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Case Report

# Endovascular assisted removal of intrapelvic lag screw after intramedullary proximal femoral nail: A case report and literature review

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ABSTRACT

*Background:* Trochanteric fractures are very common hip injuries often fixed with intramedullary nailing as the recommended treatment. Medial lag screw migration of the intramedullary nail system is an uncommon complication. The objective of this case report is to highlight the importance of optimal reduction in hip fractures and the need for a multidisciplinary approach with vascular assistance in intrapelvic lag screw migration.

*Case report and results:* We collected 24 cases of intrapelvic migration of the lag screw in the latest literature. Here, we report the case of a 68-year-old patient with medial pelvic migration of the lag screw after minor trauma and its removal using peroperative simultaneous angiography. After removal of the osteosynthesis material, a revision to a total hip arthroplasty was performed.

*Conclusion/discussion:* This is the first case demonstrating an endovascular assisted removal simultaneous with revision surgery. We suggest that a multidisciplinary approach is warranted in which the orthopedic surgeon is assisted by a vascular surgeon. An endovascular assisted open removal of the lag screw with conversion to a hip arthroplasty is considered a safe treatment.

## Introduction

Trochanteric fractures are common hip injuries and account for 50 % of all fragility hip fractures. It is projected that 2.6 million people worldwide will suffer from these fractures in 2025 [1,2]. Open reduction and internal fixation (ORIF) with a dynamic hip screw or proximal intramedullary femoral nail is the treatment of choice. Fixation with intramedullary nails offers biomechanical advantages and has been shown to be superior in outcome than any other device [3]. A failure of fixation is seen in approximately 5 % of all these trochanteric fractures [4].

Primary medial migration of the lagscrew is described by Law et al. [6]. Medial intrapelvic migration of the lag screw is a rare complication after internal fixation with an intramedullary device. Kim et al. identified only 15 cases in a 2019 review article [5].

We present a case of a patient with medial pelvic migration of the lag screw after minor trauma and its removal using peroperative simultaneous angiography. We will discuss different treatment strategies and the safest approach to prevent further intrapelvic damage.

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## Case report

A 68-year-old woman presented at the Emergency Department after a mechanical low-energy fall on the left hip. She reported left-sided hip pain and no ability to weight bear. She had a history of asthma, diabetes type II, COPD, and chronic renal failure. 4 weeks prior to the ER presentation, the patient underwent an intramedullary femoral nailing with a gamma 3 nail (Stryker, Belgium) for an intertrochanteric hip fracture. Several days after hospital discharge, she already felt progressive hip pain and swelling. Clinical examination showed groin pain and pain during passive mobilization of the injured hip. AP pelvis and left hip radiographs showed a failure of the implant with medial pelvic migration of the lag screw and perforation of the femoral head and medial acetabular wall (Fig. 1a). An urgent 3D contrast-enhanced computed tomography (CT) scan was performed and confirmed the lag screw located deep in the pelvis, between the internal and external iliac vessels, 6 mm anterior to the internal iliac artery (Fig. 1B, C). Minimal intra-abdominal fluid was present without additional intra-abdominal injuries.

Urgent removal of the lag screw was essential to prevent potential further intra-abdominal injury. An endovascular assisted lag screw removal, with the possibility of immediate vascular embolization of the internal iliac artery, was considered safer than a standard open removal. A 6 Fr Destination guiding sheath (Terumo, Leuven, Belgium) was introduced by the vascular surgeon in the contralateral common femoral artery and progressed to the left common iliac artery. An embolization catheter (2.7 Fr Progreat, Terumo, Belgium) was then advanced into the internal iliac artery branch most proximal to the screw. Simultaneously, an open anterolateral approach was performed for the nail and lag screw removal under serial angiography with the use of contrast (Fig. 2). There were no signs of contrast extravasation. After removal, internal and external iliac veins and arteries were intact and no additional embolization was necessary.

After removal of the lag screw, femoral nail and femoral head, the revision to a total hip arthroplasty was performed. The acetabular defect was filled with autografts, harvested from the femoral head. A total hip replacement was performed using a long femoral uncemented stem and cemented acetabular cup, due to the peroperative osteoporotic bone quality (Fig. 4). Full range of motion and partial weight-bearing were allowed and further postoperative period was uneventful.

After thorough inspection of the removed hardware, a little scratch on the nail next to the groove was found (Fig. 3a, b). This finding raised the suspicion of the set screw not to be secured correctly in the groove of the lag screw. Because of this error, the lag screw was able to migrate medially.

## Discussion

Trochanteric hip fractures are very common hip injuries in elderly patients. Intramedullary nailing is considered a safe internal fixation technique with very low complication rates and the treatment of choice for these types of fractures [7]. In a study by Yeganeh et al., comparing intramedullary nailing with Dynamic Hip Screw, intramedullary nailing is recommended as the first treatment option, due to reduced hospital stay and less non-union [8]. Failure of fixation was seen in approximately 5 % of all these trochanteric fractures.

The so-called '*Z*-effect phenomenon', described by Werner-Tutshku et al. in double lag screw devices is a well-known cause for migration of the femoral neck element [9]. However, the biomechanical force between a single device (e.g. gamma nail) and a double lag screw device is quite different. In a single lag screw device, specific biomechanical conditions are required for medial migration of the lag screw to occur. Weil et al. identified toggling and propagation of the lag screw medially with respect to the proximal fracture fragment as the most significant factor. This is caused by deficiency of the lateral buttress on the femoral cortex, medial calcar instability of the fracture and nonunion. Additionally, bidirectional cyclic loading (e.g. during gait) and unloading (e.g. soft-tissue tensioning) at the hip joint can result in propagation of the lag screw medially in unstable pertrochanteric fractures. [10]

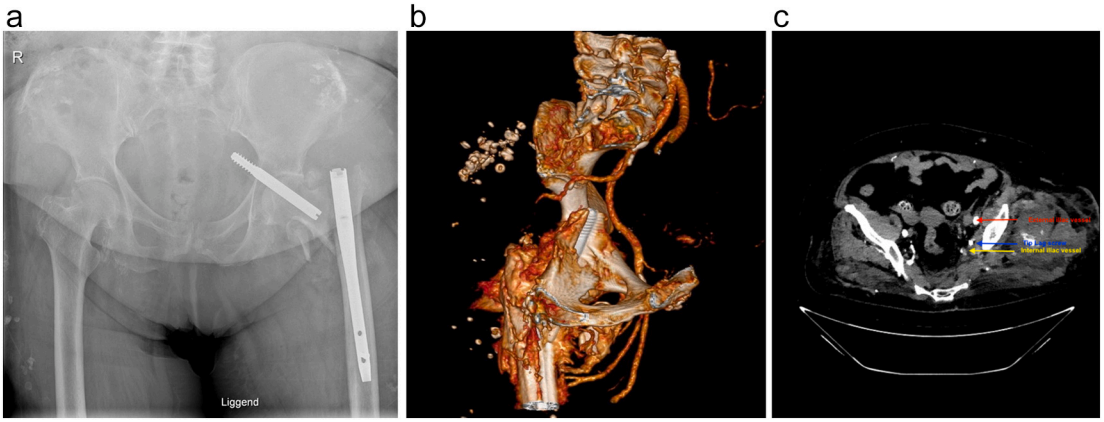


**Fig. 1.** AP Pelvis and Hip radiograph, showing failure of reduction and medial pelvic migration of the lag screw with perforation of the femoral head and medial acetabular wall (A). A 3D contrast-enhanced computed tomography scan showing the lag screw located deep in the pelvis, between the internal and external iliac vessels (B,C).

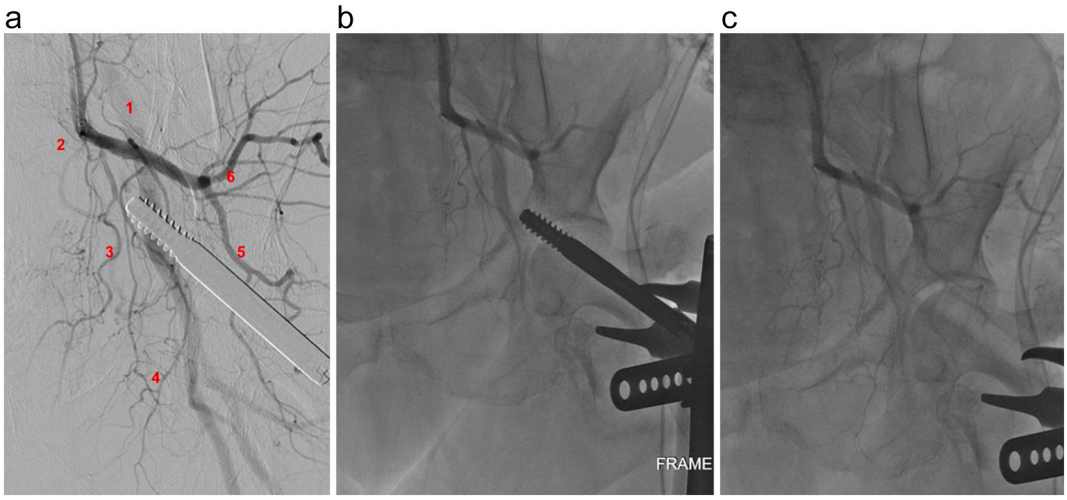


**Fig. 2.** Peroperative endovascular fluoroscopic images show intact iliac arteries and veins before (A), during (B) and after removal. No injuries of the vessels were observed on final angiography (C). 1: External iliac artery, 2: Sheath in internal iliac artery 3: Superior vesical artery, 4: Obturator artery, 5: Inferior gluteal artery, 6: Superior gluteal artery.

**Fig. 3.** Macroscopic image of the removed lag screw (A). The red arrow demonstrates the defect, caused by the set screw deviated from the groove (B).

Georgiannos et al. identified some key points to prevent complications or implant failure after intramedullary fixation. First of all, optimal and anatomic reduction of the fracture should be the goal. To maintain stability, any damage to the femoral head and over-reaming of the trajectory must be avoided. A lag screw of an appropriate length should be used, respecting the tip-to-apex distance (TAD) $< 25$ mm. The lag screw should be positioned inferiorly or centrally in the AP view and central in the lateral view. The set screw locking mechanism should be correctly secured in its gutter to prevent untenable migration of the lag screw. A radiographic follow-up before discharge from the hospital should always be performed [11]. The radiographic predictors for fixation failure (TAD, lag screw position and quality of reduction) should always be examined peri- and postoperatively [12]. We hypothesize that in our case the incorrect engagement of the set screw in the groove with a sub-optimal anatomic reduction could not offer an adequate stabilization of the lag screw causing loosening and medial migration.

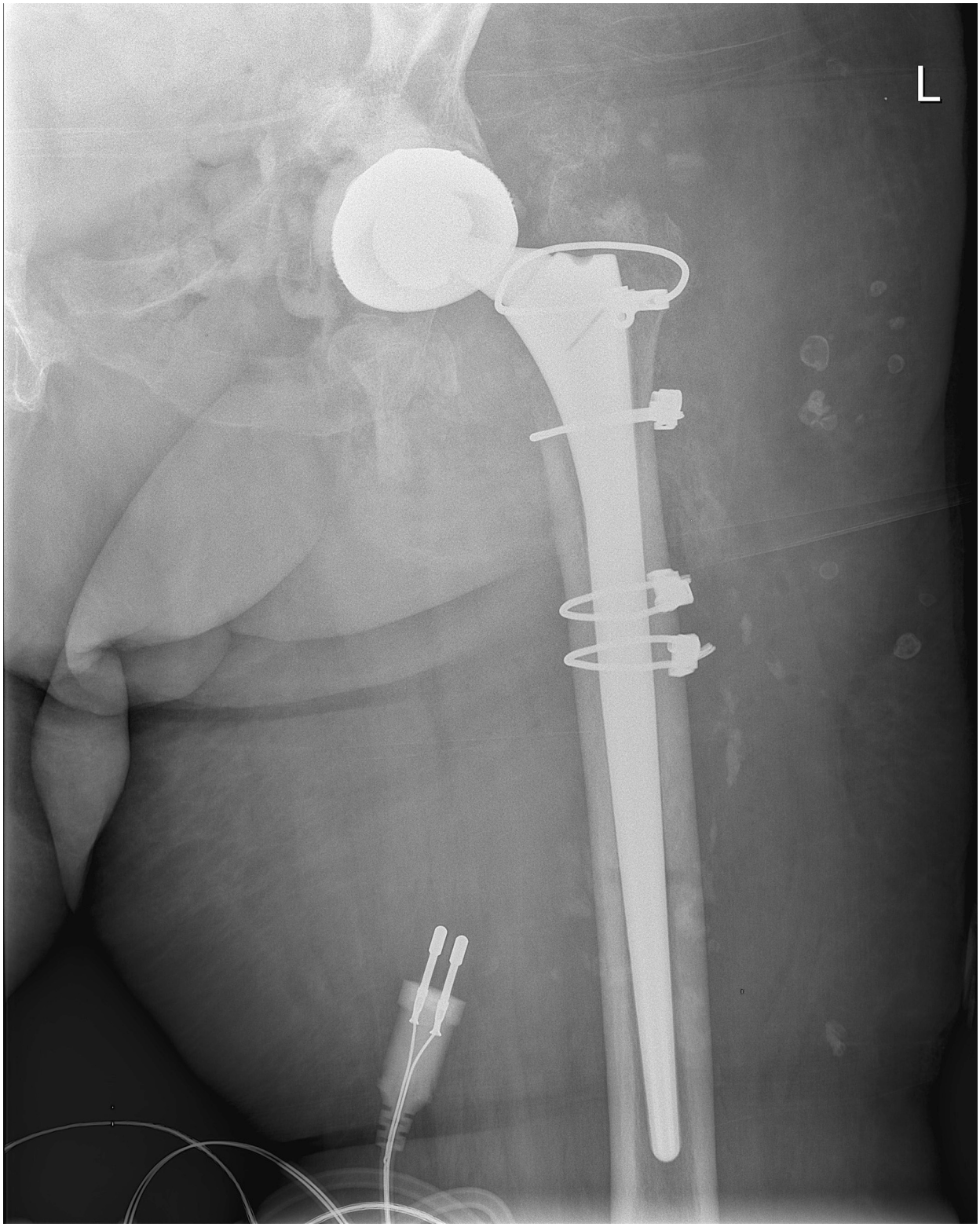


**Fig. 4.** Postoperative anteroposterior radiograph of the left hip after total hip replacement.

Medial migration of the lag screw is a rare complication, occurring approximately <1 % after internal fixation [13]. Pelvic penetration through the acetabulum is even more rare. Until now, 24 cases of intrapelvic migration of the lag screw are described in the literature (Table 1). In most cases, primary osteosynthesis with the short gamma 3 nail was used at the index operation. After implant failure, revision is always required. When the fracture was considered to be fully healed, removal of the implants should be sufficient. The majority of surgeons chose to convert to a total hip arthroplasty with an open femoral approach [14,15]. In only two cases, the iliac branches were preventively embolized pre-operatively to prevent excess hemorrhage during surgery. [15] As this can lead to major bleeding resulting in patient death through exsanguination [16]. Further damage can hypothetically be enforced by the fibrosis process, walling off the lag screw in scar tissue. But this can make the attempted removal more complicated.

Kuroshima et al. used a laparoscopic approach to remove the lag screw intra-abdominally [17]. The risk of major and uncontrollable hemorrhage remains very high with this approach. Moreover, there is an inherent risk to damage intra-abdominal organs and nerves in the vicinity of the iliac vessels. We performed an endovascularly assisted open removal of the screw, with later conversion to a total hip arthroplasty. We consider this approach a very safe strategy to prevent major bleeding complications during the removal of these migrated screws. Preventive embolization of the iliac vessels was not considered in our patient, as there was no acute perforation of any iliac branches. The risk of gluteal claudication and other embolization-related pain syndromes was considered greater than the risk of sudden iliac trauma during the procedure.

We believe that for these cases, a multidisciplinary approach is warranted in which the orthopedic surgeon is assisted by a vascular colleague to prevent potentially fatal complications. An extensive pre-operative planning should be made. A 3D contrast-enhanced computed tomography (CT) scan is a must for localization of the lag screw in the deep in the pelvis, to check for intrapelvic or vascular damage and to estimate the possibility of major vascular damage during surgery. The lag screw should be removed assisted by endoscopic live images of the vessels to see possible vascular damage during surgery.

**Table 1**
Review of 24 cases of intrapelvic migration of the lag screw.

| Authors | Used implant | Approach | Revision |
|---|---|---|---|
| Kohei Kuroshima (2021) | Gamma 3 long nail (Stryker, Kalamazoo, Michigan, US) | Laparoscopic removal | Removal implant |
| Yong-Woo Kim (2019) | Gamma 3 fixation nail [TFN], Stryker Howmedica, Kalamazoo, MI, USA. | Open femoral approach | THR |
| Takasago et al (2014) | Short Gamma-3 nail (Stryker, Tokyo, Japan) | Open femoral approach | THR |
| Lee et al. (2017) | Short Gamma-3 nail (Stryker, Kalamazoo, Michigan)/lag screw | Open femoral approach | THR |
| Akçay et al. (2013) | Proximal Femoral Nail - unknown | Open femoral approach | Removal implant |
| Thein E (2014) | Short Gamma 3 nail (130°; 11 × 180 mm, Stryker Corporation, Kalamazoo, MI, USA) | Intrapelvic approach (branch embolized pre removal) | THR |
| Robinson SJ (2011) | Intramedullary Hip Screw (Smith and Nephew, Memphis, Tennessee) | Intrapelvic approach (branch embolized pre removal) | Removal implant |
| Jung-Woo Lee, M.D (2017) | Gamma 3 nail | Open femoral approach | Death |
| Xinning Li (2010) | Short Gamma 3 nail | Open femoral approach | Revision lag screw |
| Dimitrios Georgiannos (2016) C1 | Long gamma nail | Open femoral approach | Dynamic condylar screw (DCS) plate |
| Dimitrios Georgiannos (2016) C2 | Long gamma nail | Open femoral approach | Dynamic condylar screw (DCS) plate |
| Nagura et al (2015) | Short Gamma-3 nail (Stryker, Tokyo, Japan)/lag screw | Open femoral approach | Removal IMHN |
| Liu et al. (2014) | Proximal Femoral Nail Antirotation (PFNA; manufacturer not specified)/helical blade | Open femoral approach | THR |
| Akçay et al. (2013) | Proximal Femoral Nail (PFN; manufacturer not specified)/lag screw | Open femoral approach | Removal lag screw |
| Frank et al. (2011) | Trochanteric Fixation Nail (TFN; Synthes, Inc., West Chester, Pennsylvania)/helical blade | Open femoral approach | Revision lag screw |
| Li et al. (2010) | Short Gamma-3 nail (Stryker, Kalamazoo, Michigan)/lag screw | Open femoral approach | Revision lag screw |
| Lucke et al. (2010) | Short Gamma-3 nail (Stryker, Mahwah, New Jersey)/lag screw | Open femoral approach | THR |
| Tauber and Resch24 (2006) | Short Gamma-3 nail (Stryker, Mahwah, New Jersey)/lag screw | Open femoral approach | THR |
| Ramkumar et al. (2005) | Trochanteric nail (DePuy ACE — Johnson & Johnson) | Extra peritoneal transabdominal approach (intrapelvic approach) | THR |
| Lozano-Alvarez C et al. (2013) | Short Gamma-3 nail | Open femoral approach | Removal lag screw |
| Flint JH et al (2010) | Long Gamma-3 nail | Open femoral approach | THR |
| Lal H et al. (2012) | Long proximal femoral Nail | Open femoral approach | Removal lag screw |
| Heineman DJ et al. (2010) | Gamma nail (Stryker, Mahwah, NJ) | Open femoral approach | THR |
| Pinheiro AC et al. (2016) | Gamma3 Stryker | Open femoral approach | Removal implant and revision with plate and sliding screw. |

## Conclusion

Pelvic penetration after intramedullary nailing is considered very rare, as we only collected 24 cases in the latest literature. Treatment of these cases should be considered as an operation with a high complication ratio or even fatal outcome. Therefore, a multidisciplinary approach is needed with pre-operative planning. An endovascular assisted open removal of the screw assisted by endoscopic live images, with conversion to arthroplasty is considered the safest treatment.

## Declaration of competing interest

The authors declare that there is no potential conflict of interest relevant to this article.

## Acknowledgements

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