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RIA-FAQ

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Frequently Asked Questions about the Reamer Irrigator Aspirator system

Prepared by members of the RIA Task Force. Last updated May 2017

What are the approved indications for the use of the Reamer Irrigator Aspirator system (RIA)?

Indications for the use of RIA (**Fig 1**) are:

- To clear the medullary canal of bone marrow and reaming debris
- To effectively size the medullary canal for the acceptance of an intramedullary implant or prosthesis
- To harvest finely morselized autogenous bone and bone marrow for any surgical procedures requiring bone graft to facilitate fusion and/or fill bone defects
- To remove infected and necrotic bone and tissue from the intramedullary canal in the treatment of osteomyelitis.

What other uses of RIA are described in the literature?

The use of RIA has also been reported in the management of impending pathologic fractures [1]. When reaming an intact femur, many surgeons have recommended venting the bone distally in order to minimize the intramedullary pressure production during reaming. With the use of RIA, distal venting may not be necessary since the device is designed to minimize the build-up of pressure during reaming.

Can I use the RIA in patients with osteomyelitis?

Yes, the RIA system can be used and may provide some advantage in the debridement of intramedullary infection due to the irrigation and aspiration of the intramedullary cavity [2–4].

Can I use the RIA in oncology patients?

Yes, RIA can be used in oncology patients. The use of RIA may provide some advantage in decreasing embolization of intramedullary contents [1].

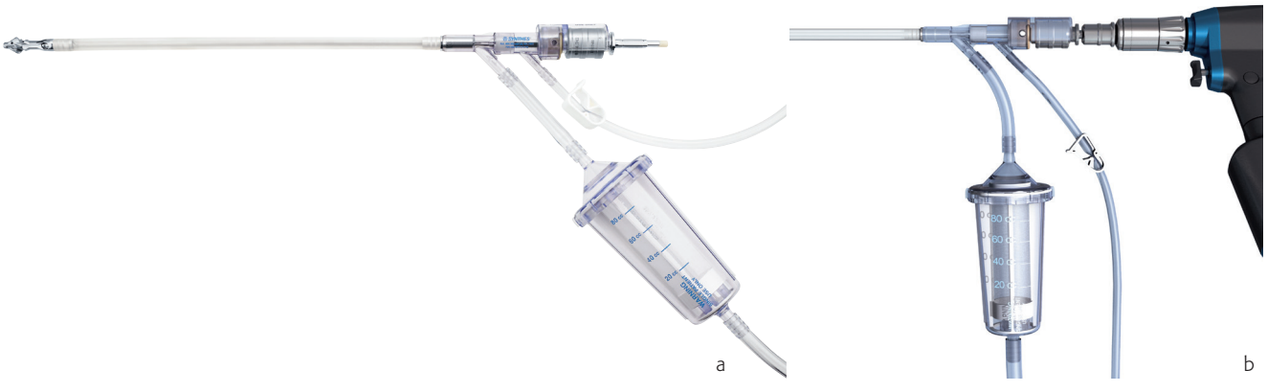
What materials, in addition to the RIA assembly, are required for the use of RIA?

Additionally required materials include:

- 1–2 liter container of irrigation fluid (eg, isotonic 0.9% NaCl)
- Irrigation tubing set ("TURP", cysto-bladder, cystoscopy)
- 2–5 liter suction container. Because the system will not work properly if the suction canister becomes completely filled, it is therefore helpful to use a large suction canister. It is also important to have an adequate level of suction. Ideally, the RIA suction tubing should be connected to its own dedicated suction device. If other items are attached to the suction source, these should be closed off during the use of RIA to achieve optimal suction
- Aspiration/suction tubing (minimum 6 mm or ¼ inch diameter)
- If you wish to harvest intramedullary material for bone graft, the graft filter for RIA (item 352.229S) is also required.

What type of power is required for the RIA?

A power drill that provides 3.5–4.5 Nm of torque and 700–900 RPMs is recommended.



a b

Fig 1a-b The Reamer Irrigator Aspirator system (**a**) with attached power tool (**b**).

What is the smallest diameter reamer head available?

The smallest diameter reamer head is 12 mm. This diameter can be used for reaming the femur in almost all adult patients.

If preoperative radiographic measurement indicates that the intramedullary diameter is smaller than 11 mm then it may be necessary to initially use standard reamers to enlarge the intramedullary canal to safely accept the 12 mm RIA reamer head. Selecting too large of a reamer head with respect to the intramedullary canal size can place excessive torque on the drive shaft and can lead to breakage of the reamer drive shaft.

If preoperative radiographic measurement indicates an unusually small canal diameter then RIA should not be used.

What is the largest diameter reamer head available?

The largest diameter reamer head is 19 mm.

Can reamer heads be interchanged?

Reamer heads are not designed to be interchanged in the current RIA system.

How do you determine the proper reamer head size?

The diameter of the isthmus is measured on an AP view of the femur (**Fig 2**). The AP measurement has been found to be a more accurate measurement of the canal diameter than measurement made on lateral views [5].

To estimate the canal diameter, position the image intensifier for an AP view of the limb at the level of the isthmus. Hold the radiographic measurement ruler perpendicular to the limb and overlay the diameter tabs over the isthmus. It is important to realize that the distance of the measurement ruler to the bone will affect the diameter measurement.

If a CT scan is available, this can also be used for measuring the intramedullary canal diameter. Generally, a reamer head 1–1.5 mm larger than the intramedullary diameter is used.

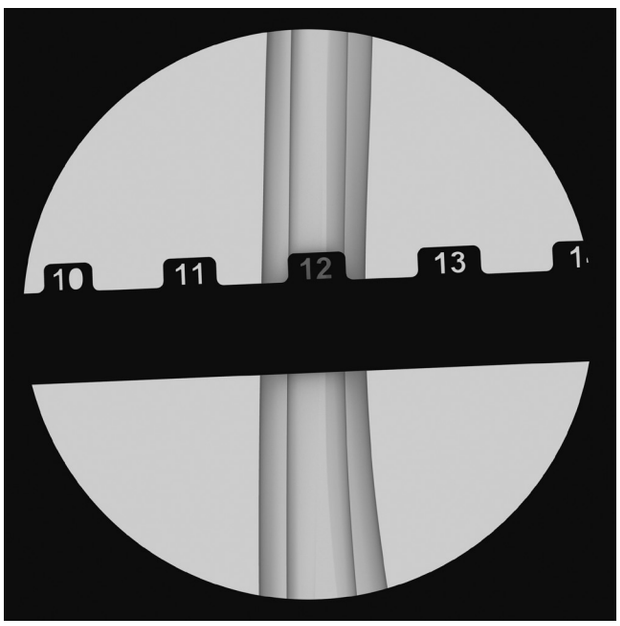


Fig 2 Measurement of the canal diameter.

How do I know if I have assembled the device correctly?

The reamer head is attached correctly when it can spin freely and is retained by the tube assembly.

What technique is recommended when advancing the RIA down the intramedullary canal?

It is recommended to use a technique of gradual advancement then slight retraction of the reamer head in order to allow the irrigation to flow in advance of the reamer head. As you advance the reamer you will meet slight resistance and may feel the sharp flutes of the reamer head grabbing the intramedullary cortex.

What should I do is the system clogs during harvesting?

It is important to ensure that the saline irrigation flows freely, that the suction is adequate, and that the suction canister is not full. In order to achieve adequate suction, a dedicated suction unit should be used. If there are additional items attached to the suction, these devices should be closed off during the RIA reaming procedure. If either the inflow or outflow are not flowing properly the blood in the reaming assembly can coagulate. If the system clogs with coagulated blood it may be necessary to remove the RIA device from the canal, dissemble the outer RIA tube from the drive shaft, and rinse with saline. It is helpful to have someone watch both the irrigation and suction to ensure that they are both flowing freely during the reaming.

How much operative time does the RIA procedure add to a typical case?

In general, using RIA for bone graft harvest is much faster than obtaining bone graft from another source. Similarly, because RIA typically requires only a single pass, it is faster than sequential reaming with standard reamers. There is some additional time required for RIA set-up, including irrigation fluid and separate suction tubing, however this can typically be completed promptly.

What is the best entry point for the proximal femur?

Both the piriformis and trochanteric entry points can be used depending on the surgeon's preference. If a trochanteric entry site is used, attention must be paid to the entry angle trajectory. If the trochanteric entry is angled too far away from the long axis of the femur there is risk that bowing of the guidewire will result in eccentric reaming of the medial femoral cortex, which can increase the risk of iatrogenic fracture.

Since the piriformis entry starts more posteriorly, this entry site should be used with caution in elderly patients because of the associated increased bowing seen in their femur. This increased anterior bow places the anterior cortex at risk during reaming.

Can I use a retrograde approach to the femur with RIA?

Yes, the femur can be reamed in a retrograde fashion with RIA. In a retrospective review of 32 retrograde procedures with 62 antegrade procedures, investigators found no significant difference in graft volume, hospital length of stay, or the ability to ambulate on postoperative day one. At 6 months, the antegrade group had a nonsignificant increase in hip pain (8.1% vs 3.1%, p=0.66) and the retrograde group had a significantly higher incidence of knee pain (15.6% to 1.6%, p=0.02), but neither hip nor knee complaints were present at final follow-up [6].

Caution should be exercised in using the retrograde approach if you determine that a larger diameter reamer will be required. While it is commonly accepted that a 12.5 mm entry site can be safely placed in the distal femur for retrograde nailing, the use of a much larger entry site to accommodate a larger reamer may be detrimental.

It is recommended that the knee joint be thoroughly irrigated to remove any intraarticular debris, and that the entry site be sealed with a hemostatic agent to minimize extravasation of intramedullary bleeding into the knee joint.

Can I ream in prone position?

While antegrade femoral reaming can be performed in the prone position, it is probably not the ideal position and the surgeon must be conscious of the altered anatomic landmarks. Fluoroscopic imaging may be compromised in the prone position increasing the risk of eccentric reaming. It can be especially difficult to position the obese patient in a manner to allow appropriate access to the entry site in the prone position. Retrograde femoral reaming in the prone position, by flexing the knee 90 degrees, has also been described [7].

In many cases, it may be preferable to harvest the bone graft in the supine or lateral position then reposition the patient in the prone position for the subsequent surgical procedure.

Can I use the RIA in the tibia?

If a femoral bone graft source is not feasible, the RIA system can be used in the tibia as long as the reamer head is of the appropriate size for the given anatomy. The tibial canal should have at least an 11 mm diameter in order to use the smallest available RIA reamer, which is 12 mm in diameter.

How much bone graft can typically be harvested from the femur?

Bone graft volume of 30–40 cc can typically be collected from the femur.

How can I increase the amount of graft harvested?

If the initial graft harvest is insufficient, and you believe that there is remaining sufficient cortical thickness, you can repeat the reaming with a larger diameter reamer.

Additional graft can also be obtained from the metaphyseal region by repositioning the distal end of the guidewire into a new location. When the guidewire is initially inserted it is typically placed in a straight fashion, as one would do for placing an intramedullary nail. To obtain additional graft, the guidewire is removed and bent to produce a gentle curve distally. It is then repositioned into the medial and/or the lateral condyle. Repeat reaming harvests additional cancellous bone from this new metaphyseal location. In order to minimize the risk of eccentric reaming of the isthmus and further blood loss, the reamer head can be manually passed beyond the isthmus before the power, irrigation, and fluid are initiated. Fluoroscopic visualization of the reamer passing distally to the femoral isthmus should be used to avoid iatrogenic perforation of the cortex.

When using a bent guidewire, care must be taken that the reamer does not get stuck on the guidewire. If the guidewire bend is too acute, then the reamer cannot advance along the guidewire. Further advancement of the reamer can result in the guidewire penetrating into the knee joint or damaging the guidewire due to the sharp reamer tip [8].

Are there unique features or properties of the RIA bone graft?

The RIA bone graft is typically of a finer consistency than other bone grafts. The intramedullary canal contains bone marrow and vasculature structures that make up two microenvironments or “niches”. Most stem cells found in the bone marrow are hematopoietic stem cells (HSC), whereas the smaller population is the mesenchymal stem cells (MSC). Within the vascular niche, a cell line of mesenchymal origin is found surrounding and in direct contact with the endothelial cells of the microvasculature. Because of the rich intramedullary blood supply, bone harvested from the intramedullary canal may contain a larger quantity of blood vessel fragments and thus a greater number of these MSCs than bone harvested from the iliac crest [9].

In a prospective study of ten consecutive skeletally mature patients presenting for repair of tibial or femoral nonunion, graft material was harvested from both the iliac crest and the intramedullary canal of the femur or tibia (with use of the RIA). Portions of each autologous graft sample were assessed histologically and by genomewide transcriptional profiling for biochemical markers known to be expressed during fracture healing. Transcriptional analysis showed that the intramedullary RIA graft samples had higher levels of expression of genes associated with vascular, skeletal, and hematopoietic tissues. In addition, stem cell markers and growth factors that act early in the osteogenic cascade were more abundant in the intramedullary RIA graft samples compared with the iliac crest samples [10].

At what point in the procedure should I collect the bone graft?

The RIA graft should ideally be obtained as close to the time of implantation as possible to maintain cellular viability. If the graft is harvested earlier it should be kept covered with a blood soaked sponge. In order to avoid unnecessary bone graft harvest, in certain cases it may be important to first ensure that there is no evidence of gross infection at the implantation site prior to bone graft harvest.

Once a patient has undergone RIA bone graft harvest, can I harvest bone graft from the same bone at a later time?

Yes, RIA can be used to sequentially harvest bone graft from the same bone. A series of 8 instances of sequential reaming of the same femur in 7 patients has been reported. The same size or smaller diameter reamer was used for the sequential harvest in 6 cases, while a larger reamer was used in two cases (0.5 mm and 2.5 mm larger). Six patients were harvested twice, and one patient was harvested three times. The average graft volume obtained in the first reaming procedure was 34 mL (range, 25–50 mL) while the average graft volume obtained during the subsequent reaming procedures performed on average 9 months later (range, 3–16 months) was 45 mL (range, 28–65 mL). The graft volume was the same or increased during the subsequent intramedullary reaming in all but one case indicating that the intramedullary canal is a potentially renewable source for bone graft [11].

What are the main potential complications of using RIA?

When using RIA for harvesting bone graft there is a risk of creating an iatrogenic fracture if excessive or eccentric reaming is performed. Because of the rich intramedullary blood supply, excessive bleeding is another potential complication when using RIA.

The most serious complication is iatrogenic fracture of the harvested bone. This can occur both at the time of reaming or in a delayed fashion. Risk fractures identified for iatrogenic fracture are osteopenia, over-reaming, multiple reamings of the metaphyseal area, and eccentric reaming.

In one published series of 204 patients undergoing RIA for bone graft harvesting (201 cases) and of intramedullary debridement (3 cases), the authors reported a complication rate of only 1.96% (N=4). The mean harvested bone graft volume was 47 ± 22mL (20–85 mL). Two patients sustained supracondylar femur fractures 6 and 17 days following antegrade femoral bone graft harvest. One occurred from twisting while seated while the other patient fell from standing. One patient sustained a subtrochanteric femur fracture from a fall from standing at 41days after the retrograde femoral bone graft harvest. A prophylactic intramedullary nail was placed in one patient in whom posterior cortical perforation was noted during the antegrade femoral bone graft harvest [12].

In another case series of 97 RIA procedures from 4 independent orthopedic centers, authors reported a 6.2% (N = 6) complication rate. There were 3 femur and 1 tibia fractures that occurred 2–14 days postoperatively. Two anterior distal femoral cortical defects were treated with protected weight bearing and prophylactic intramedullary nailing. The authors recommended avoiding RIA bone graft harvesting in patients with a history of osteoporosis or osteopenia unless postharvest intramedullary stabilization was considered [13].

How do I control eccentric reaming?

Eccentric reaming can be avoided by ensuring that an accurate and properly directed starting point is used. Eccentric reaming can also occur when the guidewire use is bent at a sharp angle. Care must be exercised to avoid attempting to advance the reamer past the distal/bent end of the wire, which can result in causing the guidewire to penetrate the distal cortex. Typically, this occurs in the anterior part of the distal femur due to its antegrade bend [14].

To avoid these complications, it is important to perform frequent intraoperative fluoroscopy during the reaming and visually follow the reamer head as it is advanced down the intramedullary canal.

When using RIA for bone graft harvest, what are the risk factors for fractures and how can they be minimized?

Patients with a history of osteoporosis or a radiographic appearance of osteopenia may be at a heightened risk for subsequent fracture after intramedullary bone graft harvesting. Some investigators have concluded that risk of fracture is compounded in patients with radiographic evidence of osteopenia because of the importance of the ratio of the endosteal and periosteal diameters in long bone torsional stiffness [13].

While the risk of fracture using this device for bone graft harvest is low, it can be minimized by avoiding over-reaming of the intramedullary canal. The largest reamer head that should be used is 2 mm larger than the smallest diameter of the isthmus to avoid disproportionate reaming and cortical thinning. Care must also be taken to avoid eccentric reaming. It is important to perform frequent intraoperative fluoroscopy during the reaming and visually follow the reamer head as it is advanced down the intramedullary canal. If there is concern for fracture potential following RIA bone graft harvest then prophylactic intramedullary nailing may be recommended.

How can I minimize blood loss when using RIA?

Suction should be clamped off whenever active reaming is not being performed such as when repositioning the guidewire, exchanging irrigation bags or suction canisters, or any other delay. Following completion of the RIA bone graft harvest, a commercial hemostatic product can be used to plug the entry point, minimizing the risk of ongoing bleeding and gluteal hematoma formation.

Does RIA reduce the risk of emboli?

RIA was designed to address the issue of embolization seen with standard reamers. Several animal studies have shown a reduction in embolization of intramedullary contents using RIA compared to standard reaming [15–16].

In one small study of 20 patients, investigators reported a statistically significant difference in the amount of fat presented to the lungs using RIA versus conventional reaming [17].

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Recommended reading

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