



Case Series

The role of angioembolization and C-clamp fixation: Damaged control orthopaedic in haemodynamically unstable pelvic fracture

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ABSTRACT

Introduction: Unstable pelvic fracture may emerge to major bleeding complication. Angioembolization is one of method to stop the bleeding effectively. This case series aims to analyze whether the bleeding of unstable pelvic fracture is managed by angioembolization to achieve the better functional outcome.

Presentation of case: Three cases of haemodynamically unstable pelvic fracture were studied retrospectively and prospectively. A staged approach using damage control orthopaedic surgery was performed. Initial resuscitation began from fluid resuscitation, pelvic wrapping using binder. All patients followed with pelvic external fixation, while 2 patients immediately replaced binder to C-Clamp, and 1 patient with anterior frame. Angioembolization was done to all patients. All patients required definitive internal fixation, while only 2 patients reach the definitive surgery. Finally, we measured the functional outcome of all patients using Hannover Pelvic score, Majeed pelvic score, and Iowa Pelvic score.

Discussion: We review some literatures regarding pelvic angioembolization. The previous study suggested to resuscitate patients when the hemodynamic is unstable, the angioembolization procedure is still preferred. The indication and successful definition of this procedure is still unclear, yet it shows decrease of mortality rate of pelvic injury if this procedure starts ahead a schedule.

Conclusion: Angioembolization as a part of damaged control orthopaedic has been shown a favorable result in managing unstable pelvic injury.

1. Introduction

Pelvic fracture is highly associated with substantial blood loss up to 20% of patients who came in also with hemodynamic instability. Blood loss in pelvic fracture leads to mortality rate number of up to 50% due to disrupted arteries or veins that is present within the pelvis [1]. Majority (85%) cause of the bleeding is the blood vessels rupture through the bone, with the rest 15% being sourced from the arteries [1].

Good resuscitation is necessary to deal with the hemorrhage, this is mainly acquired by using blood product and mechanical stabilization. Recent cases had shown that type of blood vessel determine the severity of the hemorrhage. In number of studies, arterial bleeding is more threatening than the vein. Among the arteries, the most recognized source of bleeding is the internal iliac artery and its branches [2]. If the patient is in shock, the vital sign usually shows low systolic blood pressure within 24 h and needs to give transfusion as much as 2000 L of

fluid, and more than 4 blood bags [3].

There are numerous methods for emergency hemodynamic stabilization such as external fixations, pelvic binders, and circumferential wrapping. The effective method to control intrapelvic hemorrhage is where angiographic embolization came in [4]. It has success rate of up until 85%. Yet unfortunately, there are reported cases and based on statistics, the mortality rates are within the number of 16–50%. This case series aims to discuss whether it is effective to control intrapelvic hemorrhage using angioembolization and to consider the benefit and drawbacks of this method [4]. This case series has been reported in line with the most recent PROCESS Guideline [5].

2. Presentation of Cases

Three patients admitted to Cipto Mangunkusumo Hospital at various times with polytrauma and haemodynamically unstable pelvic fracture.

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Table 1

The Shock grade classified according to Hannover algorithm [26]. All of the patients encountered an “unstable” condition that should immediately managed properly according to protocol therapy.

Factors	Parameters	Patient A	Patient B	Patient C
Shock	BP (mmHg)	80/54	89/37	100/59
	Blood units	1000 cc	1200	500 cc
	Lactate	1.7	2.9	2.7
	Base deficit	-9.9	-3.0	-2.3
	ATLS class	grade III	grade III	grade III
Coagulation	Platelet count	614.000	192.000	162.000
	Fibrinogen	802	352.8	97.2
	D-dimer	8280	1300	0.9
Temperature	Celsius degree	36.5-36.6	35.2-36.4	36.5-36.6
	Lung Function (PaO2/FiO2)	normal	normal	normal
Soft tissue injuries	Chest trauma score	No	No	No
	Abdominal trauma	No	No	No
	Pelvic trauma (AO Classification)	C2	B1	C2
	Extremities	Open fracture of left tibia and fibula	Closed fracture of right proximal fibula, Open degloving injury of right leg	None
	Summary of Hannover grade	Unstable	Unstable	Unstable

All of them came at night at the busiest hour of duty. They have the same high-energy pain mechanism. Data including admission of vital signs included systolic blood pressure (SBP), heart and breathing rate, Glasgow Coma Scale (GCS) admission, body temperature, pelvic radiography, and initial laboratory results included complete blood count, base deficit, lactate level, fibrinogen and D-dimer. We measured the clinical grade using Hannover algorithm (Table 1), the International Severity Scale (ISS) polytrauma score, the Advanced Trauma Life Support (ATLS) shock grade guideline, and the pelvic fracture pattern were classified according to the Marvin-Tile classification and the algorithm of the treatment for pelvic fractures in Cipto Mangunkusumo Hospital (Fig. 1). All patients were also being the subject to a Focused Abdominal Ultrasound of Trauma (FAST) exam.

The inclusion criterias are unstable pelvic fracture by Marvin Tile classification (B and C), the “unstable” clinical grade of Hannover algorithm, and were treated with angioembolization (Table 2). Among 3 patients then sequentially treated with same procedure; fluid resuscitation, temporary pelvic stabilization was done immediately at emergency with pelvic binder and exchanged to temporary external fixation which 2 patients use C-clamp and one patient with anterior frame (Fig. 2). Unfortunately, the hemoglobin rate was fall and decision to proceed angioembolization was made. We recorded a disruption of arteries at different area for every patient. After angioembolization, there were no extravasation of contrast or ongoing bleeding (Fig. 3).

All patients required internal fixation, but only 2 patients attended elective surgery, and one refused due to insurance problem. We also

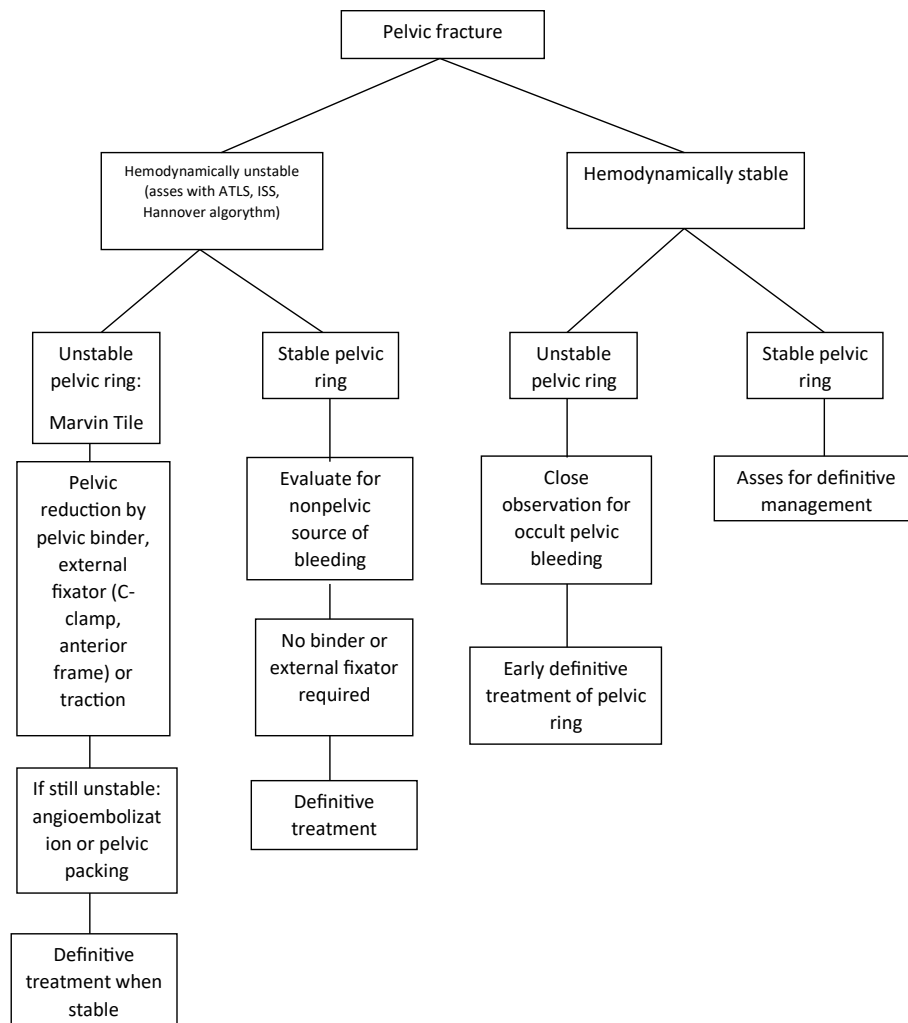


Fig. 1. The algorithm of the treatment for pelvic fractures in Cipto Mangunkusumo Hospital.

Table 2
Characteristic of the patient in initial encounter at the emergency department.

Factors	Patient A	Patient B	Patient C
Age/Sex	43/female	41/male	22/male
Admission vital sign			
- Systemic blood pressure (mmHg)	80/54	106/75	100/59
- Heart rate (x/minutes)	182	107	120
- Respiration rate (x/minutes)	23	16	22
- Admission GCS	15	15	14
Total fluid resuscitation (exclude blood)	2000 cc in 2 h	1000 cc in 5 h	1000 cc in 4 h
Initially required blood transfusion	1000 cc PRC and 500 cc FFP	1000 cc PRC and 300 cc FFP	500 cc PRC and 500 cc FFP
Initial laboratory result			
- Base deficit	-9.9	-3.00	-2.3
- Lactate level	4.8	2.9	2.7
Fracture pattern (Marvin-Tile Classification)	C2	B1	C2
Initial ISS Score	25	13	25
Hannover classification	Unstable	Unstable	Unstable
Type of temporary pelvic stabilization	C-clamp	C-clamp	Ex-fix
Time to angioembolization (hours)	8	10	11
Time to definitive internal fixation (days)	16	Refused the treatment	46
Embolized arterial vessel	cervico-vaginal and uterine artery	Superior gluteal artery	Superior gluteal artery
Embolitic agent	Gelfoam	Coil	Gelfoam
Total hospital LOS (days)	17	14	12

recorded additional data including gender, age, timing of angioembolization, timing to definitive internal fixation, total blood transfusion, and overall hospital length of stay. All of the patients were followed-up until 12 months and functional outcome of the patient was measured using Hannover, Majeed, and Iowa pelvic score (Table 3). All the treatments were done by orthopaedic surgeon adult reconstruction consultant.

3. Discussion

Pelvic fracture often associated with unstable hemodynamic state and disruption of arterial blood vessel inside pelvic compartment that mandatorily required radiological intervention. Regarding the Marvin Tile classification of pelvic fracture, type C (rotationally unstable, vertically unstable) is the most common type of fracture that require angioembolization, although other assessment is considered as important as the fracture pattern [1,6]. The best treatment scheme for these patients is still debatable. Even though the majority believe that there is a need for an immediate reduction and external stabilization of the damaged pelvis, different devices and treatment options have been suggested. Nevertheless, there is still no widely recognized opinion as to whether to select from such potential approaches [7]. In the United States, pelvic binders are used in pre-hospital and emergency department for pelvic ring injuries in particular. One of the most popular guidelines for this fracture has been suggested by AO Trauma foundation [8].

The comparison of the pelvic binder and the external pelvic fixation in patients with blunt pelvic fractures demonstrated a reduction in the requirements for transfusion and hospital stay in the pelvic binder group. However, the two study groups differed significantly in terms of ISS Score and systolic blood pressure on admission [7].

Angioembolization is used to control posttraumatic intra and retroperitoneal bleeding. During the acute phase, the goal of the treatment is to prevent early death from hemorrhage. Iliac arteries and their branches are major contributor to hemorrhagic shock in pelvic fracture

[3,6,9,10]. The effectiveness based on literatures are vary from 59 to 100% [11]. Unresponsive to resuscitation resulting in hypotension and continuous need of blood transfusion is one of the most important factor contributing the shock status. A study by Cook et al. [12], stated that a patients with pelvic fracture whose blood pressure were hypotensive have an overall mortality rate of 43% regardless of the treatment. Other study done by Caillot et al. [13] stated similar thing with the overall mortality rate of 19% and 42% in case of hemorrhagic shock, and this mortality rate was significantly higher with Tile C than A or B. Mortality rates ranged from 18 to 40% of pelvic fractures and pelvic fracture itself play an important role in the long-term clinical outcome after the injuries [14]. The long-term outcome of patients with posterior or combined anterior and posterior pelvic ring injuries is poorer than those with isolated anterior injury [15]. Unstable pelvic fracture require aggressive and well planned therapeutic regime [16,17]. It is also associated with multiple trauma or polytrauma [18].(Fig. 4).

Chou et al. [3] published a study reporting that mortality rates were 36.4% in patients receiving angiographic embolization less than 3 h after admission to ED, while mortality rates were 75% in patients receiving angioembolization more than 3 h after initial injury.

However, outcome of the pelvic ring is excellent in the long term if treated properly. The outcome of the complex pelvic fracture treated with internal fixation were good with Majeed score in 78.6% cases in Tile B and 50% in Tile C. A good Hannover score was also good in 64.3% of Tile B cases and 80% in the Tile C cases [19]. According to Lefaiivre et al. who conducted [20] systematic review for this topic stated that currently the existing literature in this area is insufficient and need further investigation to record a more meaningful way about the functional outcomes the fractures after the fixation (Fig. 5).

The usage of pelvic angiography for the treatment of the pelvic fracture is rather unusual in our center. Nonetheless, the use of pelvic angiography and surgical angiographic embolization is often addressed in the treatment of unstable pelvic fractures and unstable hemodynamics [10]. In a study performed by Costantini et al. [21], patients admitted to a Level 1 trauma center were just 3.8% of patients needing pelvic angiography, with an even lower percentage of patients undergoing therapeutic embolization. These results shed light on the true need for pelvic angiography in the urban trauma center [21]. Borg et al. [22] developed a pelvic discomfort index (PDI) to help the attending surgeon to evaluate the outcome after the fixation of the pelvic. This index composed of 14-item questionnaire which were open-ended.

The first step in maintaining hemodynamic state includes intravenous crystalloid fluid administration and whole blood administration [23]. All immediate treatments will concentrate on hemorrhage prevention and other life-saving steps in a fast and minimally stressful manner. For decreased death rates, prevention of coagulation disturbances, systemic inflammatory reaction, adult respiratory distress syndrome, and multiple organ failure syndrome is of utmost importance [11,24].

For decades, pelvic angiography has become a proven procedure that has developed into a highly efficient way of managing hemorrhage from the internal iliac arteries, and is still the standard treatment for fracture-associated arterial hemorrhage [25]. Nevertheless, moving an unstable patient from the emergency room to the interventional radiology suite can be a fatal risk if the patient needs laparotomy or thoracotomy to resolve continuing torso hemorrhage or intense resuscitation in the intensive care unit [1,2]. Specific guideline to use in management of unstable pelvic fracture is still ambiguous [14], nevertheless the author was trying to summarize as initial fluid resuscitation, temporary pelvic stabilization subsequent to preperitoneal packing (fill it up, wrap it up and pack it up) before it comes to definitive surgery [12,14,26]. Careful assessment to define initial condition was made by ATLS guideline, ISS score for polytrauma, and Hannover algorithm, while the chest Xray and pelvic should not await. A delayed definitive surgery was concerned as damaged control orthopaedic.

Managing pelvic fracture polytrauma patient is a major diagnostic

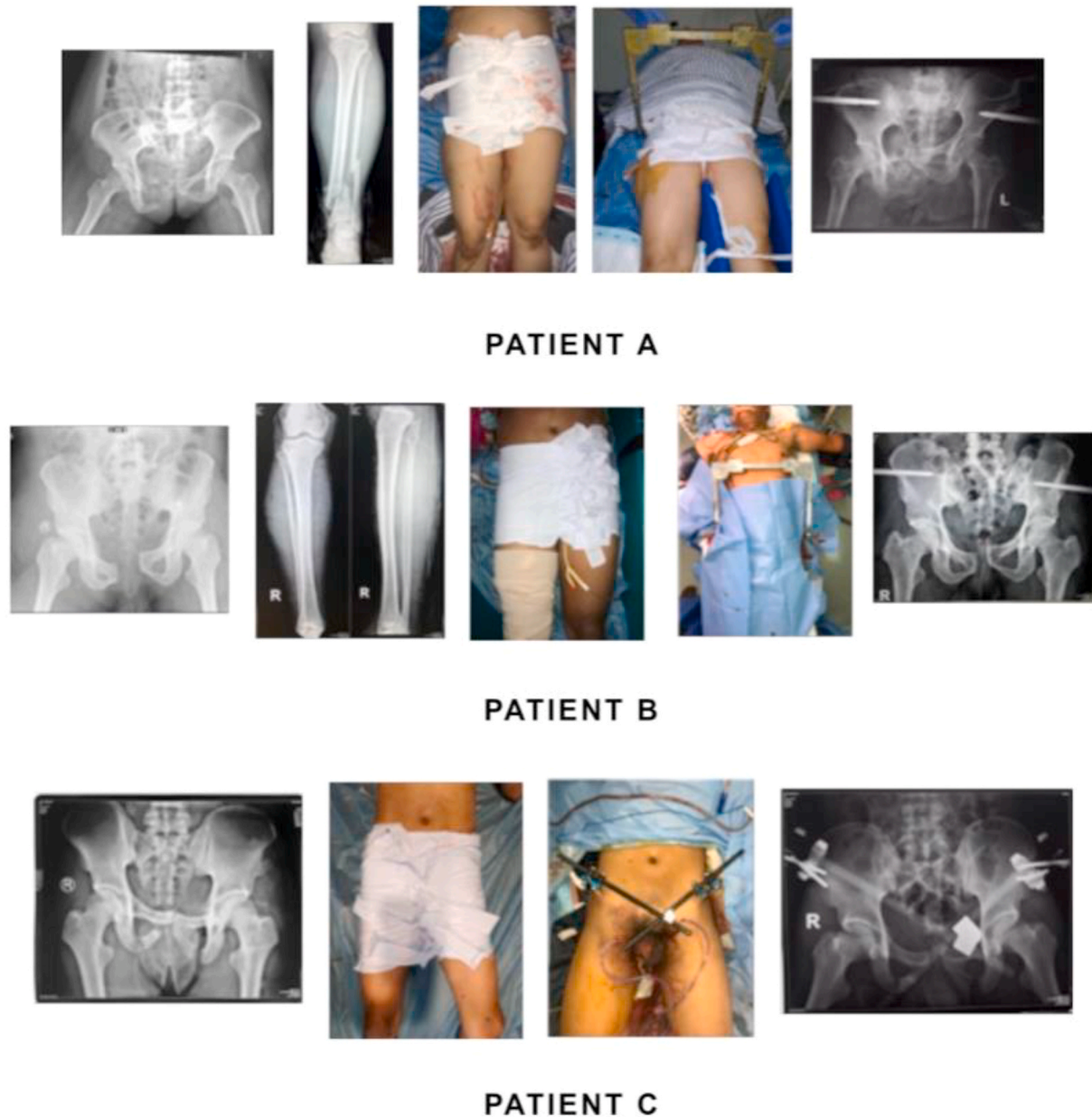


Fig. 2. Patient A, 43-years-old female, with polytrauma ISS score 25 consist of C2 type of pelvic fracture and open fracture of left distal tibia fibula. The pelvic binder was applied then immediately exchanged into C-clamp; **Patient B**, 41-years-old male, with polytrauma ISS score 13 consist of B1 type of pelvic fracture and closed fracture of right proximal fibula. The pelvic binder was applied then immediately exchanged into C-clamp; **Patient C**, 22-years-old male, with polytrauma ISS score 25 pelvis MTC 2, Faringer zone 1. The pelvic binder was applied then immediately replaced into anterior frame.

and therapeutic challenge both in the immediate post-injury and subsequent definitive fixation phase [26–29]. Pelvic and acetabular fractures are unusual injuries that comprise between 3% and 8% of all fractures [4]. Nevertheless, these fractures, often caused by high-energy trauma, are at high risk of subsequent complications, which have a direct impact on outcomes and survival rates. That makes DCO is the most suitable pelvic fracture therapy option [9,30]. Due to the anatomical proximity of arteries and nerves, the poor prognosis of pelvic fractures is related to the high incidence of hemorrhagic shock [31]. Ideally these type of fractures should be fixed by definitive treatment in under 24 h [24,32]. For most cases (90%), bleeding is caused by venous disturbance emerge from cancellous bone, and in just 10% of cases bleeding is caused by an arterial injury. Mortality of pelvic fracture patients with polytrauma and poor hemodynamics in one series has been reported to be as high as 50%. Late mortality is typically due to

uncontrolled hemorrhage, while the underlying accidents and sepsis-induced MODS result in late death. With advancements in resuscitation, pelvic trauma-related mortality is more likely to be near to 7% [9,27].

4. Conclusion

Pelvic injury is a high energy trauma mechanism thus result in serious internal bleeding. One of the most effective strategies to stop the bleeding is pelvic angioembolization. All the patients must receive initial resuscitation and reduction of the pelvic to decrease the internal hemorrhage. Used of external fixators e.g., C-clamp and anterior frame has been shown to reduce the bleeding. Pelvic angioembolization is a good choice for treating the patient with unstable pelvic fracture.

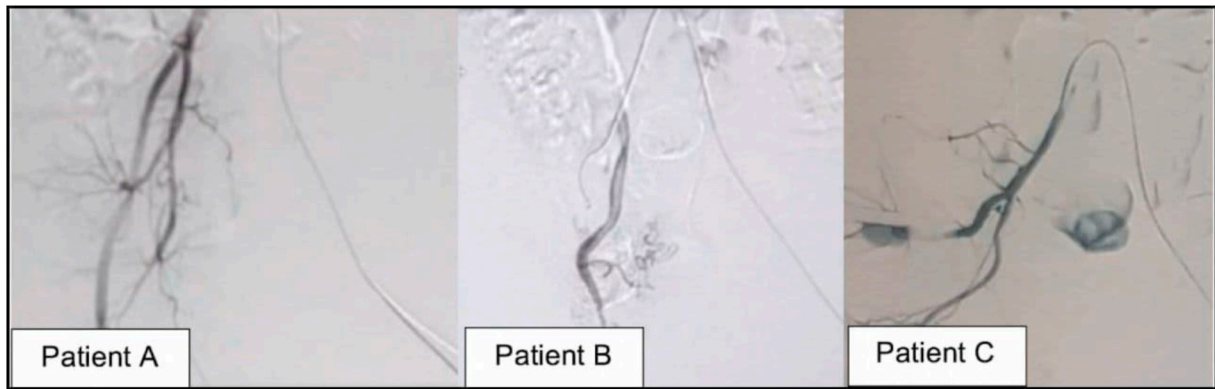


Fig. 3. Angioembolization performed on special room. With sedation and local anesthetic, a small catheter is inserted at the groin, guided under the fluoroscopy to the arteries of interest. a. A contrast visipaque is injected through the catheter to fill the vessels and visualize the anatomy, showed extravasated right cervicovaginal artery branch, inferior to the distal branches of the right uterine artery. b. Superior gluteal artery was inflated using coil, while c. The same manner as patient B (disruption of superior gluteal artery) but the disrupted blood vessel was occluded by gelfoam.

Table 3
Comparison of functional score [18] of all patients post operatively at 3, 6, and 12 months follow up.

	Hannover Pelvic Score			Majeed Pelvic Score			Iowa Pelvic score		
	3 months	6 months	12 months	3 months	6 months	12 months	3 months	6 months	12 months
Patient A	55	63	71	60	72	81	62	70	76
Patient B	54	60	69	61	75	87	70	81	88
Patient C	67	70	76	59	70	76	61	70	79

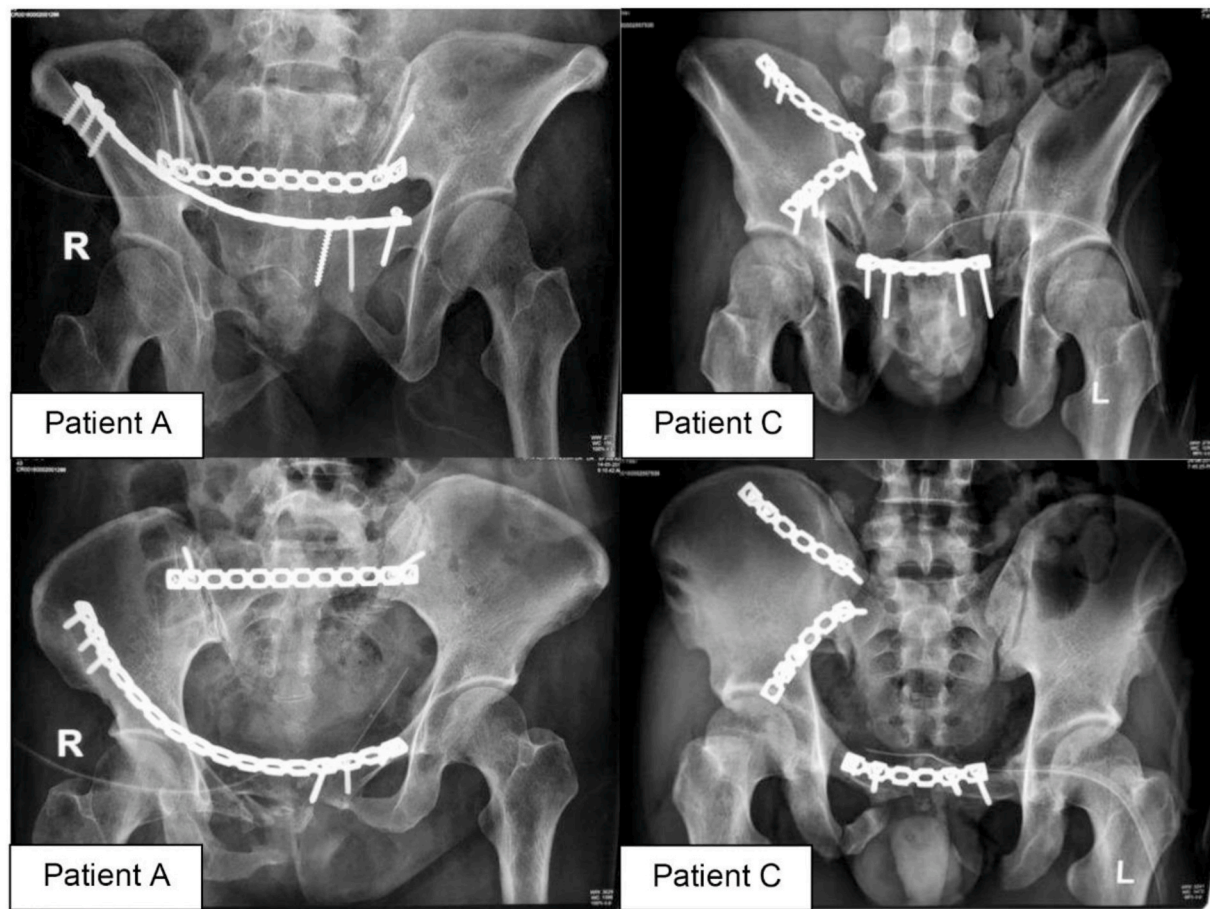


Fig. 4. Post operative inlet and outlet x-ray after ORIF, patient B refused to undergo definitive treatment thus no x-ray was taken.

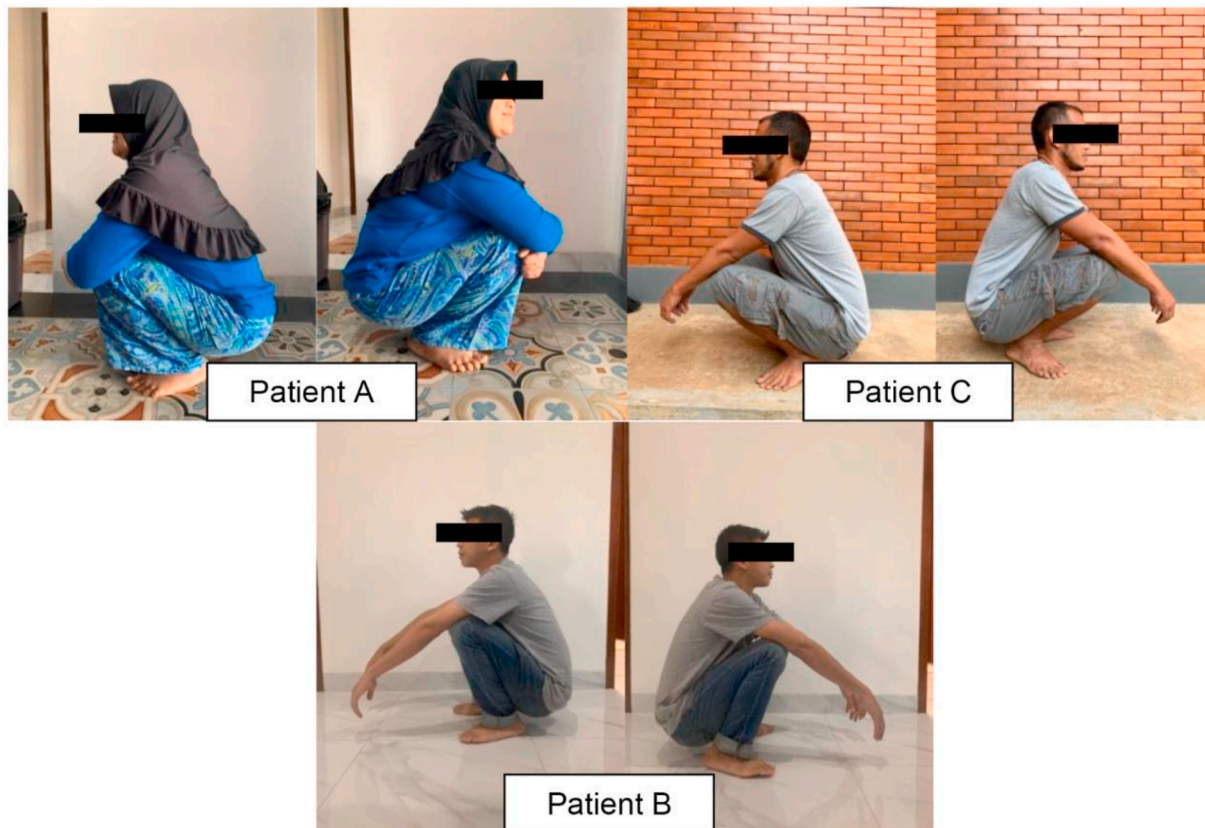


Fig. 5. Clinical outcome postoperatively taken, all of the patients were able to squat and could tolerate moderate activities like walking in distance (approximately 100 m), doing daily activities like climb the stairs, sexual intercourse and pray.

Ethical approval

This is a case series; therefore, it did not require ethical approval from ethics committee. However, we have got permission from the patients to publish their data.

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Author contribution

Ismail HD contributes in the study concept or design, data collection, analysis and interpretation, oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.

Ido Prabowo contributes in the study concept or design, data collection, analysis and interpretation, oversight and leadership responsibility for the research activity planning and execution.

Consent

Written informed consent was obtained from the patients for publication of this case series and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Registration of research studies

Not applicable.

Guarantor

Ismail HD is the sole guarantor of this submitted article.

Disclaimer

No patients or author details are included in the figures.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.02.003>.

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