Internal Rotation Instability



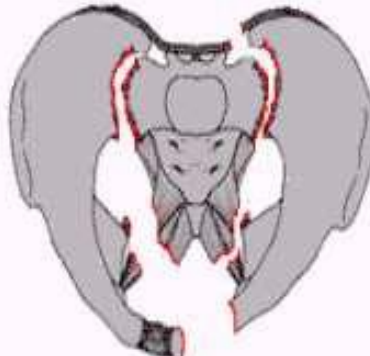
B3

Bilateral Rotational Instability



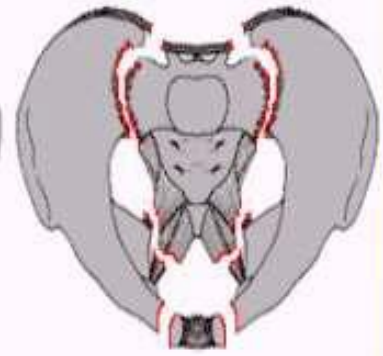
C1

Unilateral



C2

Bilateral
One side rotationally unstable
One side vertically unstable



C3

Bilateral
Both sides completely unstable