



# Novel Venting Technique for Intramedullary Rod Fixation of Pathologic Fractures

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**Abstract:** This article introduces a novel technique to vent the femur and potentially decrease the embolic load created by reaming during intramedullary rod fixation of impending pathologic femur fractures. We used readily available operating room equipment to create a distal femoral vent hole without interfering with standard intramedullary instrumentation and with minimal increase in surgical time. This technique can be used for the prophylactic intramedullary stabilization of impending pathologic femur fractures from metabolic bone disease, metastatic cancer, and bisphosphonate use.

Prophylactic intramedullary fixation of impending pathologic fractures is an important preventative technique. Intramedullary rods provide longitudinal structural support, protecting weakened cortices from fracture displacement, providing pain relief, and allowing for restoration of function.<sup>1,2</sup> In the femur, prophylactic stabilization of an impending fracture in a metastatic tumor population has demonstrated decreased hospital stays and improved likelihood of support-free ambulation.<sup>3</sup> The intramedul-

lary fixation of an intact bone is usually technically easier, but carries some potential procedural risks. Reports in the literature have shown severe pulmonary and cardiovascular dysfunction as a result of marrow embolization from the reaming and instrumentation of an intact femur.<sup>4,5</sup> This embolic phenomenon has been reported in the arthroplasty literature with intramedullary access for femoral stems.<sup>6,7</sup>

While canal entry is associated with an intramedullary pressure spike, the reaming of the canal also increases intramedullary pressures causing bone marrow to extravasate into the venous circulation.<sup>8</sup> Venting an intact femur prior to prophylactic instrumentation has been previously demonstrated to reduce this phenomenon.<sup>9</sup> This venting may decrease embolic load, especially if active collection of the extravasated bone marrow contents is performed. This article presents a simple and novel solution requiring minimal additional equipment to vent the distal femur during intramedul-

lary reaming and potentially decrease the embolic load.

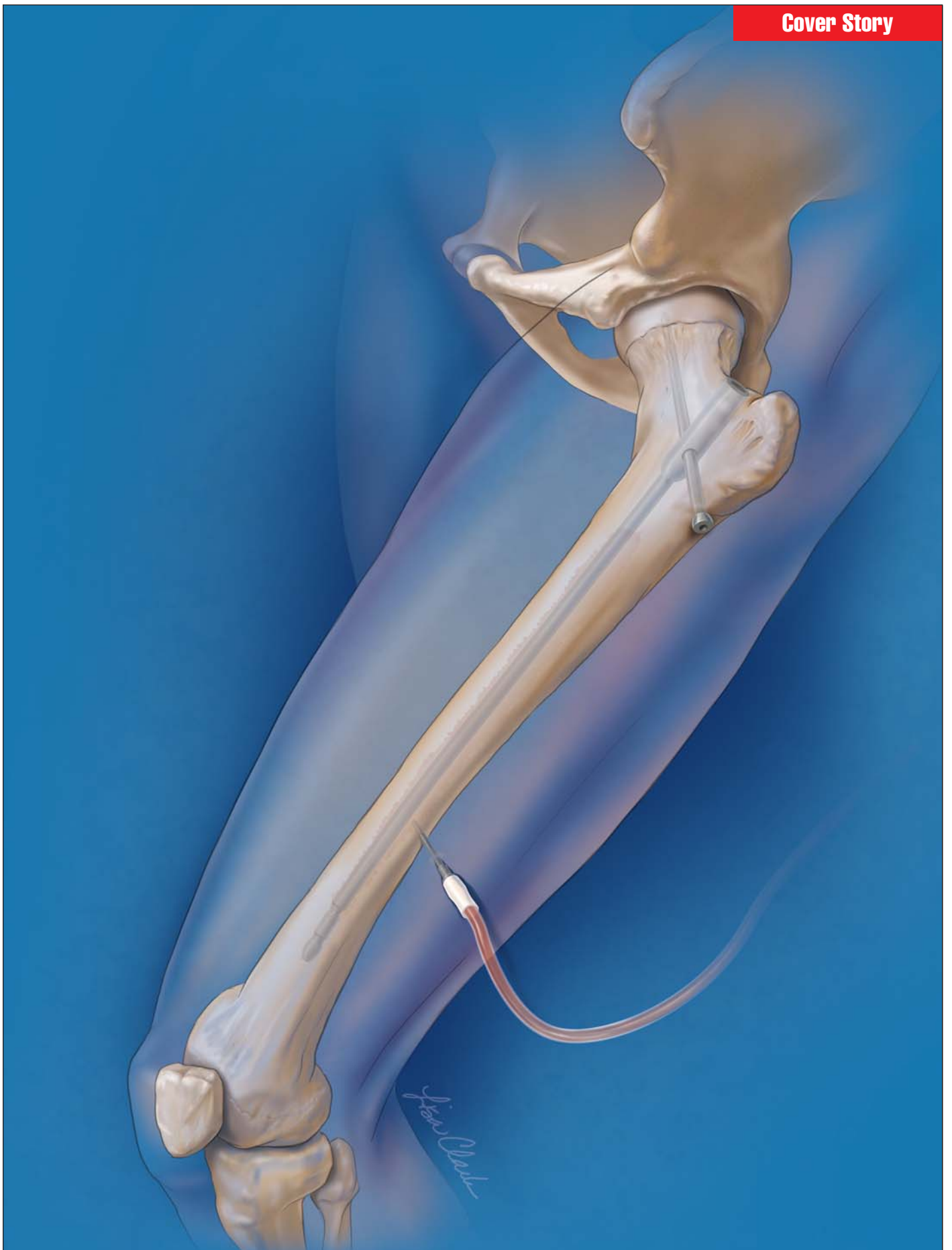
## VENTING TECHNIQUE

The patient is positioned in a standard position on the fracture table for a cephalomedullary nailing technique. We perform our venting technique of the distal femur prior to any instrumentation of the femoral canal. We use bipolar fluoroscopy to localize the distal flare of the femur approximately 3 cortical diameters proximal to the proposed location of the end of the femoral nail. This location is carefully marked out on the skin. A 1-cm percutaneous incision is then made along the lateral aspect of the distal thigh at the location of the beginning of the metaphyseal flare. The incision is carried sharply to the skin and iliotibial band, and a hemostat is used to spread through the soft tissues down to the lateral femoral cortex. Fluoroscopic localization is used to drill a 4.5-mm hole in the lateral femoral cortex that is slightly widened by moving the drill in a circular fashion.

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**Figure 1:** Standard suction tubing fitted to external fixation sleeve.

The triple sleeve (4-mm pin size) from the Stryker Hoffman II external fixation set (Stryker Orthopaedics, Mahwah, New Jersey) is then placed into the hole created in the lateral femoral cortex. The 2 central trocars are removed, and the standard outer sleeve from the 4-mm pin external fixation soft tissue protection device is left in the lateral femoral cortex and found to fit snugly with no additional fixation. Standard suction tubing is then attached to the end of the soft tissue protection sleeve and connected to low-intensity suction. The standard operative suction tubing fits securely on the external fixation sleeve with no required modification (Figure 1).

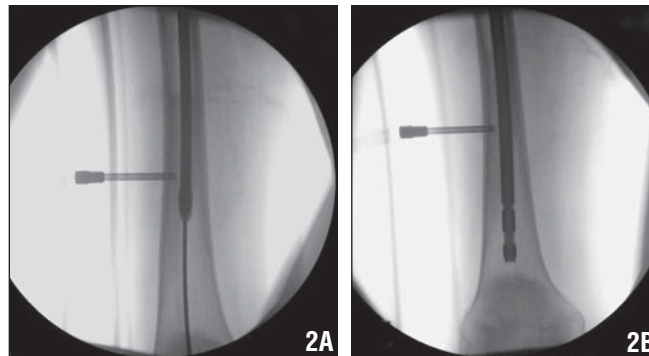
C-arm fluoroscopy is used to confirm the depth of the trocar to ensure that it will not interfere with the intramedullary guide rod reamers or later intramedullary nail passage. The position is confirmed to be well proximal to the distal end of the templated nail length.

Standard technique is then used to perform a cephalo-

medullary nailing of the patient's femur. The output from the suction device is carefully monitored for excessive blood loss. On initial insertion of only the guidewire, an output of intramedullary contents from the suction device occurs solely from passing the guidewire into the distal femur. The guidewire is advanced past the portal, and subsequent reaming and nail placement takes place uneventfully with no disruption of the cannula (Figure 2). Significant output occurs from the suction device during the reaming and during later nail placement. The total output from the femoral canal during the procedures is approximately 300 and 150 cc, respectively.

The nail bypasses the small corticotomy by >3 cortical diameters, decreasing the risk of stress fracture, and the corticotomy is of a similar diameter as standard distal interlocking screws.

Once the nail is seated and the procedure is complete, the cannula is easily removed with pliers. No excessive extravasation at the distal femoral portal



**Figure 2:** Radiographs of undisturbed external fixation sleeve in lateral femoral cortex during reaming (A) and after nail placement (B).

site exists, and the wound is irrigated and closed using standard techniques.

The patient's experience no complications during the procedure and has no systemic evidence of embolization of marrow contents during the perioperative period.

## CASE REPORTS

### Patient 1

An 84-year-old man visiting from Europe sustained a mechanical fall and presented to the emergency department with mild right hip pain. Initial radiographs demonstrated a small nondisplaced greater trochanteric fracture. Subsequent imaging revealed a large ectatic lesion in his right proximal femur with severe proximal cortical thinning. A biopsy confirmed late-stage Paget's disease. Surgical stabilization was recommended given the cortical thinning and occult fracture. The patient had an uneventful rehabilitation period and returned home to Scotland on discharge.

### Patient 2

A 62-year-old woman on long-term bisphosphonate therapy for

osteoporosis presented with right anterolateral proximal thigh pain. She sustained a mechanical fall in the few months prior to presentation, and radiographs demonstrated a stress fracture of the right proximal femur. A trial of conservative therapy in addition to discontinuation of the bisphosphonate was attempted, but she continued to have intermittent pain that did not improve. She elected to have prophylactic surgical stabilization of her stress fracture. Following the procedure, she remained in the hospital for 2 days. At follow-up, she progressed rapidly to full weight bearing with no support and regained normal gait.

## DISCUSSION

Intramedullary fixation of impending pathologic fractures is an important technique to decrease pain and prevent subsequent complete fractures. We should anticipate an increasing incidence in the near future considering the new data with respect to insufficiency fractures related to bisphosphonate therapy. Impending fracture stabilization

from any source (eg, neoplastic, metabolic, or medication induced) involves intramedullary instrumentation of an intact bone. With no fracture to allow for marrow extravasation, the increased intramedullary pressure of the reamings combined with the insertion of the implant could potentially result in embolic phenomena. In our patients' cases, the 300- and 150-cc output would have otherwise had no place to extravasate and could potentially have resulted in systemic embolization of the intramedullary contents.

One alternative technique to potentially decrease embolization from intramedullary nailing is the use of the reamer-irrigator-aspirator technique. This device is reported to decrease temperatures and pressures within the intramedullary canal. However, the data on the in vivo efficacy of this device are conflicting.<sup>10</sup> Any clogging of the suction port may result in increased pressures ahead of the reamer head and may render it ineffective. Furthermore, the minimal diameter for the reamer-irrigator-aspirator reamer is 12 mm. This could be prohibitive in patients with a narrow canal, as was the case with our first patient. Additionally, a recent case series has demonstrated iatrogenic complications of the reaming device, including intra- and postoperative fractures due to eccentric reaming and the aggressive cutting flute profile.<sup>11</sup>

Additional authors<sup>8,9,12</sup> have previously described venting of the distal femur to allow for extravasation of intramedullary contents. We are unaware of any references with respect to the use of a formal cannula. In this technique, the outer sleeve from the external fixator triple sleeve was placed in a unicortical fashion under fluoroscopic guidance with adequate distance from the end of the planned nail. The cannula was then attached to standard operating room suction tubing. This created an efficient means of removing the intramedullary reamings and potential fat emboli by a device constructed from readily available standard operating room equipment.

A potential complication that should be noted from the intramedullary suction, which is also mentioned in the reports from the reamer-irrigator-aspirator literature, is the excessive blood loss from negative-pressure suction.<sup>13</sup> The output should be carefully observed, and the patient's hemodynamic status should also be monitored.

When reaming through proximal femoral lesions, the potential for distal seeding of the lesion exists if the tissue is not contained.<sup>9</sup> The previous descriptions of simple vent holes potentially allows for distal uncontrolled extravasation of proximal bone disease into the soft tissues of the distal femur. With this new technique, the reamings (both marrow and

potentially diseased bone tissues) were collected through the suction apparatus. Once the cannula is removed, a potential exists for some leaking of intramedullary contents. However, this is not proven to be clinically significant because long-term follow-up on this technique is not yet available. The patients have had no untoward consequences from the reaming cannula insertion, and we feel that it potentially prevented significant embolic loads.

This article describes a novel and simple technique for venting the distal femur for prophylactic intramedullary nailing of impending or pathologic fractures. This technique involves no added cost and allows for suctioning of marrow contents. We hope this technique will provide added safety and simplicity to the prophylactic nailing procedure. □

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