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Proceeding

Technical Note: Bone Autograft Harvest using Ria System through Lateral Epicondyle Extraarticular Entry Point

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Abstract

The RIA (Reamer Irrigator Aspirator) is designed for autologous bone graft harvest, intramedullary debridement and reaming for endomedular nails in adults. Femoral bone graft harvest can be performed through antegrade or retrograde intraarticular entry points, both with known complications. The objective of this article is to describe a safe and reproducible method of harvest using this device through a lateral epicondyle extraarticular entry point.

Keywords: Bone Autograft; Lateral Epicondyle; RIA System; Retrograde Reaming; Extraarticular Entry Point

Abbreviations

RIA: Reamer Irrigator Aspirator; AP: Anteroposterior

Introduction

The Reamer Irrigator Aspirator system (RIA; DePuy Synthes, West Chester, PA) was first developed to lower pulmonary complications during endomedullary reaming. It allows the surgeon to maintain a low endomedullary temperature while removing organic debris by generating a constant negative pressure, thanks to the system's irrigation and aspiration ports [1-3], thus minimizing complications such as thermal bone necrosis and fat emboli. Its main indications are obtaining non-structural bone autograft, endomedullary debridement for infections, and reaming for endomedullary nailing [1,4,5].

Iliac crest autograft has been the standard technique for autograft harvesting. However, this procedure has high morbidity and complications like infection, hematoma formation, nerve and vascular injury, and chronic pain, to name a few [6]. On the other hand, RIA has been associated with low donor site morbidity [4,6,7] while being able to obtain a large volume of autologous bone graft (even more than with the standard technique) [1,6] and maintaining growth factors as well as the osteoconductive, osteoinductive and osteogenic potential from the harvested cells [6,8-10].

Manufacturer suggested techniques for RIA application include antegrade and retrograde entry points [11-14]. The latter describes an intraarticular entry point, potentially leaving organic debris inside the joint, development of hemarthrosis, and arthrofibrosis. This raises the challenge in the development of new methods to optimize treatment and lower complication rates. This article aims to describe the retrograde reaming technique for bone autograft harvest through an extraarticular entry point proximal to the lateral epicondyle, thus avoiding joint compromise.

Preoperative considerations

Preoperative planning is essential. The surgeon must be familiar with the RIA system and have all the equipment to perform a safe procedure while avoiding complications. We highlight radiographic evaluation, including anteroposterior (AP) and lateral femur X-rays, essential for isthmus and cortical width measurement [3,12]. Anesthesia should be aware of sudden drops in hemodynamic parameters due to the system's capacity to lower the volemia if not paid attention during reaming [5,13]. This procedure is not recommended in osteopenic orosteoporotic patients.

Surgical technique

The patient lies supine, with the operative extremity with the knee in full extension, while the contralateral limb lies in a mild hip extension, just lower than the operative femur so that intraoperative fluoroscopic imaging can be performed. Initially, a knee AP image is obtained with a radiopaque marker showing the lateral epicondyle level (Figure 1).

Figure 1: Marker showing the lateral epicondyle level.

Next, a direct lateral longitudinal approach of 3 cm is performed proximal to the epicondyle, making an incision on the iliotibial band in line with its fibers and blunt dissection is carried down to the bone. With a 3.5 mm drill bit, a lateral cortical window is created approximately 1.5 cm proximal to the lateral epicondyle (Figure 2).

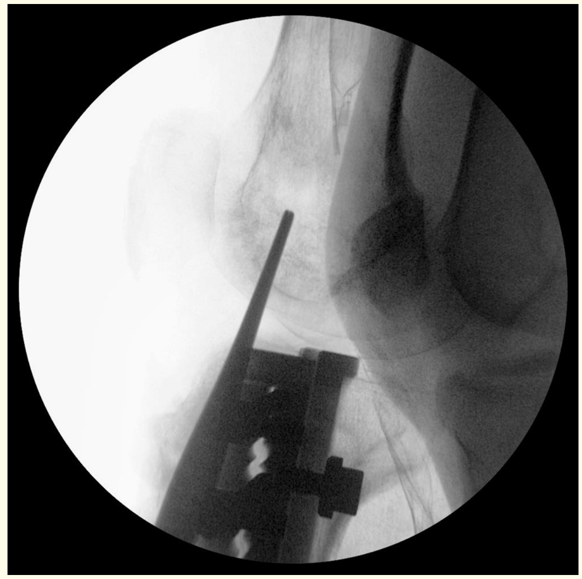

Figure 2: Cortical window proximal to the lateral epicondyle.

Through this lateral window, the reaming guidewire is inserted towards the endomedullar canal (Figure 3). We recommend a slight bend in the guidewire tip to aid in its manipulation (Figure 4).

Figure 3

Figure 4

Figure 3 (Superior) and 4 (Inferior): Showing introduction and guidewire tip bending, respectively.

After the guidewire has bassed the lesser trochanter, the tip is anchored in the proximal femur metaphyseal bone by impaction with a mallet (Figure 5).

Figure 5: Proximal femur guide anchoring.

Adequate reamer selection is next performed using the radiographic ruler under fluoroscopic imaging (Figure 6). Inner canal diameter measure is adjusted to address bone-skin distance by subtracting 1 millimeter if the mentioned distance is 25 mm, 2 mm if it is 50 mm, and 3 mm if it is 100 mm. Then, 1 - 1.5 mm should be added to the adjusted measure to obtain bone tissue with the reamer head, obtaining the actual reamer head diameter.

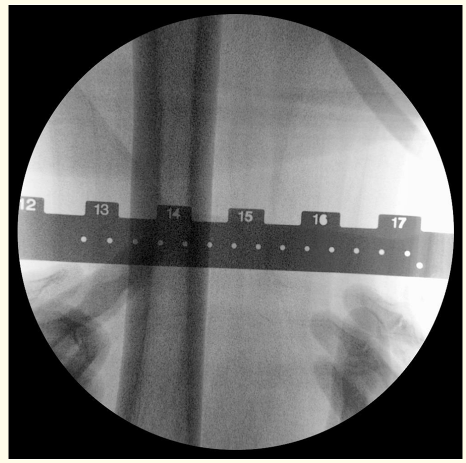

Figure 6: Reamer head measurement with a radiopaque ruler.

Finally, the assembled RIA is inserted through the lateral window (Figure 7), the system is activated, and reaming is initiated (Figure 8).

Figure 7

Figure 8

Figure 7 (Superior) and 8 (Inferior): RIA insertion and endomedullary reaming, respectively.

Recommendations for a safe technique

The device must be cautiously assembled, and the reamer head should be meticulously selected. We prefer close fluoroscopic support for inner diameter measuring, entry point location, guidewire placement, and reamer head advancing in the distal femur as well as at the isthmus. Instrument positioning should be checked at each step in order to avoid eccentric reaming. Despite this precaution, the first medullary portion could be subject to eccentric reaming, but given the guidewire's flexibility, this only happens in a small segment. Bending the guidewire's tip should also be attempted with caution as too much angulation can predispose to eccentric reaming or instrument blocking.

RIA's original surgical technique states that reamer progression should be done advancing 2 - 3 cm and retracting 5 - 8 cm to allow autograft aspiration. If graft volume seems insufficient, the harvesting procedure can be repeated by changing the reamer head for a 1 mm larger one. In a recent biomechanical study, reaming more than 4 mm than the original canal diameter at the isthmus could reduce significantly femoral torsional stiffness suggesting the use of prophylactic plating or nailing [15].

As previously mentioned, it is essential to note that aspiration can lead to abrupt volemic changes, so we recommend clamping the aspiration each time reaming is stopped and avoiding reaming more than twice. Persistent clamping can predispose to stasis inside the aspiration tube and its obstruction, so this maneuver should not be prolonged. If the surgeon considers it, hemostatic agents can be used in the entry point after the procedure, although with this novel technique, this step is not strictly necessary. Table 1 synthesizes surgical pearls for a safe technique.

Recommendations for a proper surgical technique
Avoid this procedure in osteopenic or osteoporotic patients.
Preoperative radiographic evaluation for femoral isthmus measurement.
Careful assembly of the instruments.
Use of intraoperative fluoroscopy to identify entry point, 1.5 cm proximal to the lateral epicondyle.
Bend the guide wire slightly for better access. Impact on the proximal femur.
Use radiopaque guide for proper drill selection, add 1 - 1.5 mm to corrected measurement.
Imaging control during reaming to avoid eccentricity.
Advance 2 - 3 cm and back 5 - 8 cm to allow autograft aspiration.
During graft obtaining, clamp the aspiration every time it is not being reamed, to avoid hemodynamic complications.
If more grafting is required, use a new larger reamer head (+ 1 mm)
We suggest unloading the limb for 6 weeks.

Table 1

Discussion

Although bone autograft helps in the treatment of different pathologies, its harvest carries an additional procedure with well-documented complications regardless of the donor site, extraction technique, or surgeon skills [6]. From this arises the concern to develop new techniques to minimize complications and obtain larger amounts of graft.

The use of RIA has low complication rates (1.9 - 6.2%) [5,16]. Even though some considerations need to be done for correct execution. Planning is crucial, from patient selection to technique execution. One of the most discussed difficulties in the current literature is eccentric reaming, leading to occult cortical breaches and even fractures requiring surgical stabilization [5,13,17].

Antegrade techniques can breach the medial cortex in far lateral trochanteric entry points, weakening the proximal femur and predisposing it to fractures. Too posterior piriformis entry can lead to anterior cortical breach [4,7,11,12]. When reaming too distal, articular compromise could occur through the medial femoral condyle [13]. In retrograde reaming, adequate fluoroscopic imaging throughout the whole procedure should be granted to avoid eccentric reaming [6]. In a retrospective review of 32 retrograde and 62 antegrade procedures, the investigators did not find significant differences regarding graft volume, hospital length of stay, or first post-operative day weight-bearing capacity. Although the antegrade group had more significant hip pain at six months follow-up, this difference was not statistically significant. On the other hand, the retrograde group had significantly higher knee pain at six months follow up (15,6% vs. 1,6%, p = 0.02). Despite this, neither group had pain at the final follow-up. A significantly higher incidence of iatrogenic fractures and the eventual need for nailing happened in the antegrade reaming group (4 versus 0 cases, p = 0.01) [14].

Regarding retrograde reaming with intraarticular entry point, attention must be drawn to its particular risks: development of hemarthrosis, knee pain, and arthrofibrosis. Although allograft bone plug use to block the entry point has previously been described, the bone plug can be prominent inside the joint, and it could also leave intra-articular debris, leading to an immune response or even infection, as well as rising the procedure s total cost. This technique needs articular washout and does not provide access to the femoral condyles if more graft volume is needed.

We recommend that the donor limb remain non-weight bearing for six weeks as well as donor and recipient limbs should be the same, so non-weight bearing status will not be a problem.

The advantages of the presented technique can be stated. First, the risk of intraarticular bone debris is eliminated, as well as there is no need for an articular washout to be performed as in the traditional retrograde technique. Septic arthritis risk is minimized, and posterior cruciate ligament or chondral injury is avoided. Since it does not compromise the knee joint, lower post-operative pain and less intraarticular adherence development should be expected. The need for hemostatic agents to stop intraarticular bleeding is also eliminated, and access through the lateral femoral condyle allows for greater volume harvest. In our experience, this extraarticular approach can lead to lower knee pain rates, shorter operative times, and fewer intraarticular complications.

Conclusion

In conclusion, we can say the RIA system allows autologous bone graft harvest, but it is not free of complications. With adequate preoperative planning and a good understanding of the surgical technique, lateral extraarticular retrograde reaming is a safe and interesting alternative, reproducible, and with low morbidity. Greater use of the RIA system to harvest bone graft highlights the need for randomized controlled trials that compare this entry point with the classic approaches to determine which one is better in terms of graft volume and patient safety.

Conflict of Interest

The authors declare that they have no conflict of interest.

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