

CASE REPORT

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# Lower abdominal cyst complicated with suspected infection following INFIX internal fixation for pelvic fracture: a report of two rare cases

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## Abstract

**Background** The Internal Fixator (INFIX) is a popular method, known for its minimal invasiveness and short operation time, for treating anterior pelvic ring fractures. Studies have shown that postoperative complications may occur, including anterolateral femoral cutaneous nerve injury, the femoral nerve paralysis, and delayed fracture healing. These complications are believed to be related to surgical stimulation, an excessively long lateral end of the connecting rod, a small distance between the screw and bone surface, insufficient pre-bending of the connecting rod, and difficulties in fracture reduction.

**Case presentation** We report two unique cases of lower abdominal pseudocyst complicated with suspected infection after INFIX treatment of pelvic fractures at our trauma center. Following surgical removal of the internal fixation, resolution of the cysts was observed in both patients, and subsequent postoperative follow-up revealed the absence of any residual sequelae. These cases have not been reported in previous literature reviews.

**Discussion** The lower abdominal cysts, potentially arising from the dead space created during intraoperative placement of the INFIX rod, may increase infection risk. The etiology remains uncertain, despite the presence of abnormal inflammation markers in both cases, and staphylococcus aureus found in one. These cysts were confined to the lower abdomen, not involving the internal fixation, and hence, only the INFIX was removed. Postoperative oral cefazolin treatment was successful, with resolved pseudocysts and no subsequent discomfort.

**Conclusion** We report two unprecedented cases of post-INFIX abdominal cysts, with a suspected link to intraoperative dead space. Despite uncertain etiology, successful management involved INFIX removal and oral cefixime therapy. These findings necessitate further exploration into the causes and management of such complications.

**Keywords** Pelvic fracture, INFIX, Postoperative infection

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## Background

Tile C pelvic fractures, involving both the anterior and posterior pelvic rings, often lead to vertical pelvic instability. This type of fracture typically requires surgical intervention to restore stability [1]. A common internal fixation method employed in such cases is the Internal Fixator (INFIX) which is frequently applied in anterior pelvic ring fractures; it is praised for its simplicity, minimal invasiveness, and reliable clinical efficacy [2, 3].

Despite these advantages, postoperative complications, including injury to the anterolateral femoral cutaneous nerve, femoral nerve paralysis, and delayed fracture healing has been reported [4]. Analysis suggests that these complications may arise due to intraoperative exposure stimulation, an excessively long lateral end of the connecting rod, a short distance between the screw and the bone surface, unsatisfactory (insufficient) pre-bending of the connecting rod, and challenges associated with fracture reduction [4, 5].

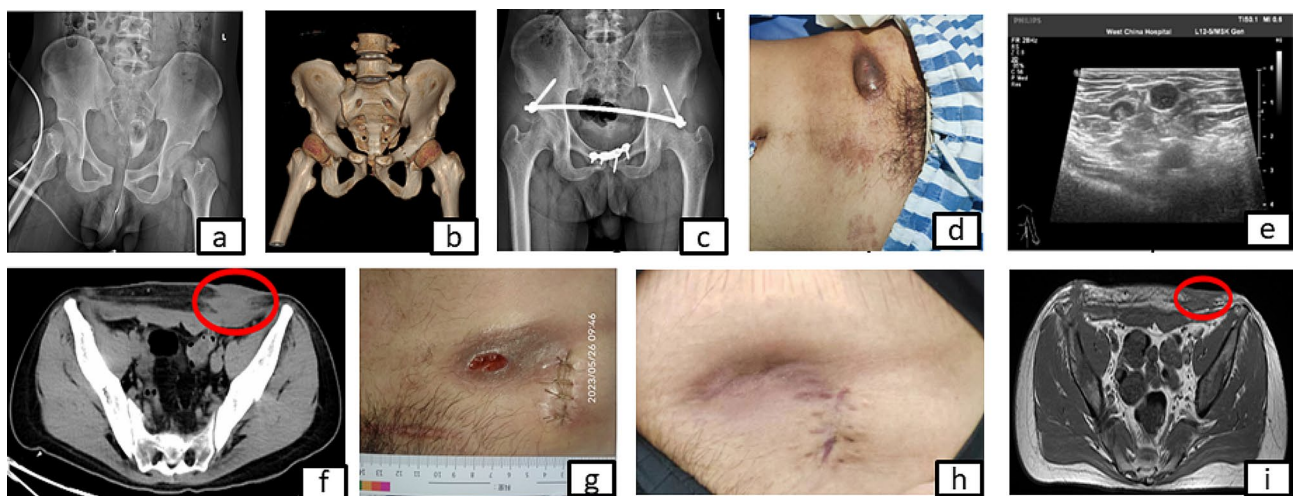
Postoperative infection, another potential complication of INFIX, is relatively rare. A meta-analysis demonstrated an approximate infection incidence of 2.3% [4], with most reported cases being superficial infections and rare instances of deep infections.

In this report, we present two rare cases of patients who developed lower abdominal pseudocysts following the use of INFIX for pelvic fractures. Following surgical removal of the INFIX internal fixation, the pseudocysts resolved, and no obvious sequelae was observed.

## Case presentation

**Case 1** A 29-year-old male patient, admitted to our trauma center ward for pelvic fracture secondary to a road traffic accident (Fig. 1). Following complete radiographic investigation (X-Ray, 3D CT Scan) (Fig. 1a and b), the patient was diagnosed with Tile B1 pelvic fracture according to Tile classification system. Some important Concomitant injuries such as: right clavicle fracture, right distal radius fracture and left calcaneus fracture were equally reported. For the fractures of the right radius, right clavicle, and left calcaneus, open reduction and internal fixation (ORIF) was performed. Due to bilateral superior pubic ramus fractures with significant pubic symphysis diastasis (>2.5 cm) and rotational instability of the anterior pelvic ring, surgical intervention was indicated. Therefore, we performed open reduction and internal fixation using INFIX and a pubic symphysis reconstruction plate. The operation lasted 60 min with a total blood loss of 200 ml. Postoperative imaging, including anteroposterior, inlet and outlet pelvic X-rays, and a three-dimensional CT scan of the pelvis, showed good fracture reduction with an excellent Matta score. The laboratory examinations on the first postoperative day reported: hemoglobin (Hb) level 109 g/L; white blood cell (WBC) level  $14.73 \times 10^9/L$ ; C-reactive protein (CRP) level 104 mg/L; erythrocyte sedimentation rate (ESR) level 74 mm/h and the albumin level was 34 g/L.

The patient was discharged on the fourth postoperative day. During the first and third month postoperative follow-ups, X-ray examinations did not reveal any consistent abnormal findings (Fig. 1c).



**Fig. 1** A 29-year-old male patient, who sustained a Tile B1 open book pelvic fracture secondary to a road traffic accident. (a) and (b) images respectively displaying preoperative X-Ray and 3D Ct scan demonstrating pubic symphysis diastasis; (c) Anteroposterior X-ray image of the pelvis obtained at 3-month outpatient clinic follow-up; (d) Gross photograph of the lower abdominal pseudocyst; (e) Color ultrasound image of the pseudocyst; (f) Cross-sectional CT image of the pseudocyst (red circle); (g) Gross photograph of the pseudocyst on postoperative day 6; (h) Gross photograph of the pseudocyst at 1-month postoperative; (i) post-operative outpatient clinic Cross-sectional MRI image of the pseudocyst showing significant reduction in the size of the left lower abdominal cyst (red circle)

**Table 1** Peri-operative laboratory investigation.

T0 = preoperative day; T1 = postoperative day 1;

T2 = postoperative day 3

Patients	Case 1			Case 2	
	T0	T1	T2	T0	T1
Sample time					
Hemoglobin(130–175 g/L)	138	143	131	129	112
White blood cell (3.5–9.5*10 <sup>9</sup> )	6.42	12.69	5.59	5.93	7.72
C-reactive protein(< 5 mg/L)	17.3	98.2	-	6.75	17.2
Erythrocyte sedimentation rate(< 43 mm/h)	49	66	108	36	-

Approximately six months postoperatively, the patient developed a progressively enlarging tender mass in the left lower abdomen (Fig. 1d). He returned to our hospital and was readmitted to the trauma center. The patient's vital signs were stable upon admission and presented as follows: body temperature was 36.1°C, pulse rate was 81 beats/min, respiratory rate was 20 breaths/min, and blood pressure measured 109/71mmHg.

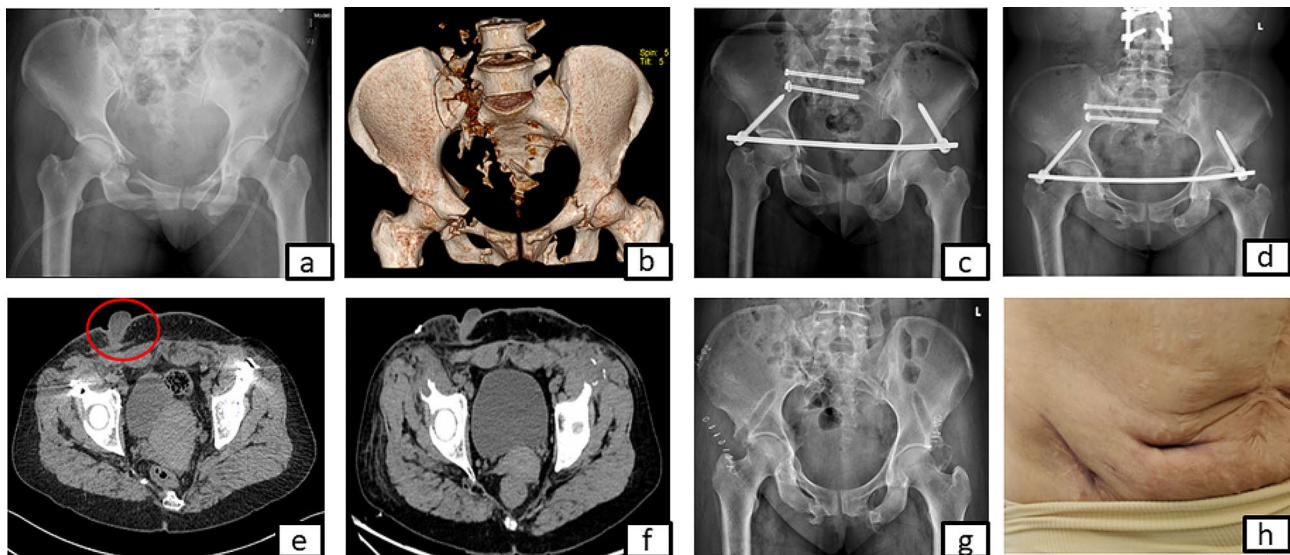
A lower abdominal superficial color Doppler ultrasound and 3D CT scans of the pelvis (Fig. 1e and f respectively), and a series of routine laboratory tests were performed (Table 1). Laboratory tests showed that the patient's WBC levels were within the normal range, ESR was slightly higher than the upper normal limit, and the CRP level was more than twice the upper limit of normal. The physical examination did not reveal the tip of the connecting rod compressing the skin of the patient's lower abdomen. The results pointed towards a lower abdominal pseudocyst complicated with infection;

resulting in the initiation of empirical oral cefixime 100 mg, twice daily for anti-infective treatment.

A preoperative puncture was performed along the lower margin of the mass; a 10 ml of bloody fluid was aspirated and sent for bacterial culture and the investigation revealed the presence of *Staphylococcus aureus*. On the sixth day of readmission, we surgically removed the INFIX device, retaining only the pubic symphysis plate.

The patient continued to take oral cefixime for anti-infection one week after surgery. Three days postoperatively, repeated laboratory tests (Table 1) demonstrated a decrease in white blood cell count whereas the ESR still raised. Following removal of the INFIX device on day 6, the patient's lower abdominal cysts markedly subsided (Fig. 1g). The surgical site was managed by our wound care nurse, and the left lower abdominal lesion was treated with infrared therapy (45 min per session, three times daily). The patient was discharged 10 days after INFIX removal. One-month post-discharge, outpatient follow-up revealed that the left lower abdominal mass had almost completely resolved (Fig. 1h), with no associated pain or tenderness. A postoperative outpatient visit MRI investigation of the pelvis indicated a significant reduction in the size of the left lower abdominal cyst (Fig. 1i).

**Case 2** A 53-year-old female patient, admitted to our hospital's trauma center due to pelvic fracture sustained from a high fall (Fig. 2). The preliminary radiographic investigations (X-Ray, 3D CT Scan) (Fig. 1a and b) reported a Tile C1.3 Pelvic fracture according to the Tile classification sys-



**Fig. 2** A 53-year-old female patient, who sustained a Tile C1.3 pelvic fracture secondary to a fall from height. (a) and (b) images respectively displaying preoperative X-Ray and 3D Ct scan demonstrating anterior and posterior pelvic ring fracture; (c) and (d) Anteroposterior X-ray of the pelvis respectively at 3 months 4 years following initial operation; (e) Cross-sectional CT image of the pseudocyst on admission (red circle); (f) Cross-sectional CT image of the pelvis after removal of INFIX; (g) Anteroposterior X-ray of the pelvis following internal fixation removal. (h) Gross photograph of the pseudocyst at 2 months postoperative

tem. Concomitant injuries such as: lumbar vertebra fractures were reported as well. The patient underwent INFIX internal fixation and sacroiliac screw fixation for anterior and posterior pelvic ring fracture respectively (Fig. 2c). After surgery, the patient was transferred to our hospital's rehabilitation center. Four years postoperatively (Fig. 2d), the patient presented with a tender mass in the right lower abdomen and was admitted to our trauma center for evaluation and treatment. The patient's vital signs were stable on admission: body temperature of 36.1 °C, pulse rate at 81 beats/min, respiratory rate of 20 breaths/min, and blood pressure at 109/71mmHg. Diagnostics investigations, including a 3D CT scan of the pelvis (Fig. 2e), routine blood and biochemical tests, pointed to the formation of a deep fascial pseudocyst in the right lower abdominal wall (and Table 1). Laboratory tests showed that the patient had mild anemia, CRP was slightly elevated, while white blood cell count (WBC) and sedimentation rate (ESR) were within normal ranges. Therefore, an intraoperative puncture-aspiration of the cyst was performed for bacterial culture, which yielded no bacterial growth.

On the second admission day, the INFIX device and the right sacroiliac screws were surgically removed. During the operation, no communication (fistula) was identified between the internal fixation rod and the pseudocyst, therefore, excision of the pseudocyst was performed.

Postoperative laboratory examinations, including routine blood tests, biochemical tests, DIC routine, and infection markers, were repeated (Table 1) along with a 3D CT scan and X-ray of the pelvis (Fig. 2f and g). The patient was discharged on the third postoperative day. During a routine outpatient follow-up visit two months later, the patient's lower abdominal pseudocyst had completely subsided (Fig. 2h), with no associated pain or tenderness.

### Surgical approach

The patient described in case 1 presented with pubic symphysis disruption requiring surgical reconstruction and stable internal fixation, while the patient described under case 2 presented with a vertically unstable pattern of fracture with both anterior and posterior pelvic ring disruption (instability) (Tile C1.3) as shown in (Fig. 2a and b); this condition eventually required both anterior and posterior ring fixation. In case 1, after the patient being placed in supine position under general anesthesia, a transverse incision of approximately 10 cm was made above the pubic symphysis, followed by layer-by-layer dissection to expose bilateral superior pubic ramus fractures and the pubic symphysis. Under direct vision, the pubic symphysis was reduced and temporarily fixed with Kirschner wires. After C-arm fluoroscopy confirmed satisfactory reduction, fixation with a plate and screws was performed. Intraoperative fluoroscopy confirmed good

fracture reduction and appropriate stable internal fixation. The wound was therefore sutured after confirming the absence of any retained gauze or instruments. Subsequently, INFIX internal fixation was performed; the anterior superior and inferior iliac spines were superficially located, and a vertical incision of about 3 cm was made on each side; blunt dissection was used to separate subcutaneous tissue, avoiding the lateral femoral cutaneous nerve, to expose the anterior inferior iliac spine. A pilot hole was created, and LC2 screws of appropriate length were inserted with C-arm fluoroscopy confirming optimal depth and position. Finally, the screws were connected and fixed with a titanium rod.

In Case 2 after stabilizing the anterior ring in first priority with INFIX; subsequently, closed reduction and internal fixation was performed for the right sacral fracture. A Kirschner wire was inserted in the posterior 1/3rd, between the right anterior superior iliac spine and the posterior superior iliac spine. C-arm fluoroscopy was used until the wire appeared as a circular point located in the sacral vertebral body. The wire was gradually advanced, with repeated fluoroscopy confirming proper position, ensuring it did not enter the sacral canal or abdominal cavity. The insertion depth was measured, and cannulated screw of appropriate length was inserted.

### Discussion

The Internal Fixator (INFIX) is a commonly used method for internal fixation of anterior pelvic ring fractures [6]. Notable advantages of this method include minimal invasiveness, a relatively straightforward procedure, and shorter operation times. Several studies have endorsed its capability of achieving good fracture reduction with good functional and radiological outcomes [2, 7–10]. It is particularly beneficial for obese patients and those with urinary system injuries, as it can potentially decrease the rate of surgical incision infections [11]. Anterior pelvic ring fixation is usually simultaneously combined with other fixation methods to ensure better stability and good clinical outcome in patients presenting both anterior and posterior pelvic ring fractures.

The application of INFIX with or without additional fixation method mainly depends on the fracture type. Patients presented in the current study presented different initial fracture pattern, imposing distinct management protocol; the first patient (case 1) presented an open book (APC I; Tile B1) fracture with anterior pubic symphysis disruption while the second patient showed a vertically unstable fracture (Tile C) with both anterior and posterior ring disruption. Antero-posterior compression (APC), lateral compression (LC) or vertical shear (VS) injury of the pelvis require fixation of the anterior ring or anterior-posterior ring simultaneously [12]. In the first patient, open reduction and internal fixation of the

disrupted pubic symphysis was mandatory; additional INFIX was added to increase the strength of the internal fixation; in our opinion, the strength of internal fixation could be augmented with an additional application of INFIX and produce positive effect on the fixation stability. The results of a study conducted by Vaidya et al. [13] demonstrated that INFIX achieves a better outcome in reducing the symphyseal widening; while other scholars reported that the use of plate provide a greater anatomical reduction in the treatment of anterior ring injuries; according to the authors, INFIX only performs closed reduction of the upper and lower pubic rami fracture and does not efficiently address the pubic symphysis disruption [11]. In our patient, we have combined INFIX with a plate to achieve symphyseal widening reduction (INFIX) and rigid internal fixation (plate and screw).

Tile C pelvic fracture is characterized by both anterior and posterior ring disruption. While INFIX remains recommended for anterior ring injury, a combined closed reduction with percutaneous sacroiliac screw fixation has become a new surgical approach for posterior pelvic ring injury. In the second patient (case 2) described in our study, we have combined INFIX with posterior sacroiliac screw to achieve optimum fixation and stabilization; this treatment approach was already applied to Tile C pelvic fracture patients in literature with satisfactory results [14].

The use of INFIX as a minimally invasive treatment for unstable anterior ring fractures is not without limitations. It has been observed to be less effective in fracture reduction and fixation compared to plate and screws [11]. Additionally, INFIX is associated with complications such as anterolateral femoral cutaneous nerve injury, ectopic ossification, and femoral nerve paralysis [4, 15]. Infection is an infrequent complication of INFIX, with a systematic review and a meta-analysis indicating an incidence of 3% [16], and 2.3% [4] respectively.

The common risk factors for postoperative infection include diabetes, liver cirrhosis, smoking, intravenous drug use, and significant Morel-Lavallee lesions [5]. A systematic review indicated that most patients' infections occurred within ten weeks postoperatively, with a minority presenting late, beyond six months [16].

Despite the presence of numbers of potential complications listed above, cases of abdominal wall cysts following INFIX procedure has not yet been described in literature; in the current article, two patients developed lower abdominal cysts six months and four years respectively post- INFIX fixation. The question of the etiology of the cyst was not clearly understood; however, on Pelvic 3D CT imaging, the lower abdominal cysts were found to communicate with the channel created by the INFIX connecting rod. We hypothesized that the pseudocysts' development could partly be attributed to the formation

of a dead space between the subcutaneous tissue and deep fascia during intraoperative placement of the connecting rod, potentially increasing the risk of infection.

The patient's cyst formation was assumed to be created when the connecting rod of INFIX was inserted. Instead of making one successful passage through the subcutaneous tissue, INFIX's connecting rod is inserted multiple times, creating a potential tunnel under the skin through which fluid or blood from the pelvic cavity drains out to form a cavity. The enlarged size of the cavity leads to the corresponding clinical symptoms. Since there was no evidence of depinning at the tip of the connecting rod or at the tail cap of the LC2 screw during the physical examination, we do not believe that the cyst formation was caused by tip friction.

The hypothesis of postoperative lower abdominal cyst complicated with infection was controversial; in case number one, the bacterial culture reported a presence of staphylococcus aureus whereas the corresponding investigation in case number two presented negative findings; however, preoperative laboratory blood test in both patients reported abnormal increase in infections markers (Table 1). We hypothesized that the presence Staphylococcus Aureus in the sample obtained in patient one could be due to sample contamination as Staphylococcus Aureus could be present at the surface of a normal skin. Although there is a potential possibility of sample contamination in the first patient, the abnormal increase in inflammation markers in both patients was not clearly understood; we still associated infection as the only cause even though the etiology was uncertain. Additionally, out of concern for the potential spread of infection, we removed the INFIX internal fixation because it was too close to the cyst, and the fracture healing was already achieved in both cases.

Additionally the cyst in both patients was confined to the lower abdomen without involvement of the internal fixation. Therefore, we opted to remove only the INFIX during surgery instead of excising the cyst. Postoperative management involved oral cefixime for anti-infective therapy. Both patients were followed up at the outpatient department at one, two and three months postoperatively. The pseudocysts in the lower abdomen had resolved, and the patients reported no further discomfort. Therefore, the authors suggest that in such patients, oral antibiotics can be given after surgical aspiration and removal of INFIX internal fixation to prevent infection, rather than complete removal of the cyst, and if necessary, pressure dressing of the cyst can be applied.

## Conclusions

We presented two rare cases of lower abdominal pseudocysts following INFIX internal fixation. We believed these pseudocysts were associated with the subcutaneous

tunnel created by the INFIX connecting rod structure. To our knowledge, such cases have not been previously reported, thus providing insights for managing similar complications. However, given the incomplete understanding of the causes and triggers, additional research is required to elaborate on the prevention and treatment approach of these complications.

#### Author contributions

Acquisition of data: Y.J.Y, J.B.J and G.R.K. Drafting of manuscript: Y.J.Y. Critical revision: Y.F, G.R.K. The author(s) read and approved the final manuscript.

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#### Data availability

All the data are contained within this manuscript.

#### Declarations

#### Ethics approval and consent to participate

Informed consent was obtained from all subjects involved in the study.

#### Consent for publication

Written informed consent was obtained from the patients for publication of the case report and accompanying images.

#### Competing interests

The authors declare no competing interests.

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