CASE REPORT – OPEN ACCESS

International Journal of Surgery Case Reports 5 (2014) 37–42

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Utilizing reamer irrigator aspirator (RIA) autograft for opening wedge high tibial osteotomy: A new surgical technique and report of three cases☆

Richard A. Seagrave*, John Sojka[1], Adam Goodyear[1], Stephen W. Munns[1]

University of Kansas Medical Center, Department of Orthopedics, 3901, Rainbow Boulevard, Kansas City, KS 66160, United States

ARTICLE INFO

Article history:
Received 28 May 2013
Received in revised form 25 August 2013
Accepted 5 November 2013
Available online 15 November 2013

Keywords:
High tibial osteotomy
Varus deformity
Reamer-irrigator-aspirator (RIA)
Allograft
Autograft

ABSTRACT

INTRODUCTION: The lateral closing wedge high tibial osteotomy (HTO) was popularized by Coventry in the 1960s. In the 1990s the medial opening wedge osteotomy gained popularity because it could achieve greater valgus correction and it did not require dissociation of the fibula from the tibia, an important consideration when treating varus knees with lateral and posterolateral ligament deficiencies (Noyes' double-varus and triple-varus knees). However, it has the disadvantage of requiring bone graft to fill bony defects. Recently, the reamer-irrigator-aspirator (RIA; Synthes, Paoli, PA) system was developed, and as a result of this procedure, a large amount of usable autogenous bone graft can be collected safely for use. To our knowledge, there is no published series combining opening wedge HTO with the use of RIA obtained autogenous bone graft.

PRESENTATION OF CASE: We present a novel technique in which a series of three patients underwent opening wedge HTO using ipsilateral, retrograde femur RIA graft to fill the bone defect. All patients had satisfactory clinical and radiologic outcomes following the new technique at latest follow up.

DISCUSSION: Opening wedge high tibial osteotomy is a well-documented and accepted orthopedic procedure, however, has the disadvantage of requiring varying amounts of bone graft. Traditionally, iliac crest or tricortical allograft have been the grafting modalities of choice, however both have inherent drawbacks to their use. In our series, the use of RIA autograft is a safe and reliable harvest technique for high tibial osteotomy, providing abundant and quality autogenous bone graft.

CONCLUSION: All three of our patients achieved radiographic union with high clinical patient satisfaction without any major complications. We feel this novel technique is a safe and acceptable operative solution grafting opening wedge osteotomies about the knee.

1. Introduction

High tibial valgus osteotomy for varusgonarthrosis was first popularized by Coventry in the 1960s.[1] His lateral closing wedge technique was limited to a 15° correction and required some form of tibial-fibular dissociation to close the wedge. The medial opening wedge osteotomy gained popularity in the 1990s because it could produce greater valgus correction (20–25°) and did not require tibial-fibular dissociation, an important consideration when using the osteotomy in conjunction with lateral/posterolateral ligament reconstruction in varus knees (Noyes' double-varus and triple-varus knees).[2,3] It has the additional advantage of being more easily adjustable intra-operatively to obtain the desired correction. One major disadvantage is the need for varying amounts of bone graft, depending on the degree of correction obtained.[4] Various techniques for filling the medial wedge defect have been describedwith iliac crest autograft or tricortical allograft remaining the most commonly used grafting modalities.[5–7] Both of these techniques have their benefits as well as inherent deficiencies and associated comorbidities to their use.[8–10]

Recently, the reamer-irrigator-aspirator (RIA; Synthes, Paoli, PA) system was developed to address concerns of increased intramedullary pressure and fat embolization during intramedullary reaming for long bone fractures. As a result of this procedure, a large amount of autogenous bone graft can be collected safely for use.[10] Studies investigating the applications of RIA graft have demonstrated comparable to superior results using RIA as opposed to the "gold standard" iliac crest bone graft with less donor site comorbidity as well as larger quantities of graft obtained.[9,11,12] Furthermore, the surgical procedure for performing opening wedge HTO gives the surgeon easy access to the RIA graft from the ipsilateral femur without requiring a second surgical exposure. We present a novel technique in which a series

* Corresponding author. Tel.: +1 913 588 5000.
E-mail addresses: rseagrave@kumc.edu (R.A. Seagrave), jsojka@kumc.edu (J. Sojka), agoodyear@kumc.edu (A. Goodyear), smunns@kumc.edu (S.W. Munns).
[1] Tel.: +1 913 588 5000.

2210-2612/$ – see front matter © 2013 The Authors. Published by Elsevier Ltd on behalf of Surgical Associates Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ijscr.2013.11.004

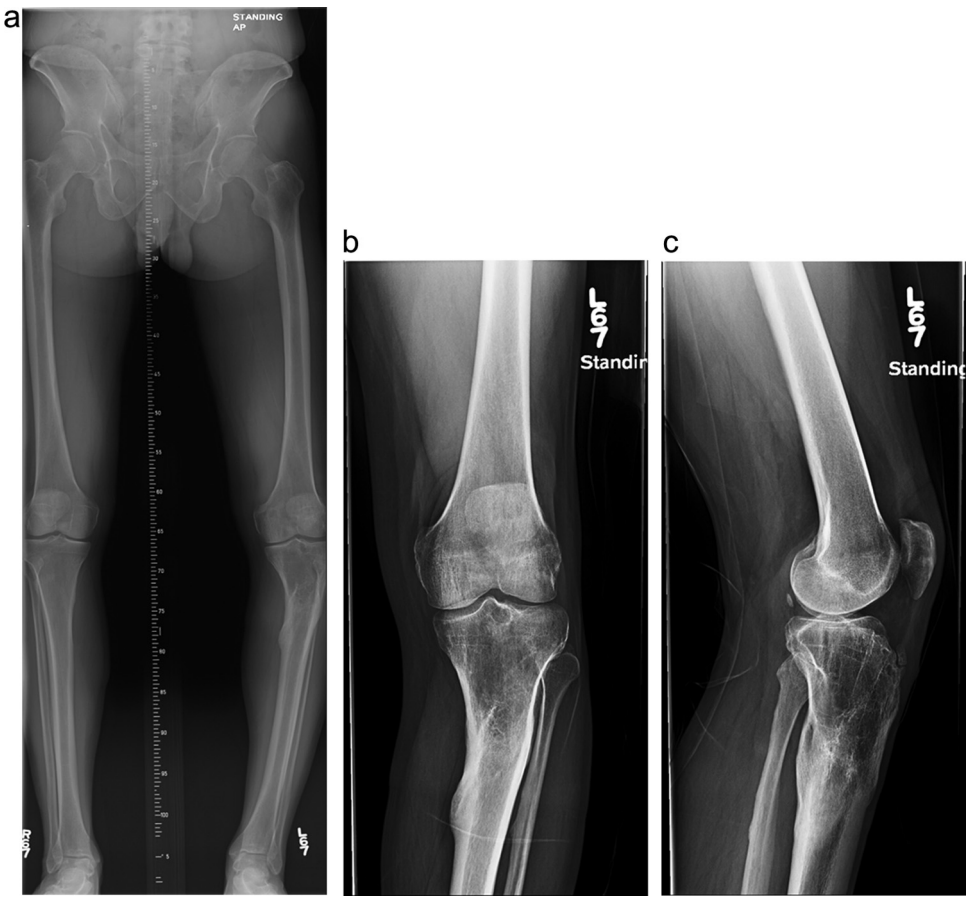

Fig. 1. (A) Pre-operative scanogram demonstrating 15 degree varus deformity. (B and C) Pre-operative AP and lateral knee radiographs again demonstrating varus deformity.

of three patients underwent opening wedge HTO using ipsilateral, retrograde femur RIA graft to fill the bone defect with excellent clinical and radiographic results.

2. Case reports

Three male patients presented to our institution with painful lower extremity due to significant varus knee deformities. Case 1 was a fifty-eight-year-old man who presented seven years status post intramedullary fixation of a proximal tibia fracture with complaints of left knee pain and difficulty with walking. On exam, his varusmalalignment measured 15° and he had a leg length discrepancy of 2.5 cm short on the symptomatic side (Fig. 1). Case 2 was a twenty-nine-year-old male who presented six months s/p ORIF of a left tibial plateau fracture with a varusmalalignment of 15° and incomplete union. Case 3 was a thirty-two-year-old male who presented with six years of left knee pain and progressive varus deformity of 22° secondary to Blount's disease.

The surgical technique for each of these patients was essentially the same. The patient was placed supine on a radiolucent table using general anesthesia and a high-thigh tourniquet. A vertical incision was made in the coronal plane centering over the MCL extending proximally to the superior pole of the patella and a medial parapatellararthrotomy was performed. The fat pad was excised sufficiently to allow exposure of the intercondylar notch for the RIA bone graft harvest.

The tourniquet was deflated for RIA harvest. A guide pin was placed in the trochlea and, under direct C-arm visualization, was advanced slightly anterior to Blumensaat's line in a retrograde fashion into the intramedullary canal. This was followed by the 13 mm diameter cannulated starting reamer, which was utilized to open the intramedullary canal. We then withdrew the guide pin and selected an appropriately sized RIA reamer based on fluoroscopic imaging obtained during the procedure. A ball-tip guide wire was advanced in a retrograde fashion through our entry portal to the level of the lesser trochanter. We then attached the RIA reamer assembly and harvested graft in a retrograde fashion by suctioning the morselized bone graft from the intramedullary canal. Following reaming, we opened the filter and retrieved the collected autograft bone. When the bone graft harvest was completed, the tourniquet was re-inflated.

The anterior portion of the medial collateral ligament was then reflected and was protected during the course of the procedure to allow it to lengthen with the medial opening wedge osteotomy. Under fluoroscopic control, a guide pin was started 5 cm distal to the medial joint line of the tibia and directed proximally to the proximal tibiofibular joint. A malleable retractor was placed subperiosteally posterior to the tibia in line with the guide pin to protect the posterior neurovascular structures. The length of the osteotomy is measured using a second identical guidepin. The osteotomy is then completed under fluoroscopic control using a wide, straight, calibrated osteotome oriented perpendicular to the tibial shaft on the superior surface of the guidepin and stopping one centimeter medial to the lateral tibial cortex leaving that cortex intact. Utilizing the Synthes (Paoli, PA) opening wedge correction device, the osteotomy was opened to the desired degree of correction. Adequacy of the correction was assessed fluoroscopically using a ball-tipped guide wire centered over the hip and ankle. The plate was secured proximally and distally with locked screws, which were confirmed both radiographically and with depth gauge to be appropriate lengths. The osteotomy was then thoroughly

Fig. 2. (A and B) AP and lateral radiographs at six weeks post-op displaying interval radiographic healing.

irrigated and then packed with the entire RIA bone graft using Russian forceps and a bone tamp.

The wound was again irrigated with orthopedic solution (Bacitracin, Polymyxin) protecting the autogenous bone graft. Wounds were then closed over suction drainage and placed in a hinged knee brace. All patients were initially non-weight bearing on the operative side and seen at 2 weeks post-op for suture removal and radiographs. Repeat radiographs were obtained at 6 weeks and progression of weight bearing was initiated at that time. Patients were then seen at 3, 6, and 12 months for further radiographs and clinical evaluation.

At six weeks, Case 1 demonstrated full radiographic healing and had no pain at his osteotomy site (Fig. 2). He was then advanced from toe-touch weight bearing to full weight bearing without complications. At three months, full length standing radiographs showed 9° of varusmalalignment on his operative side compared with 7° on his non-operative side (Fig. 3). He was 5 mm shorter on his operative side. With his deformity in the diaphysis and his shortened limb, a medial opening wedge technique was chosen to correct the alignment closer to the deformity without further shortening the limb. With his pristine medial compartment noted at surgery and varus alignment on his asymptomatic side, it was elected to correct him back to his normal alignment (not overcorrect as in varusgonarthrosis). Clinically at this point, he was very satisfied with the outcome. At six and 12 months, radiographs demonstrated no change in alignment and radiographic union. The patient maintained very high satisfaction with his outcome (Fig. 4) and had returned to normal daily activities.

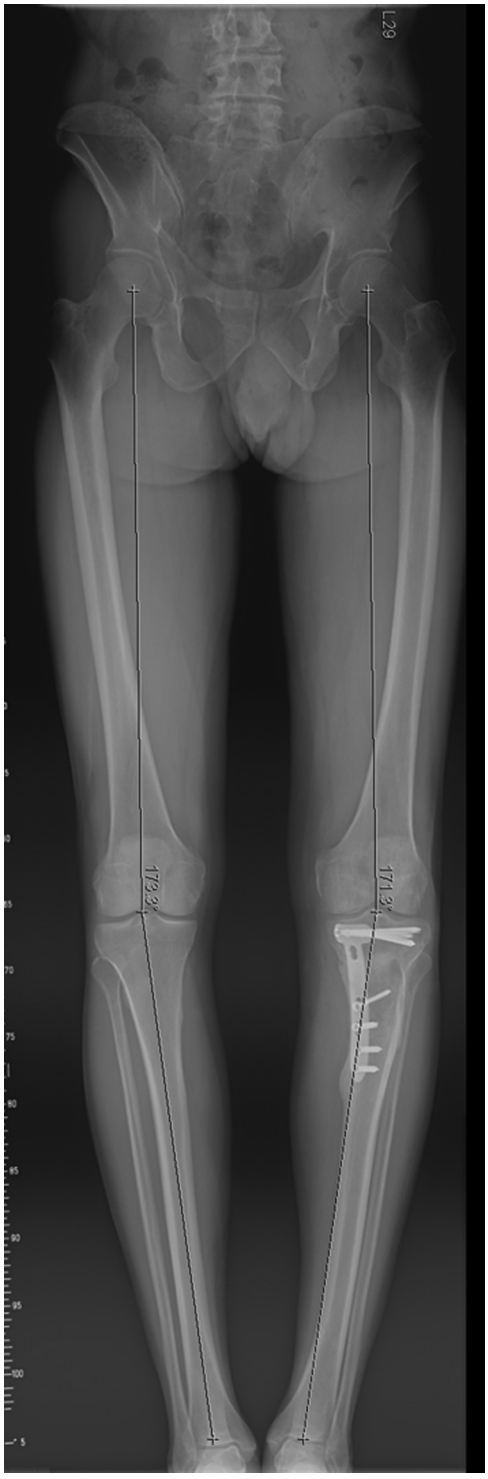

Fig. 3. (A) Repeat scanogram at 12 weeks post-op demonstrating continue radiographic healing and correction of varus deformity.

Case 2, at six weeks, also demonstrated maintained correction of his varus deformity with evidence of healing at the osteotomy site and no pain. His progression of weight bearing was uneventful, and at 3 and 6 months post op he voiced no complaints and demonstrated full radiographic healing. At 12 months, he continued to maintain high satisfaction.

At six weeks, Case 3 demonstrated excellent correction with radiographic healing of the osteotomy site. His weight bearing was progressed. He was seen again at 3 months with no complaints, a completely healed osteotomy site, and was at full weight bearing. He was seen at 6 months post op and films demonstrated complete bony union and normal alignment with congruent articular surfaces. He was released to work without restriction as a military policeman and was continuing this occupation at 12 month clinical visit.

3. Discussion

Opening wedge high tibial osteotomy is a well-documented and accepted orthopedic procedure for the varus knee. One disadvantage of this powerful procedure is the need for varying amounts of bone graft, depending on the degree of correction. As mentioned previously, various techniques for grafting the medial wedge defect have been described.[5,6] Iliac crest autograft or tricortical allograft remain the grafting modalities most commonly in use currently.[7] The potential shortcomings of both tricortical allograft and iliac crest autograft are what prompted our utilization of RIA bone grafting.

The benefits of allograft include adequate amount of grafting material as well as decreased co-morbidity due to lack of a second surgical site. However, shortcomings include increased risk of disease transmission and lack of potent osteoinductivepotential.[10] In contrast, iliac crest autograft avoids the increased risk of disease transmission and provides an osteoinductive material, but often yields less than adequate bone especially in patients that require high degrees of correction. This may require additional harvest sites increasing the comorbidities and complications or augmentation with allograft. The rate of minor complications at the iliac crest donor site has been shown to range from 9% to 39% and major complications range from 0.76% to 25%.[8,13–15] Iliac crest autograft and tricortical allograft were compared side-by-side for the use of graft in an opening wedge HTO. The use of allograft led to significantly higher failure rates than iliac crest bone autograft, indicating the use of some sort of autograft is desirable for opening wedge HTO. However, the problem of finding an adequate source of autograft with minimal comorbidities remains a challenge.[16]

The use of RIA autograft has been shown to produce ample quantities of up to 60–80 mL of bone graft.[10] Furthermore, studies have shown that RIA autograft has comparable osteoprogenitor and endothelial progenitor cells compared to iliac crest making RIA a viable alternative for bone graft. When comparing the complication rate of RIA graft donor morbidity with iliac crest, RIA was found to have a lower overall complication rate of 6% and 19.37% respectively.[17] Critics of RIA graft report unacceptable incidence of fracture of the donor long bone following large harvest. We believe this risk is substantially minimized by the 6 weeks of protected weight bearing status the patients are required from the opening wedge osteotomy procedure.

The goal for these active patients in our small case series was to provide a well-performed high tibial osteotomy with adequate correction of their particular varus deformity without causing increased co-morbidities or surgical complications. To the best of our knowledge, this application of RIA bone graft harvesting of the ipsilateral femoral canal in a retrograde fashion combined with opening wedge HTO has yet to be described in the literature. The advantage of this technique is that it minimizes donor site co-morbidity and the need for multiple incisions during high tibial osteotomy while providing equivalent “gold standard” autograft that promotes excellent bone healing and high patient satisfaction.

All three of our patients achieved radiographic union with high clinical patient satisfaction without any major complications. We

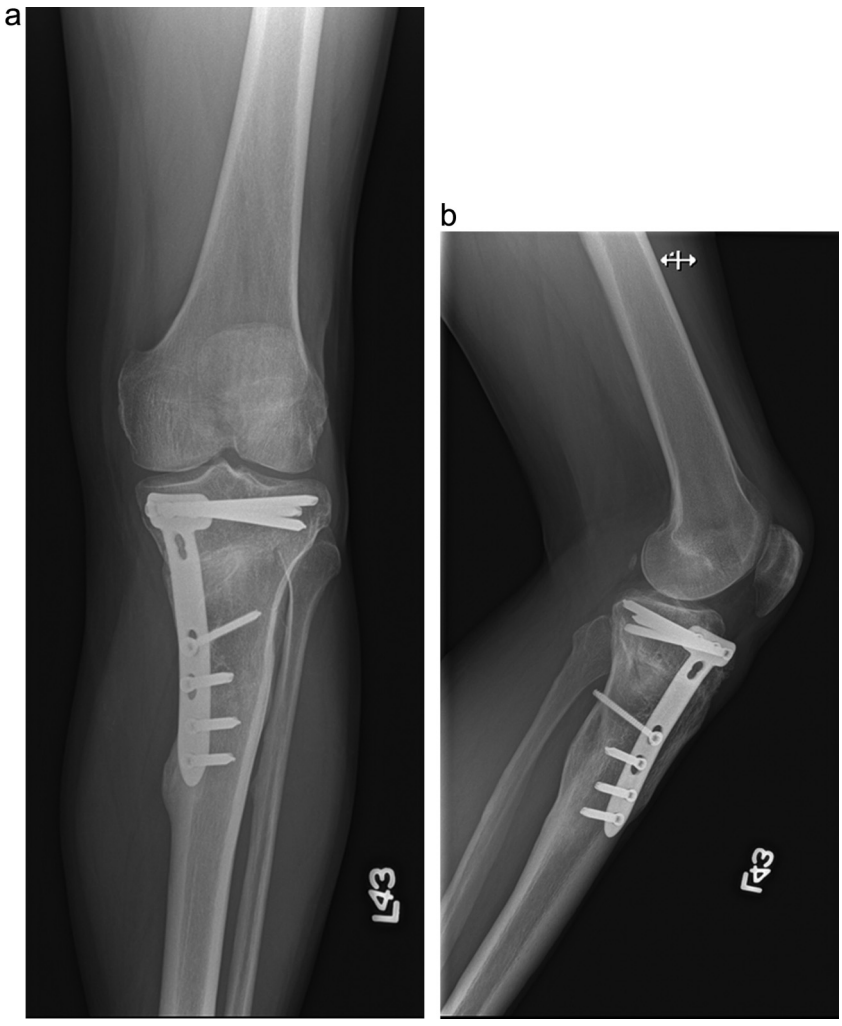

Fig. 4. (A and B) AP and lateral radiograph at 6 months post-op demonstrating healed fracture.

feel this novel technique is a safe and acceptable operative solution grafting opening wedge osteotomies about the knee.

Author contributions

Richard Seagrave, Stephen Munns, John Sojka and Adam Goodyear were contributed in study design, data collections, data analysis and writing of this article.

Conflict of interest statement

None.

Funding

None.

Ethical approval

Consent obtained.

References

1. Coventry MB. Upper tibial osteotomy for gonothrosis. *Orthop Clin North Am* 1979;**10**:191–210.
2. Noyes FR, Barber-Westin SD. *Noyes' knee disorders*. Saunders Elsevier; 2010. p. 821–96.
3. Amendola A, Bonasia DE. Results of high tibial osteotomy: review of the literature. *Int Orthop* 2010;**34**(2):155–60.
4. Amendola ABD. High tibial osteotomy/distal femoral osteotomy. In: Cole BJ, Gomoll AH, editors. *Complications in orthopedics: articular cartilage restoration*. 2011. p. 33–43.
5. Hernigou P, Ma W. Open wedge tibial osteotomy with acrylic bone cement as bone substitute. *Knee* 2001;**8**(2):103–10.
6. Koshino T, Murase T, Saito T. Medial opening-wedge high tibial osteotomy with use of porous hydroxyapatite to treat medial compartment osteoarthritis of the knee. *J Bone Joint Surg Am* 2003;**85A**(1):78–85.
7. Lobenhoffer P, Agneskirchner JD. Improvements in surgical technique of valgus high tibial osteotomy. *Knee Surg Sports Traumatol Arthrosc* 2003;**11**(3):132–8.
8. Banwart JC, Asher MA, Hassanein RS. Iliac crest bone graft harvest donor site morbidity. A statistical evaluation. *Spine (Phila Pa 1976)* 1995;**20**(9):1055–60.
9. Cox G, et al. The use of the reamer-irrigator-aspirator to harvest mesenchymal stem cells. *J Bone Joint Surg Br* 2011;**93**(4):517–24.
10. Newman JT, et al. A new minimally invasive technique for large volume bone graft harvest for treatment of fracture nonunions. *Orthopedics* 2008;**31**(3):257–61.
11. Porter RM, et al. Osteogenic potential of reamer irrigator aspirator (RIA) aspirate collected from patients undergoing hip arthroplasty. *J Orthop Res* 2009;**27**(1):42–9.
12. Schmidmaier G, et al. Quantitative assessment of growth factors in reaming aspirate, iliac crest, and platelet preparation. *Bone* 2006;**39**(5):1156–63.
13. Arrington ED, et al. Complications of iliac crest bone graft harvesting. *Clin Orthop Relat Res* 1996;**329**:300–9.

14. Goulet JA, et al. Autogenous iliac crest bone graft. Complications and functional assessment. *Clin Orthop Relat Res* 1997;**339**:76–81.
15. Silber JS, et al. Donor site morbidity after anterior iliac crest bone harvest for single-level anterior cervical discectomy and fusion. *Spine (Phila Pa 1976)* 2003;**28**(2):134–9.
16. Kuremsky MA, et al. Comparison of autograftvs allograft in opening-wedge high tibial osteotomy. *J Arthroplasty* 2010;**25**(6):951–7.
17. Dimitriou R, et al. Complications following autologous bone graft harvesting from the iliac crest and using the RIA: a systematic review. *Injury* 2011;**42**(Suppl 2):S3–15.