RESIDENT UNDERSTANDING OF COMMON ACETABULAR FRACTURES USING 3D PRINTED MODELS

DR. AMARDEEP SINGH A/L PRITAM SINGH

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THEDEGREE OF MASTER OF MEDICINE (ORTHOPAEDICS)

UNIVERSITI SAINS MALAYSIA 2022

RESIDENT UNDERSTANDING OF COMMON ACETABULAR FRACTURES USING 3D PRINTED MODELS

ACKNOWLEDGEMENTS

The author would like to express thanks and gratitude to the following individuals for their guidance and support, as well as advice throughout the preparation of this dissertation.

- Dr. Nor Azman Mat Zin, supervisor of this study and lecturer at the Orthopaedics Department, HUSM for his guidance, support and encouragement in enabling the completion of this study.
- Dr. Mohd Hadizie Din, co-supervisor in this study at the Orthopaedics Department, HUSM for all his help in providing the necessary cases of acetabular fracture and lecture during the conduct of this study.
- Dr. Nik Mohd Rizal Bin Mohd Fakri, lecturer at the Medical Education Department for his guidance in vetting Single Answer Questions for the assessment of the participants of this study.
- Associate Professor Dr. Wan Mohd Zahiruddin, lecturer at the Department of Community Medicine for his guidance in data analysis and interpretation.
- All colleagues and staff at the Department of Orthopaedic, Radiology and Medical Education, HUSM

TABLE OF CONTENTS

ACKNOWLEDGEMENTS III

TABLE OF CONTENTS IV

LIST OF ABBREVIATIONS AND DEFINITIONS VIII

ABSTRAK 1

ABSTRACT 3

CHAPTER 1: INTRODUCTION 5

1.1 INTRODUCTION 6

1.2 RESEARCH QUESTION 7

1.3 OBJECTIVE 7

CHAPTER 2: STUDY PROTOCOL 8

2.1 INTRODUCTION 10

2.2 PROBLEM STATEMENT AND STUDY RATIONALE 11

2.3 LITERATURE REVIEW 11

2.4 OBJECTIVES 15

2.5 CONCEPTUAL FRAMEWORK 16

2.6 METHODOLOGY 16

2.6.1 Study Design 16

2.6.2 Study Area.. 16

2.6.2 Study Population 17

2.6.3 Selection Criteria.. 17

2.6.4 Sample Size Estimation... 18

2.6.5 Sampling Method And Subject Recruitment.. 18

2.6.6 Research tool and Methods of Intervention... 20

2.6.7 Data Collection Method 24

2.6.8 Data Analysis 26

2.6.9 Expected Results 26

2.6.10 Benefit of study 27

2.6.11 Ethical Consideration 28

2.6.12 Budget Proposal 29

2.7 Flow Chart of Study.. 30

2.8 Gantt Chart & Milestone 31

2.9 References.. 33

2.10 Ethical Approval Letters **37**

CHAPTER 3: MANUSCRIPT **39**

3.1 ABSTRACT **40**

3.2 INTRODUCTION **42**

3.3 METHODOLOGY **44**

3.4 RESULTS **48**

3.6 CONCLUSION **53**

3.7 REFERENCES **57**

3.8 TABLES **61**

3.9 ILLUSTRATIONS **64**

CHAPTER 4: APPENDICES **65**

4.1 DATA COLLECTION SHEET **66**

4.2 ADDITIONAL TABLES **67**

4.3 LECTURE AND CERTIFICATE OF PARTICIPATION **72**

4.4 3D SOFTWARE EDITING **75**

4.5 SINGLE ANSWER QUESTIONS (SAQs) **77**

4.6 RAW DATA 102

4.7 GUIDELINES/INSTRUCTION TO AUTHORS OF SELECTED JOURNAL ..103

LIST OF ABBREVIATIONS AND DEFINITIONS

List of abbreviations:

i. CT scan refers to Computerized Tomography

ii. HUSM refers to Hospital Universiti Sains Malaysia

iii. SAQs refers to Single Answer Questions

iv. STL refers to Standard Triangle Language or Standard Tessellation Language file format of stereolithography used for 3D printing and computer aided design.

v. DICOM refers to Digital Imaging and Communications in Medicine (DICOM)

vi. PACS refers to Picture Archiving and Communication System

vii. FDM refers to Fused Deposition Modelling

viii. CME refers to Continuing Medical Education

ABSTRAK

Pengenalan

Patah tulang acetabular kebanyakkan berlaku adalah kompleks. Ia memerlukan kefahaman yang dalam untuk merawat. X-ray dan imbasan CT biasa digunakan untuk memahami patah tulang tersebut. Terdapat beberapa klasifikasi yang sedia ada untuk mengelaskan, terutamanya Judet dan Letournel klasifikasi. Namun doktor-doktor Ortopedik masih dapat kesukaran dalam pemahaman patah tulang tersebut. Percetakkan 3D kini semakin popular dan komersial dalam bidang perubatan untuk pembelajaran dan pengurusan rawatan. Tujuan kajian ini dijalankan adalah untuk menilai hasil keputusan dari pemahaman patah tulang acetabular oleh doktor-doktor (pegawai perubatan) mengunakan cetak model 3D dengan mengunakan soalan jawapan tunggal.

Kaedah Kajian

Kajian ini ialah kajian RCT yang dijalankan untuk mengkaji kesan-kesan cetakkan 3D model pelvis dalam pemahaman patah tulang acetabular oleh pegawai perubatan ortopedik dari Jabatan Ortopedik, Hospital Universiti Sains Malaysia daripada tahun pertama hingga tahun keempat dalam program sarjana ortopedik tahun 2022. Semua pegawai disaringkan sebelum menghadiri ceramah patah tulang acetabular. Selepas itu pegawai perubatan dibahagikan kepada dua kumpulan secara persampelan rawak iaitu kumpulan eksperimen dan kumpulan kawalan. Kumpulan kawalan diberikan X-ray dan imbasan CT manakala kumpulan eksperimen diberikan X-ray, imbasan CT dan cetakkan 3D model pelvic bekenaan patah tulang acetabular tersebut. Setiap kumpulan melalu lima stesen dengan corak patah tulang yang berbeza dan menjawab 25 soalan jawapan tunggal sebagai penilaian. Markah soalan dikumpulkan dan peratusan diberikan untuk tentukan hasil. Dalam analisis, semua data

kategori dipersembahkan dalam kekerapan peratusan, manakala data berangka di persembahkan dalam median dan julat antara kuartil disebabkan taburan bukan normal. Kita mengunakan Ujian Mann Whitney U dalam analisis. Nilai-P < 0.05 dianggap statistik yang ketara. Analisis dilaksanakan mengunakkan versi 26, SPSS software (SPSS Inc, Chicago, IL).

Keputusan

Jumlah perserta dalam kajian ini adalah 32. 16 perserta dalam satu kumpulan. Keputusan yang didapatkan ialah median peratus untuk pemahaman dalam kumpulan eksperimen adalah lebih ketara dari kumpalan kawalan, (p= 0.021). Walau bagaimanapun didapatkan median peratusan untuk pengelasan (klasifikasi) antara kumpulan eksperimen dan kawal adalah tidak ketara dengan pembezaan (p = 0.0127).

Kesimpulan

Secara keseluruhannya, jumlah markah yang diperolehkan dari soalan jawapan tunggal oleh kumpulan eksperimen menunjukkan keputusan yang mengutungkan dalam pemahaman patah tulang acetabular mengunakan cetakkan 3D model pelvis antara doktor-doktor ortopedik. Demikian kami mengesyorkan pengunaan cetak 3D model pelvis dalam pembelajaran dikalangan doktor-doktor ortopedik untuk latihan.

Kata Kunci:

Pemahaman Patah Tulang Acetabular , Klasifikasi Patah Tulang Acetabular

ABSTRACT

Introduction

Fracture of the acetabulum is usually present as complicated fracture. It requires good understanding of the fracture pattern in order to manage it. Understanding of the fracture morphology involves Radiographs and CT scans. Numerous of classifications are available to classify the fracture such as Judet and Letournel classification, yet residents and orthopaedic surgeons find it challenging. 3D printing has becoming more popular in the medical field to aid in education and management. This study was conducted to study the effect of 3D printed model in understanding acetabular fracture among orthopaedic residents with the use of Single Answer Questions (SAQs).

Methodology

This is an educational interventional study to evaluate the effect of the 3D printed model in the understanding of acetabular fractures among Orthopaedic residents from the Orthopaedic Department of Hospital Universiti Sains Malaysia in the year 2022 involving first to fourth year residents. All residents were screened prior attending a lecture on Acetabular Fracture. The residents then by simple randomization were divided into experimental group and control group. Control group had radiographs and CT scan while the Experimental group had radiographs, CT scan and 3D pelvic model of the associated fracture. Each group went through 5 station of cases with different acetabular fracture pattern with total of 25 single answer questions (SAQ) for assessment. The points for each SAQs were accumulated in percentage to determine the outcome. In this analysis, all categorical data were presented in frequency and percentage, while the numerical data were presented in median and interquartile range due to

non-normal distribution. We applied Mann-Whitney U Test in this analysis. The p-level of less than 0.05 was considered statistically significant. Statistical analysis was performed using version 26 of the SPSS software (SPSS Inc, Chicago, IL).

Results

There were total of 32 participants in this study. 16 in each group. It was found that median percentage of understanding in experimental group was statistically significantly higher than the control group ($p = 0.021$). However, it was found that median percentage of classification between experimental and control group was not significant ($p = 0.127$).

Conclusion

The overall scores from SAQs from experimental group indicates a favourable outcome among orthopaedic resident in understanding of acetabular fracture using 3D pelvic model. Hence we recommend the application of 3D pelvic model in learning and understanding among orthopaedic residents training.

Key Words:

Acetabular Fracture Understanding, Acetabular Fracture Classification

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The complexity of pelvic osteology requires a three-dimensional understanding of its fracture morphology. Orthopaedic surgeons are required to accurately identify and classify for decision making and preoperative planning for optimal treatment. It is commonly classified using the Judet and Letournel classification system which will indicate the likely required surgical approaches and fixation based on the fracture pattern.

At present, radiographs, and Computed Tomography (CT) scan are used in assessing acetabular fractures. Subsequently 3D Reconstruction of CT has been developed and came into practice. From studies it has been found that residents and orthopedic surgeons' struggle with the apprehension in dealing with acetabular fractures. Problems identified were during the initial training days of residency which are inadequate understanding of the pelvic osteology, difficulty in identification of fracture in relation to the complex nature and inaccuracy in describing the acetabular fractures.

Studies suggests that 3D printing of pelvic models with acetabular fracture helps in pre-operative planning, choice of approach and fixation. The understanding by residents for their postgraduate training is required to classify the fractures appropriately. Therefore, 3D printed model as an adjunct learning modality could build better understanding and classifying the fractures. This study was performed to study the effect of 3D printed Model in understanding acetabular fracture among orthopedic residents in our University Hospital setting.

1.2 RESEARCH QUESTION

Does a 3D-printed model aid in improving understanding and classifying of acetabular fractures?

1.3 OBJECTIVE

General objective:

To study the effect of 3D printed model in understanding acetabular fracture among orthopaedic residents.

Specific objectives:

1. To compare outcome in classifying of acetabular fractures among Residents with the use of 3D printed model

2. To compare outcome in understanding of acetabular fractures among residents with use of 3D printed model

CHAPTER 2: STUDY PROTOCOL

DISSERTATION PROPOSAL TITLE:

RESIDENT UNDERSTANDING OF COMMON ACETABULAR FRACTURES USING 3D PRINTED MODELS

NAME: DR. AMARDEEP SINGH A/L PRITAM SINGH

MATRIKS NO.: P-UM0340/19

MMC NO.: 67087

SUPERVISOR:

DR. NOR AZMAN MAT ZIN

CO-SUPERVISOR:

DR. MOHD HADIZIE DIN

DR. NIK MOHD RIZAL BIN MOHD FAKRI

2.1 INTRODUCTION

Pelvic osteology is complex and requires 3-Dimensional understanding of its fracture morphology. Orthopaedic surgeons are required to accurately identify for understanding and preoperative planning for optimal treatment outcome [1,2]. It is commonly classified using Judet and Letournel classification system which indicates the likely required surgical approaches and fixation based on fracture pattern [3,4].

At present, radiographs, and Computed Tomography (CT) scan are used in assessing acetabular fractures. Subsequently 3D Reconstruction of CT has been developed and came into practice. Studies have identified that residents and orthopedic surgeons' struggle with the apprehension in dealing with acetabular fractures. Problems identified were during the initial training days of residency: Lack of understanding of the pelvic osteology, difficulty in identification of fracture in relation to the complex nature and inaccuracy in describing the acetabular fractures [5,6].

There are studies suggesting that 3D printing of Pelvic models with acetabular fracture helps in pre-operative planning, choice of approach and fixation [3]. The existing knowledge and visual understanding by residents for their postgraduate training is required in order to classify the fractures appropriately. Therefore 3D printed model as an adjunct learning modality could build better understanding and classifying complex fractures [7,8]. This study was performed to study the effect of 3D printed Model in understanding acetabular fracture among Orthopaedic residents in our University Hospital setting.

2.2 PROBLEM STATEMENT AND STUDY RATIONALE

1. Residents and junior orthopedic surgeons' struggle with the apprehension in dealing with acetabular fractures.
2. To explore the use of 3D printed Model as an adjunct imaging modality in dealing with acetabular fractures

2.3 LITERATURE REVIEW

3D printing is a rapidly developing technology with a bright future as an educational tool. Numerous medical professions use it for preoperative planning, intraoperative guidance, surgical stimulation navigation, endoscopic and endovascular navigation, custom-tailored implants, and prosthesis. Nonetheless, fewer studies have been undertaken on the use of 3D-printed models as educational tools. It has been suggested that 3D-printed models help surgical trainees learn more about anatomy and comprehend complex concepts, hence improving their performance on the job [8].

The acetabulum consists of the anterior and posterior bone columns. It is related to the axial skeleton by the sacrum, a strut bone. The anatomy is like the Greek letter lambda. The (π) or inverted Y form with a shorter portion resembles the posterior column while the longer portion resembles the anterior column when viewed from the lateral side (as shown in Figure 1). Approximately 80% of reported acetabular fractures are the result of high velocity trauma, whereas the other 20% are the result of low velocity trauma [8].

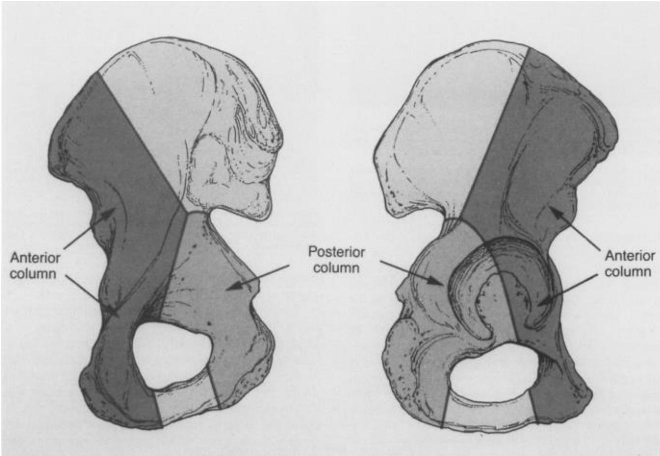


Figure 1: Division of column of acetabular

Acetabular fractures occur when an external force is applied to the greater trochanter or along the axis of the femoral shaft, causing the femoral head to strike the acetabular surface. The fracture pattern is dictated by the force direction and hip position at the time of impact. When the hip is in external rotation, a force applied along the long axis of the femoral neck causes an anterior fracture, whereas internal rotation causes a posterior fracture (as shown in Figure 2). When a force is applied along the axis of the femur during hip flexion, the femoral head impacts against the acetabular posterior articular surface [8]. This is the mechanism that has been documented most frequently. Rubert Judet and Emile Letournel, two orthopedic surgeons, created the acetabular fracture classification based on radiographic evidence, which is still in use today (as shown in Figure 3).

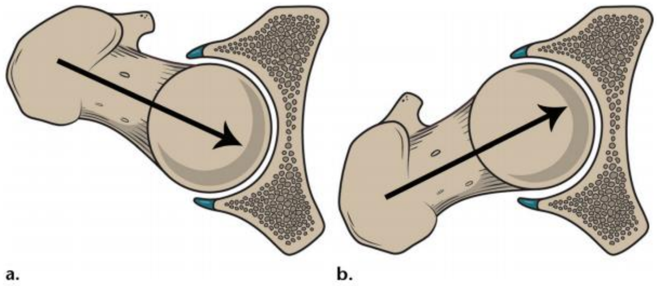


Figure 2: Mechanism of Injury of Acetabular fracture in relation to hip position

a) Hip in internal rotation b) Hip in external rotation

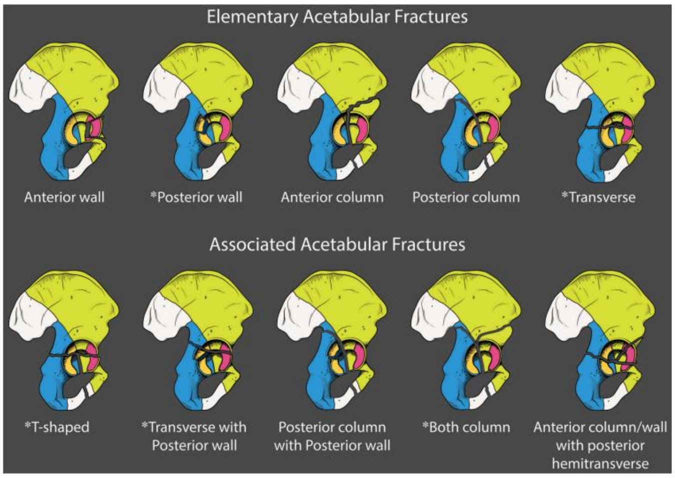


Figure 3: Judet and Letournel Classification of acetabular fracture

Classifying acetabular fractures has proven to be quite difficult. The reason for this is mostly due to the complicated anatomy of the pelvis, which necessitates a 3D spatial awareness for accurate classification and comprehension of acetabular fracture types. Despite the existing categorizations, inhabitants continue to find it extremely difficult to comprehend. For preoperative and operational planning, CT scans with 2D pictorial slices require residents and surgeons to analyze and map the fracture pattern. Acetabular fractures are difficult to comprehend, but 3D-printed models may be able to help overcome these difficulties [4,8,9].

Manganaro et al describes the guidelines required when selecting models to be printed: 1) case selection process, 2) software processing 3) printing of 3D models. It has been reported that CT scan with soft tissue algorithm were easier to segment due to lower image noise levels. CT scan created with bone algorithm had artifactual surface irregularities on 3D models. Cases with artifacts related to metallic hardware, motion related artifacts and osteopenia were recommended to be excluded. 3D Models shows promise as educational tools for teaching and improving learner confidence in using classification system. Thus, the need to consider technical and practical factors to create 3D printed models. Future of 3D printing in educational increasing as exposure to the technology increases and the cost of materials and printers decreases [8,10].

Hansen *et al.* conducted a prospective study with the participation of thirty-five orthopedic residents. Using radiographs and CT scan images, 20-question quizzes evaluate the ability to appropriately classify acetabular fractures. Before and after an intervention, a questionnaire was administered. The other half of the residents were provided with a 3D pelvic model in addition to educational instruction materials. In stratified sampling, the postgraduate year of the resident is considered. demonstrated a link between training years. The mean improvement on quizzes for the first and second years was 15%, however for the fourth and fifth years, it was 3%. After the intervention, those that utilized 3D models increased their results the most [11].

Lim *et al*. evaluated the acetabular fracture classification skills of forty-one orthopedic residents. Fifteen randomly selected testing stations including radiographs, CT scans, or 3D models. The stations were randomized, and residents filled out a response sheet. There were two resident groups: junior and senior. Seniors performed better than juniors in recognizing fracture patterns. Seniors scored higher on X-rays and 3D-printed models, but not CT scans [12].

Awan *et al*. conducted a randomized controlled trial to examine the influence of 3D-oriented models of acetabular fracture on the short-term learning results of radiology trainees. His size of the sample were twenty-two radiology residents. Musculoskeletal (MSK) lecture delivered to all participants. There were intervention (3-D models) and control groups (X-rays and CT scans). Test administered to both the control and intervention groups. Three weeks following the pretest, a posttest is administered to evaluate short-term retention. Their conclusion was the 3D printed models improve short-term memory [13].

2.4 OBJECTIVES

General objective:

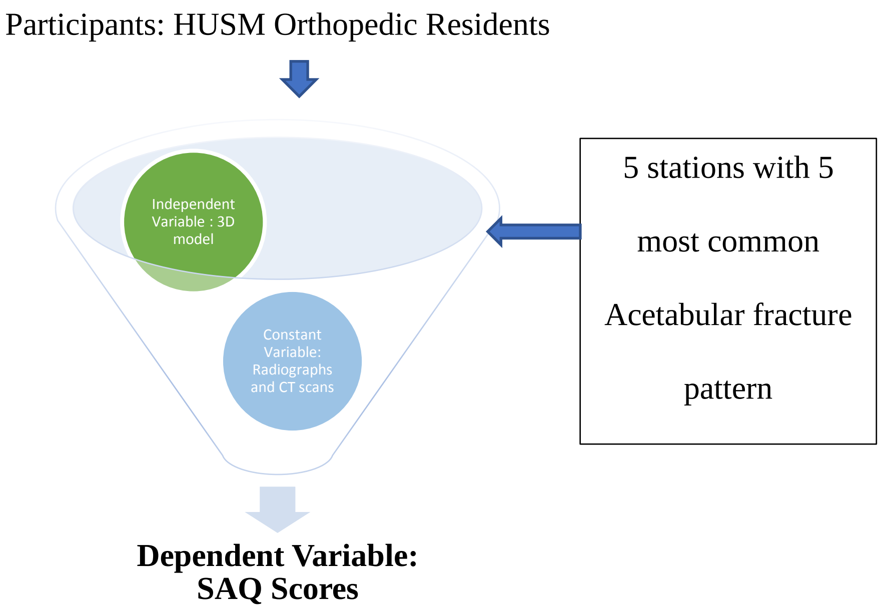
To study the effect of 3D printed Model in understanding Acetabular fracture among orthopedic residents

Specific objectives:

1. To compare outcome in classifying of acetabular fractures among Residents with the use of 3D printed model.

2. To compare outcome in understanding of acetabular fractures among residents with use of 3D printed model.

2.5 CONCEPTUAL FRAMEWORK



2.6 METHODOLOGY

2.6.1 Study Design

This is a parallel randomised interventional study using a 3D model to further enhance teaching and learning.

2.6.2 Study Area

This study will be conducted at the Health Campus, Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan, Malaysia.

2.6.2 Study Population

During the year 2022, the study population will be included orthopaedic residents from Hospital Universiti Sains Malaysia.

2.6.3 Selection Criteria

Inclusion Criteria:

1. Orthopedic residents from HUSM's first to fourth years participated in this study.
2. 1 year of minimum service MO in orthopaedics prior to master's selection
3. Experience of working with MOH (Ministry of Health) hospitals

Exclusion Criteria:

1. Non-Malaysian citizen
2. Less than 1 year in service as an MO orthopaedic
3. After attending the lecture, the subject refused to participate.

2.6.4 Sample Size Estimation

The sample size was calculated based on the specific objectives using a two-mean comparison (independent) hypothesis testing calculator by Arifin, W. N. (2020) with a sample size of 36 participants. Following was the parameters used to calculate the sample size:

- Standard deviation (σ): 15
- Expected differenced: 10
- Significance level (α): 0.05 two tailed
- Power (1- β) : 80 %
- Expected dropout rate 10 %
- Sample size, n= 36
- Sample size (with 10 % dropout), n drop = 4

2.6.5 Sampling Method and Subject Recruitment

Participants who fulfilled inclusion and exclusion criteria are included in the sampling frame. Randomization sequence created by means of a simple random sampling technique by using a random number table (as shown in Figure 4). First and second year residents will be labelled as juniors and third and fourth year residents will be labelled as senior. Sampling steps are as mentioned below:

- Each participant in the sampling frame is given an ID number.
- Randomly pick a starting point in the random number table.
- Determine the order of the numbers that will be chosen.
- Select the desired number of samples.

- A random number table is used to divide participants into experimental and control groups. Even numbers go into the experimental group, and odd numbers go into the control group.

Random Number Table

20	17	42	01	72	33	94	55	89	65	58	60
74	49	04	27	56	49	11	63	77	79	90	31
94	70	49	49	05	74	64	00	26	07	23	00
22	15	78	49	74	37	50	94	13	90	08	14
93	29	12	20	26	22	66	98	37	53	82	62
45	04	77	48	87	77	66	91	42	98	17	26
44	91	99	08	72	87	33	58	12	08	91	12
16	23	91	95	97	98	52	49	40	37	21	46
04	50	65	37	99	57	74	98	93	99	78	30
32	70	17	05	79	58	50	26	54	30	01	88
03	64	59	55	85	63	49	46	61	89	33	79
62	49	00	67	28	96	19	65	13	44	78	39
61	00	95	85	86	94	64	17	47	67	87	59
89	03	90	40	10	60	18	43	97	37	68	97

Figure 4.0

The intervention study is discussed with participants once their eligibility is confirmed. And informed consent is obtained. All participants will attend a 2-hour lecture on acetabular fracture. Subsequently, the participants in both the experimental and control groups are kept blind to the allocation of the intervention for 5 stations that will be assessed using the SAQ (Single Answer Question). Each participant will be given 25 minutes to undergo assessment on common acetabular fracture patterns through five stations. The experimental group will have pre-existing radiographs and CT scans with the intervention 3D model. The control group given radiographs and CT scans that are not accompanied by a 3D model as the intervention 3D model.

2.6.6 Research tool and Methods of Intervention

The research tools being used for this study in the following:

A. Lecture on Acetabular fracture

Prior to the study, a common acetabular fracture lecture is given, conducted by a non-principal investigator from the orthopedic faculty. The time duration was 1 hour, and the venue was an auditorium. The content of the lecture according to the given syllabus and checklist includes history, mechanism of injury, classification type of fracture, investigation, management, and complications pertaining to the injury and its management. A certificate and CME points are provided to all participants as an incentive to encourage participation.

B. Picture archiving and communication system (PACS)

PACS is a collection of technologies utilised for digital medical imaging. PACS is utilised to digitally gather medical pictures from a variety of modalities, including computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and digital projection radiography. The visual data and essential information are communicated through networks to other, perhaps distant places. In hospitals, the PACS database of Universiti Sains Malaysia is accessible through the Centricity Universal Viewer Zero Footprint client application (https://pacszfp.usm.my/zfp). PACS is used to get a variety of CT images and radiographs for acetabular fractures. Radiographs and CT scans are extracted for the stations. Using the five most prevalent acetabular fracture patterns, the selection was made. Cases with no or minimum pelvic artefacts and no hardware are culled and selected. To create 3D prints, the PACS files are also transformed to the DICOM (Digital Imaging and Communications in Medicine) standard.

C. <u>3D printed Models preparation</u>

The process of preparation is divided into 3 phases, as stated below:

1. Case selection: five most common acetabular fracture patterns from PACS obtained and converted to DICOM files, including radiographs and CT scans
2. CT scans were chosen and converted to a 3D volume rendered model using the threshold algorithm and the free 3D software programme Slic3r.
3. Printing: from available CT scans of the cases, with metallic hardware, undisplaced fracture, impacted fracture, and osteopenia excluded.

The printing scale ratio is 100% of the anatomic bone size. A cost-effective 3D printing material filament will be used via an FDM (Fused Deposition Modeling) 3D printer.

D. <u>Slic3r Software</u>

Slic3r is software (as shown in Figure 5) that is used to convert DICOM files to 3D volume rendered models and printing instructions for the 3D printer. It cuts the model into horizontal slices (layers), generates paths to fill them and calculates the amount of material to be extruded.

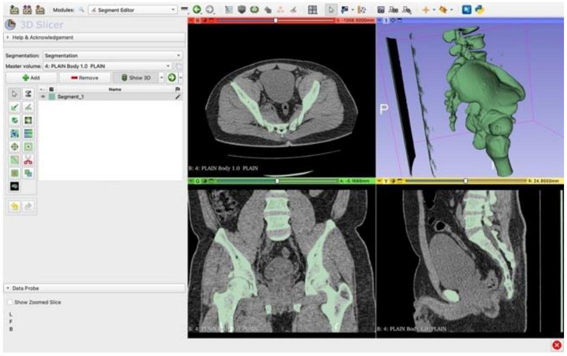


Figure 5: Slic3r 3D printing toolbox software

E. Fused Deposition Modelling (FDM) 3D Printing

FDM 3D printing is an additive manufacturing technique in which layers of materials are fused together in a specific pattern to make an object. Typically, the material is melted slightly beyond its glass transition temperature and then extruded in a pattern next to or on top of prior extrusions to create an item by building up layers.

The FDM 3D printer melts a plastic filament by forcing it through a hot end and depositing it on the print bed in layers. These layers will be fused together, accumulating throughout the printing process, and will finally create the final product (as shown in the diagram illustration in Figure 6.0).

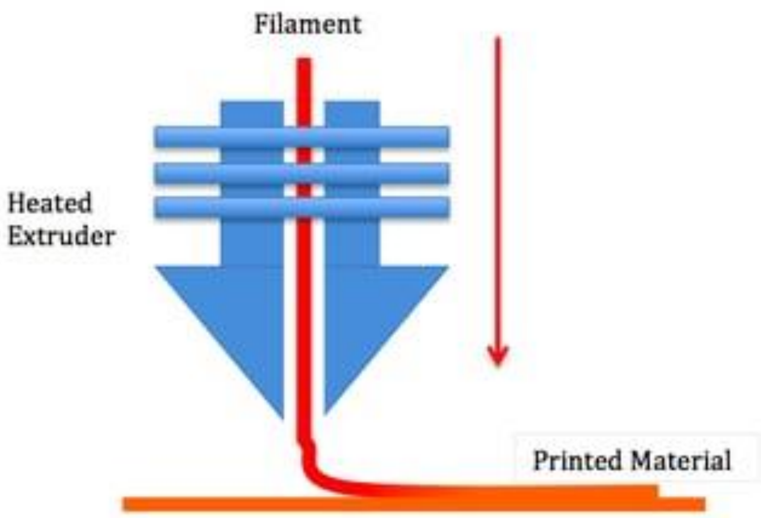
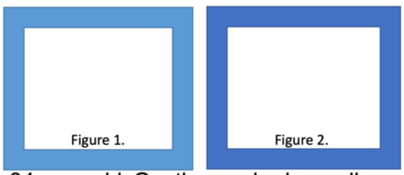


Figure 6.0 : Diagram illustration of FDM printing

F. <u>Single Answer Questions (SAQ)</u>

Members from the orthopedic and medical education faculty were selected. They will formulate five SAQs for each of the five common acetabular fracture patterns. The final selection's faculty members created and vetted a total of 25 SAQ. An example of SAQ in Figure 7.0.



34-year-old Gentleman had an alleged MVA (Car vs Divider). The following are the Images (Radiographs, CT scan, 3D Model) of the patient. What is the Judet & Letournel Classification for the acetabular fracture he sustained?

a) Transverse Type
b) T-Type
c) Anterior Wall
d) Posterior Column
e) Both Column

Figure 7.0: Example SAQ

G. <u>Conduct of Study</u>

Acetabular Fracture Lecture delivered to all participants. The participants will then be assigned randomly to one of two groups: the experimental group or the control group. There will be five stations, each containing a 3D model, CT scan, and radiographs for a distinct acetabular fracture pattern. Each evaluation station will contain five SAQ questions based on the type of fracture pattern. Stations in the experimental group will feature 3D models, CT images, and radiographs. The control group's station will feature CT scans and radiographs, but no 3D models. The auditorium will be utilized, and the standard operating procedure will be adhered to.

<u>2.6.7 Data Collection Method</u>

In the auditorium of the School of Health Sciences at Universiti Sains Malaysia, data will be collected. All participants will get a brief verbal description of the study in addition to a research information sheet. The consent will be acquired in writing. The collecting of data should take three to five hours. Prior to the start of the study, everyone will be interviewed to collect their demographic and employment backgrounds. The SAQ response sheets of the experimental and control groups were gathered. The SAQ has been graded and scored. The information will be tallied by station and group (experimental and control groups).