

**INCIDENCE OF DEEP VEIN THROMBOSIS IN PATIENTS WITH
PELVIC AND ACETABULUM FRACTURES REQUIRING
OPERATIVE INTERVENTION IN HOSPITAL UNIVERSITI SAINS
MALAYSIA: IS PREOPERATIVE SCREENING WITH DOPPLER
ULTRASOUND NECESSARY?**

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**INCIDENCE OF DEEP VEIN THROMBOSIS IN
PATIENTS WITH PELVIC AND ACETABULUM
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LISTS OF ABBREVIATIONS AND DEFINITIONS

List of abbreviations:

- i. U/S refers to Ultrasound
- ii. DVT refers to Deep Vein Thrombosis
- iii. PE refers to Pulmonary Embolism
- iv. VTE refers to Venous Thromboembolism
- v. CT Scan refers to Computer Tomography Scan
- vi. OT refers to Operation Theatre
- vii. LMWH refers to Low Molecular Weight Heparin
- viii. PACS refers to Picture Archiving and Communications System
- ix. HUSM refers to Hospital Universiti Sains Malaysia
- x. CPG refers to Clinical Practice Guidelines
- xi. MREC refers to Medical and Ethics Research Committee

ABSTRAK

Pengenalan

Kecederaan pelvik dan asetabulum kerap berlaku disebabkan oleh kecederaan impak tinggi menyebabkan pesakit berisiko tinggi untuk mendapat trombosis vena dalam dan embolisme peparu. Kajian ini dilakukan untuk mengenalpasti kejadian trombosis vena dalam dan embolisme peparu di kalangan pesakit yang mendapat kecederaan pelvik dan asetabulum untuk menekankan kepentingan memulakan profilaksis bagi mencegah pembekuan darah dan memastikan saringan dibuat kepada pesakit sebelum pembedahan dijalankan.

Kaedah Kajian

Kajian retrospektif telah dilakukan terhadap 78 pesakit yang telah dirawat di Hospital Universiti Sains Malaysia untuk kecederaan pelvik dan asetabulum yang memerlukan pembedahan dari Januari 2015 sehingga Disember 2019. Kesemua pesakit yang memerlukan pembedahan disaring untuk trombosis vena dalam dengan menggunakan ultrasound Doppler dan akan dibandingkan dengan jumlah pesakit yang didapati menghidap trombosis vena dalam selepas pembedahan. Analisis statistik deskriptif dilakukan dengan menggunakan IBM SPSS Statistik Versi 24.

Keputusan

Sejumlah 78 orang pesakit menyertai kajian ini yang merangkumi 30.8% pesakit wanita dan 69.2% pesakit lelaki. Saringan pra-pembedahan yang dilakukan dengan ultrasound Doppler menunjukkan tiga (3.8%) pesakit didapati menghidap trombosis vena dalam. Seorang (1.3%) pesakit mempunyai simptom dan telah menghidap embolisma peparu. Sejumlah seorang

pesakit yang terdahulu didapati negatif semasa saringan pra pembedahan didapati menghidap trombosis vena dalam selepas pembedahan dan seorang pesakit menghidap embolisme peparu.

Kesimpulan

Kejadian trombosis vena dalam di kalangan pesakit dengan kecederaan pelvik dan asetabulum berdasarkan saringan pra pembedahan adalah rendah berbanding dengan kajian- kajian yang pernah dilakukan sebelum ini tetapi sangat penting untuk dikenalpasti bagi mengelakkan morbiditi dan mortaliti kepada pesakit. Walaupun pesakit didapati negatif semasa pra pembedahan, mereka masih berisiko untuk menhidap penyakit thrombosis vena dalam dan embolisme peparu. Pemberian profilaksis kepada pesakit tidak dapat mencegah berlakunya penyakit seperti di atas. Justeru, kami mencadangkan penggunaan Ultrasound Doppler untuk saringan sebelum pembedahan bagi pesakit yang mengalami kecederaan pelvik dan asetabulum untuk disertakan dalam 'Malaysian Clinical Practice Guidelines'.

Kata Kunci:

Pelvik, asetabulum, thrombosis vena dalam, embolisme peparu, Doppler ultrasound

ABSTRACT

Introduction

Pelvic and acetabulum fractures commonly occur due to high impact injury putting patients at higher risk of developing thromboembolic diseases such as deep vein thrombosis and pulmonary embolism. This study was performed to determine the incidence of lower extremity deep vein thrombosis in patients with pelvic and acetabulum fractures to determine the importance of preoperative screening with Doppler ultrasound prior to surgical intervention.

Materials and methods

This was a retrospective study involving 78 patients admitted to Hospital Universiti Sains Malaysia with pelvic and acetabulum fractures requiring surgical intervention from January 2015 till December 2019. All patients planned for surgical intervention were screened preoperatively with Doppler Ultrasound to detect for lower limb DVT. These were compared with incidence of lower limb DVT post operatively. Descriptive statistical analysis was performed using IBM SPSS Statistics Version 24.

Results

There were 78 patients included in this study consisting of 30.8% females and 69.2% male patients. Preoperative screening with Doppler ultrasound showed 3 (3.8%) patients were diagnosed with lower limb DVT whereas 1 (1.3%) was symptomatic and diagnosed with PE.

Postoperatively, 1 patient developed DVT and 1 patient developed PE. Both of these patients were negative for DVT preoperatively.

Conclusion

The incidence of VTE in patients with pelvic and acetabulum fractures in our centre based on preoperative screening is low but is significantly important to prevent further morbidity and mortality. However, negative preoperative screening cannot safely rule out patients from developing VTE postoperatively. Despite initiation of thromboprophylaxis in trauma patients, we cannot prevent the incidence of venous thromboembolic diseases. We recommend preoperative screening with Doppler ultrasound prior to operative intervention to detect DVT especially in asymptomatic patients with pelvic and acetabulum fractures to be included in our Malaysian Clinical Practice Guidelines for management of DVT.

Key Words:

Pelvic, acetabulum, deep vein thrombosis, pulmonary embolism, Doppler ultrasound

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Venous thromboembolic diseases encompasses deep vein thrombosis and pulmonary embolism. Patients with pelvic and acetabular fractures are commonly associated with high impact injury of which, they may also have other associated injuries such as head, chest, abdominal and extremities. Coagulopathy is present at admission in 25% of trauma patients and is associated with shock and subsequent 5-fold risk of mortality [1]. All or one of the components of Virchow's triad of hypercoagulability, venous stasis and endothelial dysfunction may be disrupted after major trauma contributing to the increased risk of developing thrombosis [2].

All patients with unstable pelvic and acetabulum fractures require operative fixation in order to achieve fracture stability and thus allow early mobilisation and reduce the postoperative hospital stay. Prolonged immobilisation is also an added risk factor to development of venous thromboembolic diseases.

The administration of mechanical and/or pharmacological thromboprophylaxis is advocated upon admission to reduce the risk of venous thromboembolic diseases in such patients. Pharmacological thromboprophylaxis can be administered immediately provided the patient is hemodynamically stable. However appropriate delays in commencement of pharmacological thromboprophylaxis may be considered in patients with active bleeding, presence of coagulopathy, hemodynamic instability, solid organ injury, traumatic brain injury or spinal trauma [3].

The importance of screening and surveillance for deep vein thrombosis preoperatively should be emphasised in these groups of patients especially in detecting asymptomatic patients to allow administration of appropriate treatment and to prevent further morbidity and mortality. Lower limb deep vein thrombosis can lead to pulmonary embolism which can be detrimental

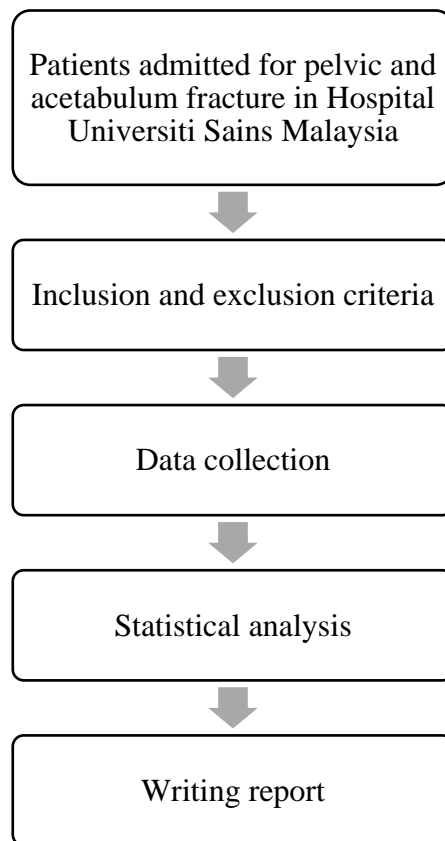
and potentially fatal. Doppler ultrasound is used as a screening modality in our centre as it is easily accessible, cost effective and non-invasive.

1.2 PROBLEM STATEMENT AND STUDY RATIONALE

Currently there are no studies done to ascertain the incidence of deep vein thrombosis with pelvic and acetabular fractures requiring operative intervention in our local population as compared to other countries. Is the incidence in our centre comparable to that of other countries?

There is no standardized screening protocol in our local hospitals for patients with pelvic and acetabulum fractures. Therefore by undertaking this studies, we may have sufficient data to implement screening protocol for such patients with pelvic and acetabulum preoperatively to enable early diagnosis and management prior performing operative intervention.

1.3 CONCEPTUAL FRAMEWORK



1.4 RESEARCH QUESTIONS

1. What is the incidence of deep vein thrombosis in patients with pelvic and acetabulum fractures in our centre?
2. Is preoperative screening for DVT with Doppler ultrasound necessary for patients with pelvic and acetabulum fractures undergoing operative intervention?

1.5 OBJECTIVES

General:

To determine the incidence of deep vein thrombosis in patients with pelvic and acetabulum fractures requiring operative management in Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan.

Specific:

1. To determine the incidence of preoperative deep vein thrombosis in patients with pelvic and acetabular fractures
2. To determine the proportion of patients with negative Doppler ultrasound findings preoperatively developing lower extremity deep vein thrombosis post operatively

CHAPTER 2: LITERATURE REVIEW

2.1 LITERATURE REVIEW

Moed et al. [4] in 2012 studied 229 patients between 2003 and 2007 in patients with pelvic and acetabular fractures requiring operative management. These patients were administered mechanical and pharmacological thromboprophylaxis preoperatively and screening for proximal DVT via Duplex ultrasound was performed preoperatively and one day prior to discharge. Asymptomatic DVT was detected in 15% of patients of which 7% were detected preoperatively and 8% postoperatively. Two patients with negative scans preoperatively developed symptomatic PE post operatively.

Studies done by Otrowska et al. [5] reported a 5% rate of thromboembolic events with a 2.5% rate of PE with 1 death occurring intraoperatively despite being started on thromboprophylaxis. Patients were screened via Greenfield Risk Assessment Profile to determine if they were at low or high risk of developing DVT but no preoperative screening was performed. Further radiological imaging was only performed for patients who were symptomatic of DVT or PE. Based on this study, Greenfield Risk Assessment Profile could not effectively predict those who were at high risk of developing DVT.

In 2005, Stannard et al. [6] studied 222 patients with pelvic and acetabular fracture who had undergone operative intervention, of which 12% developed venous thromboembolic diseases despite being started on mechanical compression or pharmacological thromboprophylaxis. Of these patients, 44.5% had lower extremity clots whereas 48% had definite pelvic vein thrombosis. Patients were started on either mechanical compression or on pharmacological therapy. No screening was done preoperatively for these patients. They underwent bilateral magnetic resonance venography and ultrasound 24 hours prior to discharge or earlier if developed symptoms and signs of venous thromboembolic diseases.

Prospective studies done by Steele et al. [7] on patients with pelvic and acetabulum fractures requiring operative intervention reported an incidence of proximal DVT of 10%. 5%

of patients developed PE. Patients were administered low molecular weight heparin preoperatively and only postoperative screening was done on day 10 to 14 and outcome was compared with timing of initiation of prophylactic treatment. Preoperative screening was not performed for all patients except for patients from referring centres of which transfer was delayed for more than 7 hours. Incidence of proximal DVT was lower in at 3% and 22% in patients who were administered LWMH after 24 hours of injury.

Earlier studies were performed in the Western population to ascertain the incidence of VTE in patients with pelvic and acetabulum fractures. Studies done in the Asian population were also comparable to those done in the Western population. Sen et al. [8] in 2011 studied the incidence of VTE in the patients with pelvic and acetabulum fractures in the Indian population. Neither mechanical nor chemical thromboprophylaxis were initiated for these patients. No preoperative screening was done for the patients except when they develop symptoms suggestive of DVT or PE. Post operatively, patients underwent Computed Tomography Pulmonary Angiography (CTPA) and indirect venography which not only detects PE but DVT as well. 26.8% of patients had radiological evidence of VTE of which, 6 patients had clinical evidence of VTE. The rest were asymptomatic. Wang et al. [9] in 2019 studied 110 patients with pelvic and acetabular fractures who were started on mechanical and chemical thromboprophylaxis post injury. Preoperative screening with Duplex ultrasonography was performed before and after operative intervention. However, DVT was detected in 29.09% of patients. 19.09% of those which developed DVT had proximal DVT whereas 11.0% had distal DVT. Another 2.73% developed PE.

Various radiological modalities were used to screen patients for DVT and PE. The use of Doppler ultrasonography allows the evaluation of the entire deep venous system (whole leg ultrasonography) which is from the groin to the ankle. Thrombi can be classified to proximal

or distal. Proximal thrombi involves thrombi in popliteal and more proximal veins and whereas distal thrombi are found in the tibial or calf muscle veins [4].

Studies done by Shahzaad et al. [10] showed that color Doppler ultrasonography had 99% sensitivity and 80% specificity in detecting DVT as compared to venography. Based on this study, venography had a positive predictive value of 99% and negative predictive value of 80% with a 99% sensitivity, 80% specificity and 98% accuracy. According to Goodacre et al. [11], compression ultrasound alone had pooled sensitivity of 93.8% for proximal deep vein thrombosis, 56.8% for distal deep vein thrombosis and specificity of 97.8%. Combined colour Doppler ultrasonography have optimal sensitivity while compression ultrasound has optimal specificity. Ultrasonography is a preferred choice of imaging modality to screen for DVT as it is safe, not invasive, cost effective and efficient. It is also easily accessible in all tertiary hospitals which may serve as a referral centre for pelvic and acetabulum injuries.

CHAPTER 3: METHODOLOGY

3.1 METHODOLOGY

Research design

The study is a retrospective cohort study

Study area

Hospital Universiti Sains Malaysia, Kubang Kerian

Study population

Adult patients aged 18 and above who were admitted to HUSM for pelvic and acetabulum fractures requiring operative intervention from January 2015 – December 2019.

3.2 STUDY CRITERIA

Inclusion criteria:

1. Adult patients aged 18 years old and above
2. Closed pelvic and acetabular fractures requiring operative intervention
3. Patients who underwent Doppler Ultrasound for screening prior to operative intervention

Exclusion criteria:

1. Patients aged below 18 years old
2. Open pelvic and acetabulum fractures
3. Pelvic and acetabular fractures managed non operatively
4. Patients who did not undergo screening with Doppler Ultrasound prior to operative intervention
5. Associated vascular injuries of upper and lower extremities requiring emergency operative intervention
6. Patients with previous history of deep vein thrombosis
7. Patient on anticoagulants prior to admission

3.3 SAMPLE SIZE ESTIMATION

For objectives 1:

To determine incidence of deep vein thrombosis in patients with pelvic and acetabular fractures requiring operative intervention

Sample size is calculated using independent t-test via Power and Sample Size Calculator.

95% confidence interval

$$\alpha = 0.05$$

Difference in population mean, $\delta = 0.3$

Standard deviation, $\sigma = 0.8$

M: 1

Based on Wang et al (2019), incidence of DVT in pelvic and acetabular fractures is approximately 30% (0.3).

Therefore, $n = 113$.

Objective 2: To determine the proportion of patients with negative Doppler ultrasound findings preoperatively developing deep vein thrombosis post operatively

Based on the paper by Wang et al. there were 2 patients that had negative scans who developed pulmonary embolism post operatively (however subsequent Duplex ultrasonography was negative) out of 78 patients.

$$n = p(1 - p) \left(\frac{Z}{E} \right)^2$$

$$p = 0.026 (2/78)$$

$$Z = 1.96$$

$$E = 0.05$$

$$n = 0.026 (0.974) (1.96/0.05)^2$$

$$= 37$$

3.4 SAMPLING METHOD AND SUBJECT RECRUITMENT

Sampling was based on patients who were admitted to our centre for pelvic and acetabulum fractures. Data was obtained from our admission books and selected after considering the inclusion and exclusion criterias. Subjects were not recruited as this is a retrospective study.

3.5 RESEARCH TOOL AND DATA COLLECTION METHOD

Research tool

Radiological images such as plain radiographs, CT scans and Doppler Ultrasound findings were obtained from PACS. Further information on patient's admissions were obtained from case notes which were traced and reviewed at Unit Rekod Perubatan, Hospital Universiti Sains Malaysia.

Data collection method

Subject's previous case notes were traced and reviewed at Unit Rekod Perubatan, Hospital Universiti Sains Malaysia. Radiological images such as plain radiographs and CT scans were reviewed in PACS to further classify pelvic or acetabulum injuries by an advanced trauma surgeon and a radiologist. Doppler Ultrasound will be performed prior to operative intervention by Radiology MMed Students or registrars and verified by Radiologists. The veins are assessed for patency and compressibility as well as echogenic foci suggestive of thrombus. The location of thrombus was also assessed. Both relevant information as well as radiological findings will be transferred into data collection sheets.

Patients are not screened post operatively however if symptomatic for DVT or PE, they will be assessed clinically based on Wells criteria and further radiological imaging will be performed. Doppler ultrasound was performed to assess for DVT whereas CT Pulmonary Angiography was performed to assess for PE.

3.6 ETHICAL CONSIDERATION

1. Subject vulnerability

There is no subject vulnerability as this is a retrospective study using secondary data and this will not affect the subsequent management of the patients involved.

2. Declaration of the absence of conflict of interest

There is no conflict of interest involved in this study.

3. Privacy and confidentiality

All data collected are anonymous and will be keyed into the SPSS software and only research team members are able to access the data.

4. Community sensitivities and benefits

This study benefits the community in detecting asymptomatic patients with pelvic and acetabular fractures as this lead to significant morbidity and mortality. This is particularly relevant as the injury itself contributes to a higher risk of developing lower limb deep vein thrombosis even if patients do not have other significant risk factors.

5. Honorarium and incentives

This is not applicable to this study.

CHAPTER 4: MANUSCRIPT

4.1 ABSTRACT

Introduction

Pelvic and acetabulum fractures commonly occur due to high impact injury putting patients at higher risk of developing thromboembolic diseases such as deep vein thrombosis and pulmonary embolism. This study was performed to determine the incidence of lower extremity deep vein thrombosis in patients with pelvic and acetabulum fractures to determine the importance of preoperative screening with Doppler ultrasound prior to surgical intervention.

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Conclusion

The incidence of VTE in patients with pelvic and acetabulum fractures in our centre based on preoperative screening is low but is significantly important to prevent further morbidity and mortality. However, negative preoperative screening cannot safely rule out patients from developing VTE postoperatively. Despite initiation of thromboprophylaxis in trauma patients, we cannot prevent the incidence of venous thromboembolic diseases. We recommend preoperative screening with Doppler ultrasound prior to operative intervention to detect DVT especially in asymptomatic patients with pelvic and acetabulum fractures to be included in our Malaysian Clinical Practice Guidelines for management of DVT.

Key Words:

Pelvic, acetabulum, deep vein thrombosis, pulmonary embolism, Doppler ultrasound

4.2 INTRODUCTION

Venous thromboembolic diseases encompasses deep vein thrombosis and pulmonary embolism. Patients with pelvic and acetabular fractures are commonly associated with high impact injury of which, they may also have other associated injuries such as head, chest, abdominal and extremities. Coagulopathy is present at admission in 25% of trauma patients and is associated with shock and subsequent 5-fold risk of mortality [1]. All or one of the components of Virchow's triad of hypercoagulability, venous stasis and endothelial dysfunction may be disrupted after major trauma contributing to the increased risk of developing thrombosis [2].

All patients with unstable pelvic and acetabulum fractures require operative fixation in order to achieve fracture stability and thus allow early mobilisation and reduce the postoperative hospital stay. Prolonged immobilisation is also an added risk factor to development of venous thromboembolic diseases.

The administration of mechanical and/or pharmacological thromboprophylaxis is advocated upon admission to reduce the risk of venous thromboembolic diseases in such patients. Pharmacological thromboprophylaxis can be administered immediately provided the patient is hemodynamically stable. However appropriate delays in commencement of pharmacological thromboprophylaxis may be considered in patients with active bleeding, presence of coagulopathy, hemodynamic instability, solid organ injury, traumatic brain injury or spinal trauma [3].

The importance of screening and surveillance for deep vein thrombosis preoperatively should be emphasised in these group of patients especially in detecting asymptomatic patients to allow administration of appropriate treatment and to prevent further morbidity and mortality.

Lower limb deep vein thrombosis can lead to pulmonary embolism which can be detrimental and potentially fatal. Doppler ultrasound is used as a screening modality in our centre as it is easily accessible, cost effective and non-invasive.

4.3 METHODOLOGY

This is a retrospective study involving patients treated in a single tertiary centre which is also a referral centre for advanced trauma services from January 2015 until December 2019. This also included cases referred from other nearby hospitals which do not provide specialised orthopaedic services pertaining to pelvic and acetabulum injuries.

Patients aged 18 years old and above with pelvic and/or acetabulum fractures requiring operative intervention and had undergone screening with Doppler ultrasound prior to operative intervention were included in this study. Patients aged below 18 years old, open pelvic and acetabulum fractures, patients with pelvic and acetabulum fractures which were managed non-operatively, patients who did not undergo screening with Doppler Ultrasound prior to operative intervention, patients with associated vascular injuries of upper or lower extremities requiring emergency operative intervention, patients with complex pelvic injuries requiring immediate operative intervention, patients with previous history of DVT and patients on anticoagulants prior to admission were excluded from this study.

Patients were classified into pelvic or acetabulum fractures after review of plain radiographs and CT scan by an advanced trauma surgeon and a radiologist. The acetabulum is not just limited to the socket part of the “ball and socket” hip joint but also includes the bony masses that limit and support the acetabulum [25]. Acetabulum fractures are classified according to Judet and Letournel classification. Judet and Letournel classifies acetabulum fractures into simple (elementary) and complex (associated) fractures. The 5 elementary fractures are posterior wall, posterior column, anterior wall, anterior column and transverse fractures. The 5 associated fractures are a combination of simple fractures and classified into posterior wall and posterior column fractures, transverse posterior wall fractures, T-shaped fractures, anterior with posterior hemitransverse fractures, and bicolumnar fractures. Pelvic