

Case Report

Intrapelvic migration of the hip screw of a proximal femoral nail: report of two cases and review of the literature

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ABSTRACT

Two cases of medial migration of the hip screw in cases of cephalon-medullary nailing for the treatment of extra-articular proximal femoral fractures are reported. The first case was revised to hemiarthroplasty, that was subsequently complicated with infection and death of the patient, while the second was revised to a similar device with favorable outcome. A review of the literature is performed in order to identify the contributing factors that result in the medial migration of the hip screw. Emphasis is given in further reporting of similar cases in order to abolish this potentially lethal complication.

Keywords: Medial migration of the hip screw, Cephalo-medullary nail, Pterochanteric fractures

INTRODUCTION

Proximal femoral nailing for the treatment of inter-subtrochanteric fractures was developed based on the principles of Dr Kutscher, it entered widespread clinical use and a number of devices with similar features were developed to cover the market needs. Currently, these devices are considered the main workhorse for the management of inter-subtrochanteric fractures in many parts of the world. Despite the clinical success of the proximal femoral nailing, a number of complications were associated with these devices. One of the most uncommon is intrapelvic migration of the hip screw.¹⁻¹⁸ Apart from the two presented cases in this article, twenty cases have been documented in the international literature in English language. Weil, Gardner et al attempted in 2008 to give a hypothesis in order to understand the biomechanical contributors to this phenomenon.¹⁹ In the laboratory, they simulated a basicervical fracture and tested a wide variety of commercial implants. They concluded that none of the tested implants was immune from medial migration and that a number of reasons can contribute to the phenomenon, such as the quality of the bone, the

morphology of the fracture, intraoperative complications such as drill penetration of the articular surface, as well as the correct placement of the device. In the current article we would like to present two more case reports of medial migration of the femoral nail screw, review, and expand the existing literature in order to identify the trends in dealing with this rare complication.

CASE REPORT

An 88-year-old gentleman was seen in our hospital following a fall while at home. Despite his age, his overall health was good and claimed that he was able to mobilize unassisted before his fall. On radiographs he appeared to have a reverse oblique comminuted fracture proximal femur 31-A3.³ According to the AO classification with a long medial butterfly segment extending to the subtrochanteric region (Figure 1a and 1b). Due to the morphology of the fracture, it was decided by the operating surgeon to treat it with a long gamma nail (Stryker Howmedica, Kalamazoo, MI, USA) that was performed the following day (Figure 2). The operation was documented as uneventful, the fracture was reduced by

traction and a 370 mm long gamma nail was inserted that was locked statically distally. The immediate postoperative period was uncomplicated. Due to his age, the patient was allowed to fully weight-bear and was discharged home three days following his operation. The stitches were removed in the community and the patient was seen upon his request 3 weeks following his discharge due to gradual increasing pain at his operated hip while ambulating.

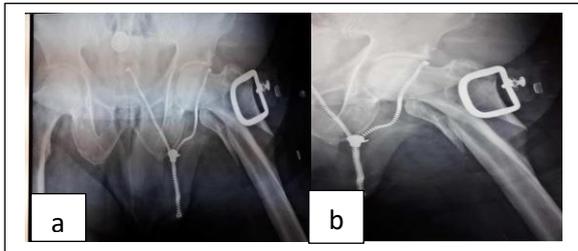


Figure 1 (a, b): Pre-operative x-ray case 1.

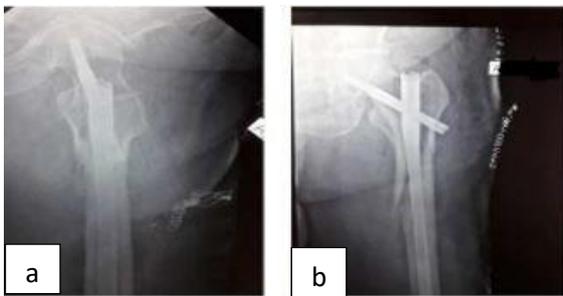


Figure 2 (a, b): Post-operative x-ray.

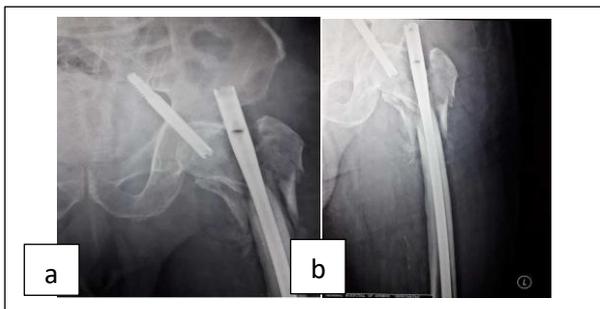


Figure 3 (a, b): Intra-abdominal migration of hip screw of case 1.

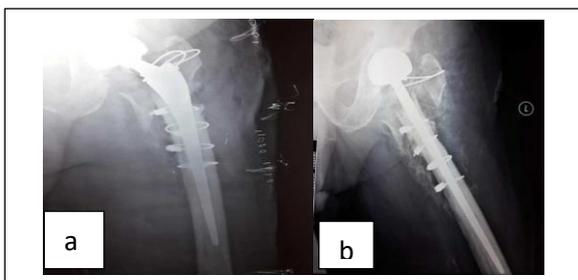


Figure 4 (a and b): Post revision of case 1.

On radiographs, medial intraabdominal migration of the femoral screw was noted (Figure 3a and 3b). He was

readmitted in the orthopedic ward. On readmission, the patient was well, claimed he did not have any change of his bowel habits, he was afebrile, his abdomen was soft without evidence of any pathology and his lower limbs pulses were palpable and symmetrical arterial perfusion. Regarding his re-admission hematological profile, his hemoglobin was 800 g/dl and White Blood Cells $8,20 \times 10^3 / \mu\text{l}$ of which 71.4% neutrophils. His C-Reactive Protein (CRP) was 157. The patient was taken to the operating theaters two days following his readmission once he had been hematologic ally optimized. Through an extensile lateral approach, the femoral nail and the femoral screw were removed with surprising relative ease. It was noted that the locking screw of the gamma nail was jammed and had never engaged the femoral-neck screw. There was no local evidence of any infection. The removed metalwork as well as tissue samples from the region were sent to microbiology. It was decided by the operating surgeon to proceed with a definite procedure and following reconstruction of the femoral shaft with cerclage wires, a cemented hemiarthroplasty was inserted (Figure 4a and 4b). His immediate postoperative period was uneventful. The microbiology reports of the intraoperative samples were received after six days that identified rare colonies of *Enterobacter cloacae* with multiple sensitivities. He was administered appropriate antibiotic therapy, however soon after there was wound dehiscence with increase of the inflammatory markers. During the following seven weeks the patient was taken to the operating theaters 3 times for wound debridement and removal of any loose metalwork. Microbiology samples taken during the reoperations revealed coagulase negative staphylococcus and *Acinetobacter baumannii*, both with multiple resistance in antibiotics. His general health progressively deteriorated due to continuing sepsis that resulted in respiratory and kidney failure. The patient deceased while in the hospital 62 days following his revision surgery.

Case report 2

A 66-year-old lady attended the emergency department of our hospital after injuring her left hip following a simple fall while at home. She had a history of Diabetes mellitus (DM), depression and hypothyroidism, all of which were controlled by oral medication. Clinically and radiologically she had sustained a multi-fragmentary pertrochanteric fracture, which according to the AO classification classified as 31-A.2.2. (Figure 5a and 5b). The patient was operated the following day with a proximal femoral nail (spectrum femoral nail, SanaMetal, Hungary) (Figure 6). The intraoperative and immediate postoperative period was uncomplicated, and the patient was allowed to fully weight bear the first postoperative day and discharged home three days following her operation. The patient was seen at the outpatient department at two weeks following the operation for stitch removal. No radiograph was obtained at that visit. Six weeks after her operation, the patient attended the clinic complaining for increasing pain at her operated hip and inability to walk. Radiographs demonstrated intraabdominal migration of

the hip screw (Figure 7a and 7b). Computer tomography (CT) of the region showed that the femoral screw had been placed fairly superior and posterior in relation to the center of the hip, and intact bone was noted inferior and central-anterior regions of the femoral head. The patient was taken to the operation theater three days following the admission, and on the traction table, the old incision was opened, and the nail was removed. It was noted that the locking screw was missing, suggesting that the surgeon forgot to put it. The femoral screw was removed with relative ease, after managing to forward the guide wire in the screw stem (Figure 8a and 8b). The femoral screw was sent for microbiology. A gamma third generation nail (Stryker Howmedica, Kalamazoo, MI, USA) was inserted inferiorly and central-anteriorly in comparison to the previous track (Figure 9). A solid purchase was achieved intraoperatively. After the locking screw insertion, a small amount of cement was inserted at the supero-lateral aspect of the femoral screw at its junction with the femoral nail, in order to decrease any movement between the femoral screw and the nail. The immediate postoperative period was uncomplicated, and the patient was discharged home with instruction to mobilize only in bed for six weeks. Following this period, the patient was allowed to weight bear. At its latest follow up at two years post-revision surgery, the patient is happy, mobilizing well, without pain and without limitation.

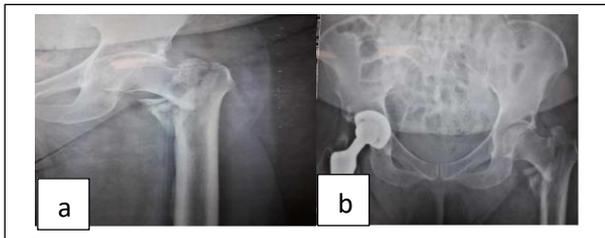


Figure 5: Pre-operative X-ray case 2.



Figure 6: post-operative X-ray case 2.

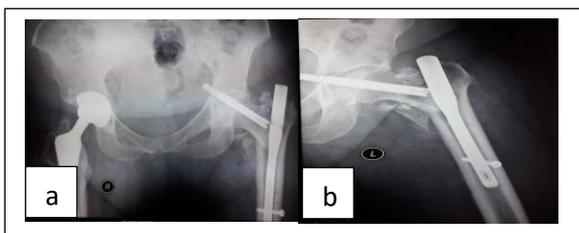


Figure 7: Intra-abdominal migration of hip screw case 2.

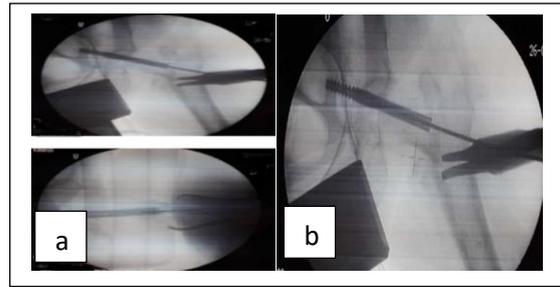


Figure 8: Intra-operative images for removal of migrated screw case 2.



Figure 9: Post revision X-ray of case 2.

DISCUSSION

To the best of our knowledge, our first presented case is the second described in the existing literature describing medial migration of a long reconstruction nail (long gamma nail, stryker, Minnesota, USA).¹⁰ In our case, the fracture involved the pertrochanteric area of the femur with multi-comminution of the medial buttress, extending distally. The surgery was documented as uneventful and the hip screw was inserted with a Tip-to-Apex Distance (TAD) marginally over 25. The operating surgeon did not insert the set screw properly and this probably contributed to the dislodgement of the hip screw. A one-stage revision was decided by the operating surgeon despite the presence of a high CRP on the grounds of the complete clinical absence of gastrointestinal pathology, his general good health and the absence of any intraoperative findings suggesting of an infection. However, the femoral nail was found to be infected. It is difficult to associate the failure of the implant with the infection and whether this contributed to the subsequent infection of the hemiarthroplasty as a variety of different microbes were cultured during the debridement of the infected wound. In respect of the second case there was significant comminution involving the medial buttress of the femur. The set screw was not inserted, allowing again mobility at the hip screw- femoral nail interface. During revision of the devise, a small quantity of cement was introduced at the superomedial junction of the hip screw with the femoral nail in order to reinforce the region and obstruct any mobility of the hip screw.

Table 1: Overall review of existing cases, including the two presented in the current paper.

Publication	Year of Publication	Age of patient	AO Classification	Type of implant	Cephalomedullar angle	Set screw	Time to discover failure	Salvage operation
Saffar et al ¹	2005	71	31-A3.3	ACE Trochanteric nail*	130 degrees	Not applicable	8 weeks	One stage revision to THR
Resch et al ²	2006	84	31-A2.3	Gamma nail**	Not mentioned	not mentioned	8 weeks	One stage revision to THR
Burghardt et al ³	2010	75	31-A2	Gamma 3 nail**	130 degrees,	yes	19 days	One stage revision to Hemiarthroplasty
Burghardt et al ³	2010	68	31-A3.3	Gamma 3 nail**	Not mentioned	not mentioned	6 months	One stage revision to Hemiarthroplasty
Heffernan et al ⁴	2010	77	31-A2	Gamma 3 nail**	125 degrees	yes	10 weeks	Revision of implants
Heineman et al ⁵	2010	83	31-A2	Gamma nail**	Not mentioned	not mentioned	3 weeks	Two stage revision to THR
Flint et al ⁶	2010	82	31-A3.3	Gamma nail**	Not mentioned	yes	4 months	One stage revision to THR
Robinson, et al ⁷	2011	83	31-A2	IHS***	Not mentioned	not mentioned	11 months	Removal of implants
Takigami, et al ⁸	2011	79	31-A2	PFNA****	Not mentioned	not mentioned	3 months	One stage revision to THR
Lal, et al ⁹	2012	40	31-A3.3	X2 lag screw construct	Not mentioned	not mentioned	12 weeks	Removal of the cervical screws
Lozano-Alvarez, et al ¹⁰	2013	87	31-A2.3	Gamma 3 nail**	125 degrees	yes	3 months	Removal of implants
Lozano-Alvarez, et al ¹⁰	2013	75	31-A2.3	Gamma 3 nail**	125 degrees	yes	7 months	One stage revision to THR
Thein, et al ¹¹	2014	69	31-A3	Gamma 3 nail**	130 degrees	Inappropriate placement	5 weeks	One stage revision to THR
Takasago, et al. ¹²	2014	63	31-A1.2	Gamma 3 nail**	Not mentioned	yes	6 weeks	Two stage revision to THR
Gomes, et al ¹³	2016	88	31-A1	Helical blade construct	130 degrees	not mentioned	2 months	Removal of implants
Pinheiro, et al ¹⁴	2016	92	31-A2.2	Gamma 3 nail**	130 degrees	not mentioned	6 weeks	Revision to other implant
van Hoef, et al ¹⁵	2016	81	31-A2	Gamma 3 nail**	Not mentioned	yes	3 months	One stage revision to THR
Lee, et al ¹⁶	2017	72	31-A2.3	Gamma 3 nail**	120 degrees	yes	2 months	Trial of removal of implants
Yong-Woo, et al ¹⁷	2019	83	31-A2	DLT nail*****	125 degrees	no	3 weeks	Two stage revision to Hemiarthroplasty
Nayak, et al ¹⁸	2019	65	31-A2.2	PFNA II*****	130 degrees	not mentioned	8 weeks	Removal of implants
Present report	2020	88	31-A3.3	Long Gamma nail**	125 degrees	no	4 weeks	One stage revision to Hemiarthroplasty
Present report	2020	66	31-A2.2	SFN*****	125 degrees	Inappropriate placement	6 weeks	Revision to Gamma 3 Nail

*DePuy ACE - Johnson&Johnson , Warsaw, IN, **Gamma nail system, Stryker, Mahwah, New Jersey, ***Intramedullary Hip Screw, Smith&Nephew, Memphis, Tennessee, ****PFNA Synthes, Oberdorf, Switzerland, *****Dyna locking trochanteric (DLT) nail, U&I, Uijeongbu, Korea, ***** Spectrum Femoral Nail, SanaMetal, Hungary

Table 2: Approach for removal of hip screw, perioperative complications and documented outcome in all published cases including the presented in this article.

Approaches for removal of screw	Number of cases
Through acetabular defect	20
Transabdominal approach	2
Perioperative complications	
None reported	11
Sepsis/infection	2
Death related to revision surgery	2
Varus malunion	4
Cut out of revision device	1
Outcome	
Independent ambulation	7
Ambulation with assistance	8
Bound to wheelchair	1
Not reported	3
Death from unrelated cases	1

The complementation of the construct with cement has not been previously described in the literature to the best of our knowledge. One could argue that the cement could prevent the bony consolidation of the fracture at the area, but we felt that its limited use increased the stability of the construct especially in view of the tract of the previous implant and the excessive weight of the specific patient.

Following review of the existing literature, a common feature in most reported cases involves the comminution or insufficiency of the medial buttress of the femur. There are only two exceptions. In the first case that was published by Thein et al, the fracture was classified as 31-A3 according to the AO classification system with intact medial cortex, however the fracture was mal-reduced with a slight rotational component and one can speculate that this mal-reduction resulted in insufficiency in the medial buttress.¹¹ In the second case however, that was reported by Gomes PL et al, there was no mal-reduction and the medial cortex was intact.¹³ We can speculate therefore that insufficiency of the medial buttress of the femur is only one of the contributing factors that results in medial migration. Werner-Tutschku et al were the first to suggest a possible mechanism for medial migration in the PFN (Synthes Produktions, GmbH, Bettlach, Switzerland).²⁰ The specific nail has two proximal screws, a superior anti-rotational screw and an inferior larger lag screw. They noticed that in 7.1 % of their reported cases there was a proximal migration of the superior anti-rotational screw and lateral migration of the inferior lag screw. They called this phenomenon as the “Z-effect”. They believed that the most important single factor for the creation of the “Z-effect” was varus mal-reduction before nail insertion. Weil, Gardner et al produced a biomechanical study that attempted to reproduce the medial movement of the femoral screw in vitro.¹⁹ In their study, they tested five commercially used implant, the PFN-a (Synthes,

Switzerland), the gamma-3 (Stryker, NJ, USA), the IMHS (Smith & Nephew, Memphis, TN, USA), the TFN (Synthes, Paoli, PN, USA) and the PFN (Synthes, Switzerland) in order to identify implant related factors that could contribute in the migration of the hip screw. They presumed a medial calcar insufficiency and mechanically loaded a hip simulator. According to their results, medial migration of the femoral neck component could be reliably reproduced in all tested devices. They felt that this phenomenon is an inherent property of the tested devices regardless of the number of femoral neck screw, different sliding interfaces, or the use of either lag screws or helical blades. On the clinical setting, according to the published cases, there are only five commercially used devices that have been associated with medial migration of the hip screw. One more commercial device is reported in the current article. The devices are summarized in table 1. This discrepancy may be due to non-reporting of similar cases and not due to an inherent property of described cephalon-medullary devices. In our opinion a detrimental cause for the medial migration of the cervical screw, is the incorrect engagement of the set screw that fixes the cervical to the femoral component, present in most but not all devices. In our cases the set screw was either absent or jammed. In the existing literature there is mention of the set screw only in 11 reports, in one case the device was designed not to have a set screw and in two of them the authors mentioned that the set screw was not used in the primary procedure.¹ Overall, few of the authors focused on its existence or its insufficiency, something that is difficult to judge if not carefully inspected as the cervical component had already dislodged from the medullary implant. We would suggest a ring-construct at the lateral aspect of the cervical component, of a diameter that would be bigger than the hole of the medullary component that normally engages the cervical sliding screw. This mechanical feature would not forbid the medial displacement but would prevent the complete dislodgement of the cervical screw and would not allow excessive migration beyond the cussing layer of the iliacus muscle. The time period between the primary operation and the development of clinical symptoms varies widely and ranges between 19 days 3 and 11 months 7 as seen in table 1. Many health authorities around the world do not review the elderly that have sustained an intertrochanteric fracture beyond the early postoperative period. We feel that the inconsistency of the presenting clinical symptom and the rarity of this complication does not justify regular radiographic surveillance as most of them have significant comorbidities and difficulties in travelling to their local hospital. Treatment options vary widely and tend to be individualized per case as seen in table 1.

In most cases the intramedullary device was revised in a hemiarthroplasty or a total hip arthroplasty whether in one or two stages.^{1-7,10-12} Other options included revision to a Dynamic Hip Screw (DHS), exchange of the lag screw into a shorted one or removal of the metalwork.^{4,7,10,13,14,16,18} The quoted reasons for this variation included the morphology of the fracture, the progression of the healing

process, the destruction of the femoral head and the acetabulum by the cervical component, the fear of laceration of intraabdominal content and the general health of the patient. Other factors that could have influenced the decision of the treatment could include the surgeons experience and the availability of appropriate alternative devices. Complications that have been reported include intra-operative death, infection intraoperative bleeding during the removal of the femoral screw and laceration of the intestines and early dislocation of a total hip replacement.^{2,5,16} Follow up of these cases has not been systemically documented and it is very difficult to reach any safe conclusions. Out of the eight cases that the treating surgeon attempted to preserve the femoral head, four were documented to have varus malunion in the long term.^{9,10,13,18} A summary in respect of follow up period and documented outcomes are presented in Table 2.

CONCLUSION

To conclude, we need to emphasize that medial migration of the hip screw in cases of cephalon-medullary nailing has not as yet been fully understood either on clinical grounds or biomechanically. Further reporting is of paramount importance and should be actively encouraged in order to reach safe conclusion as to the pathology of this rare complication. The medical industry should take in account the current and future observations in order to modify the commercial implants so as to avoid this potentially lethal complication.

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