Dissociation of a Femoral Intramedullary Magnetic Lengthening Nail During Routine Hardware Removal

A Case Report

Mitchell A. Johnson, BSE, Alexa J. Karkenny, MD, Alexandre Arkader, MD, and Richard S. Davidson, MD

Investigation performed at the Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

Abstract

Case: A 15-year-old boy with a right femur length discrepancy secondary to infection underwent hardware removal 1-year status-post right femur osteotomy with placement of an antegrade intramedullary magnetic lengthening nail after successful lengthening of 4.2 cm. During hardware removal, dissociation between the proximal (outer) and distal (inner) components of the device was observed. The distal component was removed using an endoscopic pituitary rongeur after considering multiple possible techniques.

Conclusions: In the event of nail disconnection during removal of an intramedullary implant, we recommend use of a long pituitary rongeur to retrieve the distal nail component.

Magnetic devices have been replacing traditional limb lengthening techniques through use of a magnetically driven intramedullary nail lengthened through a remote control[1]. The Stryde nail system (Nuvasive) uses the same proprietary technology as the earlier generation Precice nail (Nuvasive), but has the benefit of both early and increased weight-bearing capacity and a reinforced internal mechanism[2,3]. This updated system was approved for use in both the tibia and femur in April of 2018[4]. According to the antegrade femur operative technique guide for the Stryde nail[5], maximum weight-bearing on the nail is limited to 150 lbs for the 10.0-mm nail, 200 lbs for the 11.5-mm nail, and 250 lbs for the 13.0-mm nail. Routine hardware removal is recommended at 1 year postoperatively, providing that radiological evidence of full bone consolidation is present.

There are several reports of implant failure for the earlier generation Precice nail; however, because of limited information available regarding implant failure for the updated Stryde nail, there is a lack of trouble-shooting techniques in the literature or manufacturer guides. Reviews of 9 and 24 patients with Precice nail implants by Wiebking et al. and Schiedel et al., respectively, demonstrated a total of 3 patients with broken nails and accompanying fractures through their healing or healed osteotomy site[6,7]. Neither offered insights into specific retrieval techniques; however, breaks in the device occurred along the welding seam in 2 cases and at the connection between the lengthening unit and the extension rod in the other.

In this case report, we present a unique intraoperative complication associated with the planned removal of a Stryde femoral nail. We describe a technique for removal of the separated distal component through an intramedullary approach as well as discuss potential causes and implications of this implant failure and alternative removal techniques.

We received IRB exemption because our institution considers case reports to be IRB exempt. The patient was informed that data concerning the case would be submitted for publication, and the patient provided consent. All details and radiographic images have been deidentified to protect confidentiality.

Case Report

A 6-year-old boy presented with a 5.2-cm leg length discrepancy with a right femur 5.6 cm shorter than the left. He had a remote history of right distal femoral osteomyelitis leading to physeal bar and leg length discrepancy. The patient was treated with iliotibial band release, right femoral osteotomy, and application of an external fixation device for gradual lengthening over 6 months leading to an increase in right femoral length of 6.5 cm. Subsequently at age 13 (height 153 cm and weight 53 kg or 116 lbs), the patient had a leg length discrepancy of 5.2 cm. At this point, the patient was skeletally mature and the decision was made to perform lengthening with a right femoral osteotomy and placement of a Stryde intramedullary nail (11.5-mm diameter × 235-mm length). The procedure was performed without complication. After 7 days postoperative, the patient's family began lengthening 1/4 mm 3 times per day for a total of 55 days. The patient was non–weight-bearing until 1-month postoperative, toe-touch

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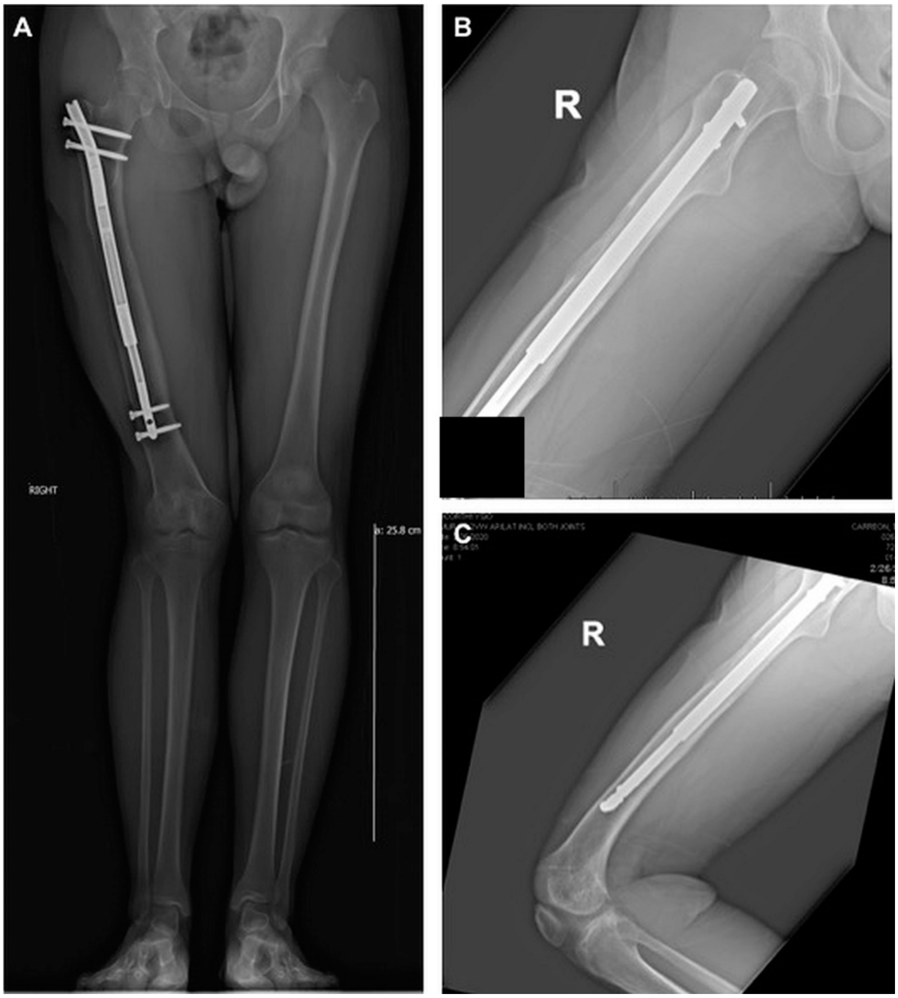

Fig. 1
Preoperative standing bone length study obtained 2 weeks before hardware removal demonstrating a right leg length of 68.3 cm and a left leg length of 69.3 cm for a total limb length discrepancy of 1 cm (**Fig. 1-A**). Lateral views of the proximal (**Fig. 1-B**) and distal (**Fig. 1-C**) femur.

weight-bearing by 2 months, and full weight-bearing at 3 months based on the radiographic appearance of the bone. The right femur was gradually lengthened by 4.2 cm with an ultimate leg length discrepancy of 1 cm (Fig. 1).

One year postoperatively, the patient underwent planned removal of the Stryde nail and interlock screws in accordance with the antegrade femur operative technique guide for the nail[5]. Using fluoroscopic guidance, the distal 2 interlock screws were removed followed by one of the 2 proximal locking screws, using appropriate instrumentation. Next, the tapered extractor was threaded into the proximal aspect of the nail at the greater trochanter. The fourth and final locking screw was then removed. The removal rod was attached to the tapered extractor, and the nail was then carefully removed from the intramedullary canal by gently backslapping along the axis of the rod (Fig. 2-A). The nail was removed easily, but on inspection, it became apparent to the authors that the component removed was only the proximal aspect of the nail which had dissociated from the telescoping mechanism with only the outer sleeve having been removed (Fig. 2-B). The distal (inner) component was retained in the intramedullary canal at the distal femur, with the most proximal aspect of the distal component located 17.25 cm from the tip of the greater trochanter. Out of concern that the distal component could be pushed more distal in the intramedullary canal, a Kirschner wire was inserted through the distal interlock hole of the nail to maintain the position of the distal nail component (Fig. 2-C). After considering options for removal, the decision was made to place a long endoscopic pituitary rongeur (Medtronic, length: 35 cm, distal cross section: 3 mm × 5.8 mm, open tip to tip distance: 16.7 mm) antegrade down the intramedullary canal to grasp the distal component (Figs. 2-D, 2-E, 2-F, and 3). Once grasped, the Kirschner wire through the distal interlock was removed, and the distal nail was carefully removed. Care was taken to ensure that no fractures or residual pieces of metal were observed on fluoroscopy before thorough irrigation and wound closure (Figs. 2-D through 2-I). Examination of the removed distal component revealed moderate corrosion at the component interface (Fig. 4).

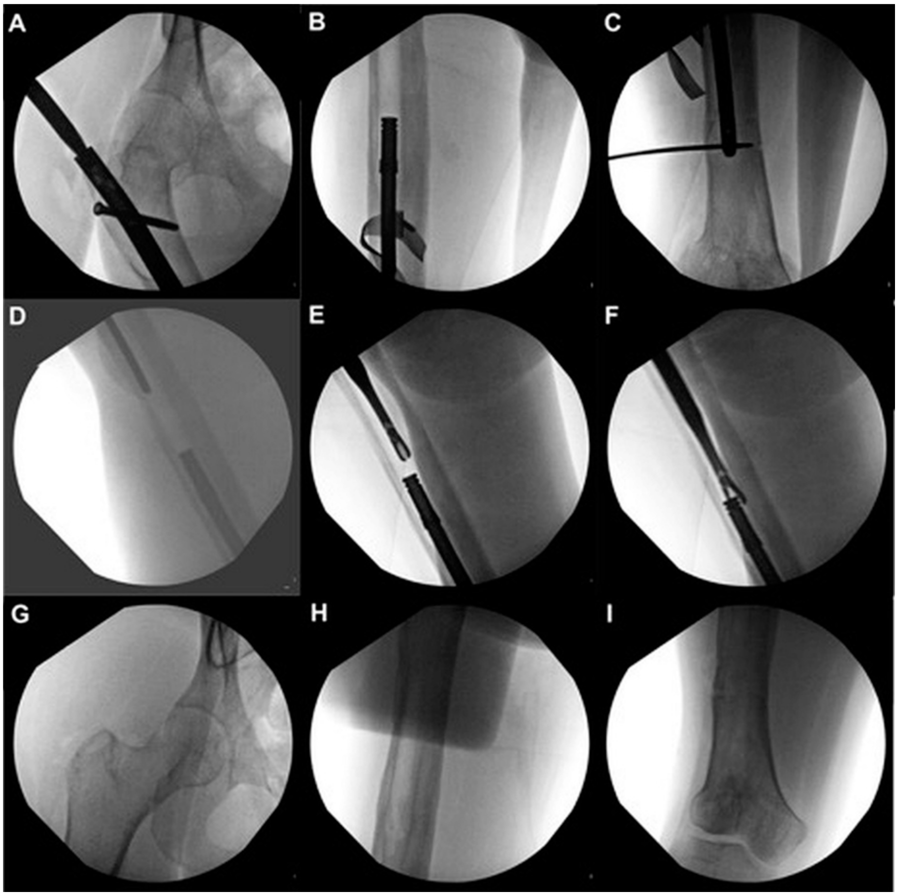

Fig. 2

Intraoperative fluoroscopy demonstrating Precice Stryde nail removal. The extractor was threaded into the proximal nail (**Fig. 2-A**). Gentle extraction of nail revealed proximal component dissociated from distal component with only distal component remaining (**Fig. 2-B**). Kirschner wire placed through distal interlock hole to maintain position of distal component (**Fig. 2-C**). A long pituitary rongeur was inserted into proximal intramedullary canal and used to grasp and remove distal component (**Figs. 2-D, 2-E, and 2-F**). No residual components or fractures noted throughout the femur (**Figs. 2-D through 2-I**).

The total time delay caused by the nail dissociation approached 30 minutes with no associated complications, including no unplanned skin incisions or additional bony defects. Follow-up at 1 week postoperative indicated appropriate wound healing, and the patient was kept partial weight-bearing on crutches for 4 weeks with no complications.

Discussion

To the authors' knowledge, this is the first report of dissociation of the newly available Stryde nail[4] during hardware removal, fortunately without any associated postoperative complication.

There are a variety of techniques in the literature for removal of standard intramedullary nails including the use of interference fit guidewires[8,9], press fitting into the hollow nail[10,11],

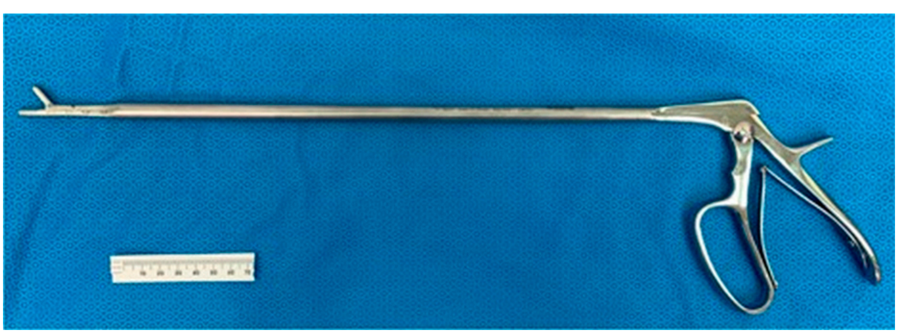

Fig. 3

Endoscopic spinal pituitary rongeur by Medtronic (950-945).

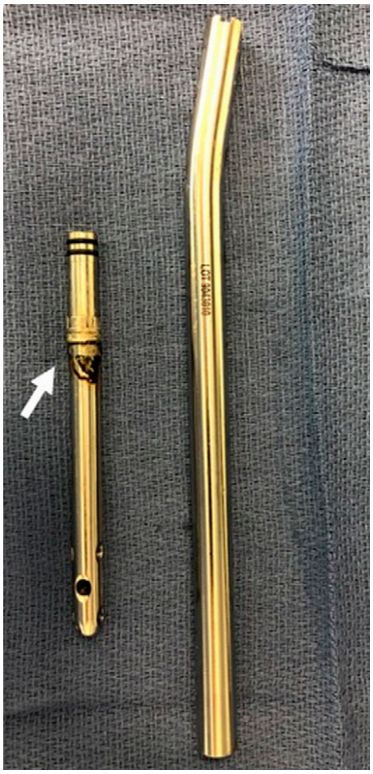

Fig. 4
The distal component (left) and the proximal component (right) of the nail are shown. White arrow indicates corrosion at the component interface.

removal from the opposite side[12,13], and others[14]. However, there is limited information regarding the removal of magnetic lengthening nails. Previous literature focuses on the removal of broken lengthening nails that are associated with a fracture through the healing osteotomy site[15,16]. Contrary to previous similar case reports, we report a new finding of the dissociation of device components at planned removal with no associated trauma or fracture.

Since no specific instrumentation exists for extracting the distal component alone, this poses a challenge should the components of the magnetic rod dissociate. Tiefenböck et al. reported a case of a Precice nail breaking at the welding seam, and a complete osteotomy was performed to remove the distal nail component[16]. Hidden et al. reported a case involving the removal of the distal end of a broken Precice nail implant through the use of a long endoscopic grasper for the inner lengthening component and stacked ball-tip guidewires providing a press fit for removal of the distal hollow sleeve[15]. In both of these cases, there was an associated trauma and resulting fracture of the bone being lengthened leading to Precice nail failure.

In this case, long pituitary rongeur forceps used for spinal surgery were requested when a shorter rongeur was found to fit within the proximal intramedullary canal but not reach the nail. If the rongeur would not fit into the canal with enough room to grasp the rod, anterograde reaming to the level of the rod could be considered. It was unknown whether a straight long pituitary rongeur could fit within the irregular canal postosteotomy or grasp the end of the nail. An antegrade reamer was also considered to cross-thread into the distal component to capture it. If these less invasive ideas did not work, the authors considered using a percutaneous retrograde Kirschner wire or flexible intramedullary nail to push the distal component proximally up the canal until it could be grasped using a rongeur. Finally, removal by an osteotomy would have been the most invasive option of last resort.

Successful lengthening after the index procedure would suggest that the nail components remained connected during lengthening. There was no indication of bending (noted as a precursor to device breakage[17]) or damage to the nail on preoperative radiographs or intraoperative fluoroscopy. It is possible that during trochanteric insertion, a bending moment applied to the component junction as the nail passes through the intertrochanteric area into the femoral shaft could disrupt the connection threads between the components. As the magnetic screw pushes the inner rod forward, the lengthening would not be altered but would be a problematic on removal. The patient's full weight-bearing allowance at 3 months from the index procedure was in adherence with manufacturer restrictions for a patient less than 200 lbs (11.5-mm nail). It is possible that the nail became disconnected during full weight-bearing after lengthening was completed.

In conclusion, this is the first reported dissociation of the Stryde nail components during hardware removal. This is important information for surgeons performing limb lengthening to consider at the time of the index procedure in terms of implant selection, surgical risk discussion, and postoperative weight-bearing precautions, as well as at the time of hardware removal, for trouble-shooting should an implant failure occur. ■

Mitchell A. Johnson, BSE[1]
Alexa J. Karkenny, MD[1]
Alexandre Arkader, MD[1]
Richard S. Davidson, MD[1]

[1]Division of Orthopaedic Surgery, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

E-mail address for M.A. Johnson: mitchell.johnson@pennmedicine.upenn.edu

ORCID iD for M.A. Johnson: 0000-0002-0241-849X
ORCID iD for A.J. Karkenny: 0000-0002-7571-1945
ORCID iD for A. Arkader: 0000-0002-7171-9835
ORCID iD for R.S. Davidson: 0000-0002-1016-8224

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