

## A New Technique for Obtaining Bone Graft in Cases of Distal Femur Nonunion: Passing a Reamer/Irrigator/Aspirator Retrograde Through the Nonunion Site

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### Abstract

Bone grafting is one of the most common orthopedic procedures.

We conducted a study to assess the possibility of passing a Reamer/Irrigator/Aspirator (RIA; DePuy Synthes) retrograde through the nonunion site in distal femur cases. This technique would avoid the complications and discomfort associated with a separate entry site for RIA. All patients with a distal femur nonunion treated with RIA bone grafting between 2009 and 2013 were included in the study. Nonunions were mobilized with excision of fibrous tissues. The distal part was angulated into varus, and then the guide wire was passed from the nonunion site laterally.

Five patients had a RIA passed retrograde through the nonunion site. Mean age of these patients was 40.4 years (range, 22-66 years). Mean reamer size was 13.4 mm (mode, 14 mm), producing an average bone graft volume of 33 mL. There were no intraoperative or postoperative fractures. In 1 case, the reamer shaft broke.

Passing a RIA retrograde through the nonunion site in distal femur cases is reproducible, and the technique avoids the discomfort and pain associated with a separate entry point as well as the complication of eccentric reaming of the proximal and distal part of the femoral canal.

**B**one grafting is the main method of treating nonunions.<sup>1</sup> The multiple bone graft options available include autogenous bone grafts, allogenic bone grafts, and synthetic bone graft substitutes.<sup>2,3</sup> Autogenous bone graft has long been considered the gold standard, as it reduces the risk of infection and eliminates the risk of immune rejection associated with allograft; in addition, autograft has the optimal combination of osteogenic, osteoinductive, and osteoconductive properties.<sup>2,4,5</sup> Iliac crest bone graft (ICBG), though the most commonly used autogenous bone graft source, has been associated with infection, hematoma, poor cosmetic outcomes, hernia, neu-

rovascular insults, and chronic persistent pain.<sup>6,7</sup> Intramedullary bone graft harvest performed with the Reamer/Irrigator/Aspirator (RIA) system (DePuy Synthes) is a novel technique that allows for simultaneous débridement and collection of bone graft, protects against thermal necrosis and extravasation of marrow contents, and maintains biomechanical strength for weight-bearing.<sup>3,4,8,9</sup> Furthermore, RIA aspirate is a rich source of autologous bone graft and provides equal or superior amounts of graft in comparison with ICBG.<sup>5,7,10-12</sup>

In some cases, RIA is associated with the complication of host bone fracture.<sup>4,6,7,11,12</sup> In addition, introducing the reamer may contribute to pain

**Authors' Disclosure Statement:** The authors report no actual or potential conflict of interest in relation to this article. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the US Department of Defense or the US government. The authors are employees of the US government.



**Figure.** (A) Guide wire passing from lateral wound through nonunion site. (B) Intraoperative fluoroscopy shows Reamer/Irrigator/Aspirator (DePuy Synthes) passing over guide wire inserted from nonunion site.

at its entry site and may require violation of local soft-tissue attachments at the hip or knees.<sup>4,7,13</sup> In this study, we assessed the possibility of using a new RIA technique to eliminate these adverse effects. We hypothesized that distal femoral nonunions could be successfully treated with the RIA passed retrograde through the nonunion site. This technique may obviate the need for a secondary surgical site (required in traditional intramedullary bone graft harvest), minimize the potential entry-site tissue (eg, hip abductor) damage encountered with the antegrade technique, and yield harvested bone graft in quantities similar to those obtained with the standard technique.

After obtaining Institutional Review Board approval for this study, we retrospectively reviewed the medical records of all patients with a distal femur nonunion treated with autogenous bone grafting between 2009 and 2013. Identified patients had undergone a novel intramedullary harvest technique that involved passing an RIA retrograde through the nonunion site. Data (patient demographics, volume of graft obtained, perioperative complications, postoperative clinical course) were extracted from the medical records. Before data collection, all patients provided written informed consent for print and electronic publication of their case reports.

## Technique

The patient was laid supine on a radiolucent table, and the affected extremity was prepared and draped free. A standard lateral incision previously used for the index procedure was employed. After implant removal, a rongeur, curette, and/or high-speed burr was used to débride the distal femur nonunion of all fibrous tissue. After mobilization and preparation of the distal femoral nonunion, var-

us angulation was accentuated with delivery of the proximal and distal segments of the nonunion into the wound (**Figure A**). A ball-tipped guide wire was subsequently passed through the nonunion site for intramedullary bone graft harvest. The standard RIA technique was then applied to obtain the bone graft (**Figure B**).

Six patients underwent 7 separate procedures for distal femoral nonunion. Of these patients, 5 underwent retrograde RIA through the nonunion site, as described above; the sixth underwent antegrade RIA in the traditional fashion and was therefore excluded. One of the 5 patients underwent another bone grafting procedure after the initial retrograde RIA treatment through the nonunion site. Several outcomes were measured: ability to obtain graft, volume of graft obtained, perioperative complications, and feasibility of the procedure.

Mean age of the 5 patients was 40.4 years (range, 22-66 years). Mean reamer size was 13.4 mm (mode, 14 mm), producing an average bone graft volume of 33 mL. There were no intraoperative or postoperative fractures. In 1 case, the reamer shaft broke during insertion and was retrieved with no retained hardware; passage was made with a new reamer shaft. No patient experienced additional pain or discomfort, as there was no separate entry site for the RIA.

## Discussion

Bone grafting for nonunion is one of the most commonly performed procedures in orthopedic trauma surgery. Use of an intramedullary harvest system has become increasingly popular relative to alternative techniques. The RIA system is associated with less donor-site pain and provides relatively more bone graft volume in comparison with ICBG harvest.<sup>6,7,10,13</sup> Conversely, intramedullary bone graft harvest may be associated with higher risk of host bone fractures, occurring either during surgery (technical error being the cause) or afterward (a result of patient noncompliance or overaggressive reaming).<sup>6,7,11,12</sup> Multiple methods of reducing the risk of iatrogenic fracture caused by technical error of eccentric reaming have been described, including appropriate guide wire placement aided by frequent use of fluoroscopy in 2 planes.<sup>4</sup> Despite these potential complications and improved donor-site pain complaints in comparison with ICBG harvest, traditional RIA harvest is still associated with pain at the entry site.<sup>4,7,13</sup>

In this study, we introduced a novel RIA technique for distal femur nonunion. This technique

reduces the complications and adverse effects associated with RIA. It removes the added pain and discomfort associated with a separate entry site. As the reamer is introduced into the medullary canal through the femoral nonunion site, and proximal harvest is limited to the subtrochanteric region, the technique also avoids the complications associated with eccentric reaming of the distal and proximal femur, which may contribute to secondary fracture.<sup>6,7,11,12</sup>

Although the proposed technique is practical, it may present some technical difficulties. First, failed fixation hardware must be removed, and by necessity some stripping of soft tissues is required. These actions are unavoidable, as hardware revision is inherent in the treatment of nonunion. During the procedure, the focus should be on minimizing the insult to bony healing. The nonunion also needs to be completely mobilized to allow adequate angulation, guide wire passage, and sequential reaming. The dual vascular insult of intramedullary reaming combined with the soft-tissue débridement and detachment required for hardware removal and mobilization can be concerning for devascularization of the fracture fragment. However, animal studies have suggested reaming does not affect metaphyseal blood flow; it affects only diaphyseal bone.<sup>6,14</sup> The metaphyseal/diaphyseal location of these distal femur nonunions is thought to provide at least partial sparing from the endosteal injury that the RIA may cause. Another difficulty is that the angle of passage of the wire requires a relatively steeper curve to be able to pass beyond the medial distal femoral wall and proceed more proximally. Strong manipulation of the segment is required, which in 1 case caused the reamer shaft to break. This complication had minimal sequelae; the shaft was easily retrieved by withdrawing the ball-tipped guide wire. In addition, strong manipulation of the segment can lead to asymmetric medial reaming or fracture—an outcome easily avoided with a small bend in the distal tip of the guide wire and frequent use of fluoroscopy. In all cases in this series, we achieved proximal passage of the wire and the reamer.

Most RIA bone graft is harvested by reaming the medullary canal at the midshaft of the femur. Passing from the distal femoral nonunion precludes obtaining only a small source of potential distal femoral bone graft, though this metaphyseal bone typically is not used for fear of eccentric reaming and secondary fracture.<sup>6,7,11,12</sup> The amount of bone graft obtained from selected patients who undergo

retrograde RIA passage through the nonunion site should be similar to the amount obtained with the traditional antegrade method. Our newly proposed technique provided an average bone graft volume of 33 mL, which compares favorably with that reported in the literature for the traditional RIA technique.<sup>1,5,6,13,15,16</sup>

## Conclusion

In distal femoral cases, retrograde passage of the RIA through the nonunion site is technically feasible and has reproducible yields of intramedullary bone graft. Adequate mobilization of the nonunion is a prerequisite for reamer harvest. However, this technique obviates the need for an additional entry point. Furthermore, the technique may limit the perioperative fracture risk previously seen with eccentric reaming of the distal and proximal femur using traditional intramedullary harvest.

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*This paper will be judged for the Resident Writer's Award.*