file reviewer dr Komang JOS (OSJ 21-0111)

Dari: komang kopling (komang168@yahoo.com)

Kepada: yuyunhand@yahoo.com

Tanggal: Selasa, 23 Maret 2021 09.10 WIB

Invitation to Review for Journal of Orthopaedic Surgery

Inbox ×

Journal of Orthopaedic Surgery <onbehalfof@manuscriptcentral.com> Wed, Mar 10, 8:38 PM (8 days ago)

to komang168, me

10-Mar-2021

Dear Dr. irianto:

Manuscript ID OSJ-21-0111 entitled "Nail-stem construct for recalcitrant nonunion in humeral periprosthetic fracture after total elbow arthroplasty" has been submitted to Journal of Orthopaedic Surgery.

I invite you to review this manuscript. The abstract appears at the end of this letter. Please let me know as soon as possible if you will be able to accept my invitation to review. Please click the appropriate link at the bottom of the page to automatically register your reply with our online manuscript submission and review system.

Journal of Orthopaedic Surgery greatly values the work of our reviewers. In recognition of your continued support, we are pleased to announce that we have arranged with our publisher SAGE to offer you free access to all SAGE journals for 60 days upon receipt of your completed review and a 25% book discount on all SAGE books ordered online. We will send you details of how to register for online access and order books at discount as soon as you have submitted your review.

Journal of Orthopaedic Surgery is committed to ensuring that the peer-review process is as robust and ethical as possible. The Committee on Publication Ethics (COPE) guidelines regarding peer review can be found at the following link. Please read the guidelines before accepting or declining my invitation. http://publicationethics.org/files/Ethical_guidelines_for_peer_reviewers_0.pdf.

Once you accept my invitation to review this manuscript, you will be notified via e-mail about how to access ScholarOne Manuscripts, our online manuscript submission and review system. You will then have access to the manuscript and reviewer instructions in your Reviewer Center.

Thank you for submitting your review of Manuscript ID OSJ-21-0111 for Journal of Orthopaedic Surgery

Inbox ×

Journal of Orthopaedic Surgery <onbehalfof@manuscriptcentral.com> 9:44 AM (1 minute ago)
to komang168, me

17-Mar-2021

Dear Dr. irianto:

Thank you for reviewing manuscript # OSJ-21-0111 entitled "Nail-stem construct for recalcitrant nonunion in humeral periprosthetic fracture after total elbow arthroplasty" for Journal of Orthopaedic Surgery.

In recognition of your continued support, Journal of Orthopaedic Surgery and our publisher SAGE are pleased to offer you 60 days complimentary online access to all journals published by SAGE. Register at http://journals.sagepub.com/page/help/reviewer-access to activate access to content from all journals. To also benefit from a 25% discount on all SAGE books ordered online, go to the SAGE website (http://www.sagepublications.com/) and add the SAGE books that you would like to purchase to your shopping cart. When checking out, enter the Promotion Code GL10JR0001 when prompted. This will automatically deduct 25% from your final bill.

We are collaborating with Publons to give you the recognition you deserve for your peer review contributions. If you opted in for recognition on Publons when you submitted this review, you will shortly receive an email inviting you to claim your review on the site. If you would like to get credit for your peer review but did not opt in and/or have not yet signed up, you can still do so by registering at https://publons.com/home/. Then simply forward this email to reviews@publons.com and the review will be added to your profile.

On behalf of the Editors of Journal of Orthopaedic Surgery, we appreciate the voluntary contribution that each reviewer gives to the Journal. We thank you for your participation in the online review process and hope that we may call upon you again to review future manuscripts.

Sincerely,
Professor Frankie Leung
Associate Editor, Journal of Orthopaedic Surgery
klleunga@hku.hk

OSJ-21-0111.pdf
1.8MB

Nail-stem construct for recalcitrant nonunion in humeral periprosthetic fracture after total elbow arthroplasty

Journal:	*Journal of Orthopaedic Surgery*
Manuscript ID	OSJ-21-0111
Manuscript Type:	Original Article
Keywords:	nail-stem construct, total elbow arthroplasty, revision surgery, periprosthetic fracture, recalcitrant nonunion, implant loosening
Abstract:	Purpose: This study aimed to describe the surgical technique used in our innovative nail-stem construct and evaluate patient outcomes for salvaging periprosthetic humeral fractures with recalcitrant nonunion after total elbow arthroplasty (TEA). Methods: Patients diagnosed with implant loosening and periprosthetic fractures subsequent to previous TEA were retrospectively registered between 2018 and 2019. A posterior incision was made on the periprosthetic humeral fracture using the triceps-splitting approach. Without disassembling the prosthetic ulnohumeral joint, the humeral stem was exposed from the humeral intramedullary (IM) canal of the fracture site. A segment of IM nail was measured and inserted proximally into the humeral canal and then pulled back to achieve adequate overlapping on the humeral stem. Cement was then packed into the humeral canal, followed by docking the IM nail into the humeral stem. The nail-stem interface was also cemented to augment fixation, and the harvested strut allograft was wrapped around the fracture site. The wound was closed in layers, and a shoulder sling was applied. The range of motion, degree of elbow stability, and level of pain were evaluated following the procedure. Results: All four patients (average age 78.7 years) achieved full range of motion and secure stability with painless elbow at 12, 16, 24, and 30 months, respectively. Conclusions: Our innovative, low-cost nail-stem construct procedure is a feasible alternative to revise TEA in patients with implant loosening, periprosthetic humeral fractures, and recalcitrant nonunion. Key Words: nail-stem construct, total elbow arthroplasty, revision surgery, periprosthetic fracture, recalcitrant nonunion, implant loosening. Level of Evidence: Level IV

Introduction

The incidence of total elbow arthroplasty (TEA) has increased in recent years; however, it has a higher percentage of complications and revisions compared to other arthroplasties.[1] The survival rates of TEA were revealed to be 92%, 81%, 71%, and 61%, at 5, 10, 15, and 20 years, respectively.[2] Infection, aseptic loosening, and periprosthetic fracture are commonly occurring complications that require revision surgery; whereas, periprosthetic fracture with recalcitrant nonunion in aseptic loosening is the most complex complication following TEA.[3,4] This may be related to several factors, including patient age, prosthetic design, and multiple prior surgical procedures.[5,6] Besides, ligament deficiency caused by nonanatomic force transmission in semi-constrained implants is the primary reason for substantial bone resorption.[7] In a study of 92 TEAs with a mean follow-up of 6.5 years, the rate of mechanical implant failure was 25%, and half of the study population showed aseptic loosening.[5] Furthermore, the overall complication and revision rates have been reported to be approximately 24% and 13%, respectively.[8,9] Fractures around the loose prosthesis associated with massive bone loss are the most technically challenging and common scenarios in revision TEA.[10] Although revision of the loose prosthesis and reduction of the fracture with allograft reconstruction have been the golden standard of treatment,[10] recalcitrant nonunion may still develop, even with different osteosynthesis methods. To overcome it, we developed an innovative and inexpensive procedure using a nail-stem

construct for salvaging this kind of periprosthetic humeral fractures following TEA. Similar approaches in cases of periprosthetic femoral fracture with nonunion after total hip arthroplasty had been reportedly described, which were treated with a nail overlapping the femoral stem tip.[11–14] The concept of our nail-stem construct used in the elbow was inspired by the procedures implemented in the hips. To our knowledge, although the basic principle was similar, no report using this technique on the elbows has been published. Herein, we describe the procedures in detail and report the encouraging early results in four patients using the nail-stem construct.

Materials and Methods

Patients

Between 2018 and 2019, we included four patients diagnosed with implant loosening and periprosthetic fractures subsequent to previous TEA (Coonrad-Morrey Total Elbow, Zimmer). The demographics involved patient age, gender, lesion site, the indication of previous TEA, and previous revision surgeries (Table 1). A total of one right and three left elbows underwent the nail-stem reconstructive procedure at our hospital. All four patients were female with an average age of 79.3 years who had previously undergone TEA for rheumatoid arthritis (two cases) and traumatic osteoarthritis (two cases). The patients were reviewed at the Department of Orthopedics of the Buddhist Dalin Tzuchi Hospital, Taiwan. Ethical approval for this study was obtained from the Institutional

Review Board and the Ethics Committee of the Buddhist Dalin Tzuchi Hospital, Taiwan.

Case 1

A 73-year-old woman underwent left primary TEA 13 years ago due to rheumatoid arthritis. Periprosthetic humeral fracture around the loosened stem occurred after a fall five years postoperatively. In the following seven years, a total of five surgeries were performed at two medical centers, resulting in persistent loosening and recalcitrant nonunion. The revision surgeries included conventional plate and wire with auto-bone grafts, exchange with a long stem, and onlay double allo-bone plating **(Figure 1)**. We used nail-stem construct to treat the recalcitrant nonunion.

Case 2

A 76-year-old woman with rheumatoid arthritis was referred to our hospital due to failed osteosynthesis for the periprosthetic humeral fracture. Recalcitrant nonunion persisted despite three revision surgeries, consisting of locking plate fixation, double allo-bone plating, and conventional plate and wire fixation with autogenous bone grafts. We solved this problem after nail-stem construct procedure.

Case 3

An 87-year-old woman presented with acute periprosthetic fracture of the humerus after a fall. She underwent primary TEA for traumatic osteoarthritis 11 years ago. Aseptic

loosening of the humeral stem diagnosed postoperatively. We treated the loosened implant and fracture with nail-stem construct.

Case 4

An 81-year-old woman underwent left primary TEA ten years ago due to traumatic osteoarthritis. Periprosthetic humeral fracture around the loosened stem occurred after a fall. The persistent loosening and nonunion occurred despite four times of surgery at two medical centers. We used the nail-stem construct in this situation.

Surgical Technique

The affected arm was placed on an elbow support in the lateral decubitus or prone position. A posterior incision was made with the triceps muscle split at the midline to expose the distal humerus. After identification of the radial nerve, extensive debridement was performed to remove all the previously implanted cement, K-wires, and screws/plate. Without disassembling the prosthetic ulnohumeral hinge, the humeral stem tip was exposed from the intramedullary (IM) canal. The humeral IM canal (Nailing System, Stryker) was then over-reamed at least 2 mm to facilitate smooth nail insertion. The length of the IM nail segment was determined by measuring the depth of the humeral canal. Appropriate nail length should easily dock distally to the tip of humeral stem with 3 to 5 cm of overlap into the stem, and be long enough proximally to reach the humeral head to achieve construct stability **(Figure 2)**. The IM nail was

pushed into the humeral canal and then pulled back distally to establish the construct. This should be practiced several times to achieve the final construct. Then the cement was packed into the humeral canal, and the IM nail was inserted to lead the stem into the IM nail with the interface being cemented to augment fixation. At the final setting of the cemented nail-stem composite, elbow flexion-extension was checked to achieve full range of motion, and the alignment was checked via fluoroscopy. For the periprosthetic bone defect, the harvested allografts were impacted and fixed with cerclage wires. The wound was closed, and a sling protection was implemented for six to eight weeks. A rehabilitation program was initiated on the first day postoperatively.

Results

In our four patients, the average duration from the primary TEA to the final revision with nail-stem construct was 10.5 years, and the previous number of surgeries averaged 3.5. All the fractures were Mayo classification type II3. For the nail-stem construct procedure, the surgical time averaged 2 hours 40 minutes, the blood loss averaged 387.5 cc, and the mean hospital stay was 8.5 days (**Table 1**).

Preoperatively, all the patients showed painful disability with deformity and instability. The average preoperative visual analogue score (VAS) was 6.5. Full range of motion with painless and stable elbow was achieved at the 12-, 16-, 24-, and 30-month follow-ups (**Figure 3**). The postoperative VAS was 1. There were no complications, such as

radial nerve injury, infection, or instability. Triceps insufficiency was observed in Cases 1, 2 and 4, but it was present prior to revision. Radiographically, solid union was achieved at the final follow-up without implant loosening or fracture nonunion in all cases (**Figure 1**).

Discussion

Periprosthetic fractures associated with humeral stem loosening remain the most technically demanding due to extensive bone loss, poor bone quality, and soft tissue contracture. Nonunion with persistent loosening of the humeral component continues to occur despite various osteosynthesis techniques, such as plate/screw/wire fixation, locking plate fixation, onlay allograft bone plating, or revision with a longer stem (**Table 2**). Therefore, we developed an innovative elongation technique to provide a "serviceable elbow" for patients with humeral bone loss following TEA. Currently, this technique performed successfully in our four patients who had failed multiple surgeries. Morrey et al[15] performed allograft prosthetic composite reconstruction for massive bone loss with limited functional restoration. Sanchez-Sotelo et al[16] treated humeral periprosthetic fractures associated with a loose humeral component with implant revision and strut allograft augmentation, resulting in a substantial complication rate. Furthermore, endoprosthetic arthroplasty has been associated with poor outcomes and high complication rates in up to 50% of cases.[4,17,18] In our study, in relation to Cases 1, 2

and 4, multiple attempts for osteosynthesis had failed in other hospitals even with the locking plate fixation procedure or revision with a long stem. Martin et al[18] used a vascularized fibula graft with double plate fixation for a patient with extensive segmental loss of the humerus. The free fibular graft brings vascularity to the region of humeral nonunion with a background of previous pathological fracture following radiotherapy. In our all cases, union was achieved even in the presence of a suboptimal soft tissue environment because adequate construct stability was achieved.

There are multiple benefits of the current nail-stem construct used. First, disconnecting the hinge is not required, and the original humeral and ulnar components can be retained without exchange. It is an inexpensive procedure compared to revision with a long stem or conversion to an endoprosthesis. Second, the IM nail can accomplish an excellent fit with its larger diameter than the very thin humeral stem. Furthermore, the nail can be designed to be as long as necessary to reach the humeral head. Unlike the thin and relatively short humeral stem with extramedullary plate fixation in an osteoporotic humerus, this IM construct can provide excellent stability and realign the humeral stem to a functional position.

Some technical specifications of this procedure need to be emphasized. First, multiple trial fit prior to final cementation is essential to achieve smooth and trouble-free insertion of the whole construct into the humeral canal. Second, suboptimal length of the nail could lead to a compromise in the range of motion and difficulty in

implantation. Third, the overlapping between the nail and the stem should not be less than 3 cm to avoid rotational instability or dislodgment. In a biomechanical model, Melvin et al[20] reported that for a stable stem–nail connection, 2.9 to 3.5 cm of overlap should be achieved. Lastly, full cementation helped maintain the whole construct among the interfaces of the humeral canal, the nail, and the stem. The additional allografts impacted into the periprosthetic bone defect will provide further bone stock. In our experience, there was not any sign of construct loosening despite immediate mobilization from the first postoperative day. All the patients achieved painless and stable elbows early, and were able to return to normal activity.

The large and long nail-stem construct can eliminate the development of stress risers commonly seen in the thin and short stems, which were the major problems causing instability and progressive loosening. With a positive result seen in the revision scenarios, we applied this construct method in Case 3 with traumatic osteoarthritis in the primary setting to prevent further periprosthetic fracture with recalcitrant nonunion. However, this needs to be verified in more cases with longer follow-up periods.

This study has some limitations. The follow-up time was short, and the case number was small. Besides, it is a technically demanding procedure; therefore, a favorable outcome may not be assured in inexperienced hands. Future studies should include more cases with a longer follow-up period to assess the efficacy of this method.

In summary, we highlighted the nail-stem construct as an innovative, inexpensive, and durable alternative procedure that can be used successfully in the setting of revision of TEA without the need for component exchange or hinge disassembly.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This study was not funded by any private or government funding agency.

References

1. Gschwend N, Scheier NH, Baehler AR. Long-term results of the GSB III elbow arthroplasty. *J Bone Joint Surg Br* 1999; 81-B: 1005–1012.

2. Krukhaug Y, Hallan G, Dybvik E, et al. A survivorship study of 838 total elbow replacements: a report from the Norwegian Arthroplasty Register 1994-2016. *J Shoulder Elbow Surg* 2018; 27: 260–269.

3. Jae-Man K, Kyoung-Hwan K, In-Ho J. Total elbow arthroplasty: clinical outcomes, complications, and revision surgery. *Clin Orthop Surg* 2019; 11: 369–379.

4. Kim JM, Mudgal CS, Konopka JF, et al. Complications of total elbow arthroplasty. *J Am Acad Orthop Surg* 2011; 19: 328–339.

5. Ersen A, Demirhan M, Atalar AC, et al. Is Coonrad-Morrey total elbow arthroplasty a

viable option for treatment of distal humeral nonunions in the elderly? *Acta Orthop Traumatol Turc* 2015; 49: 354–360.

6. Cil A, Veillette CJ, Sanchez-Sotelo J, et al. Linked elbow replacement: A salvage procedure for distal humeral nonunion. *J Bone Joint Surg Am* 2008; 90: 1939–1950.

7. Robert AK, Jennifer LD, Johannes S. Total elbow arthroplasty: elbow biomechanics and failure. *J Hand Surg Am* 2019; 44: 687e692.

8. Voloshin I, Schippert DW, Kakar S, et al. Complications of total elbow replacement: a systematic review. *J Shoulder Elbow Surg* 2011; 20: 158e168.

9. Little CP, Graham AJ, Karatzas G, et al. Outcomes of total elbow arthroplasty for rheumatoid arthritis: comparative study of three implants. *J Bone Joint Surg Am* 2005; 87: 2439–2448.

10. Ramirez MA, Cheung EV, Murthi AM. Revision total elbow arthroplasty. *J Am Acad Orthop Surg* 2017; 25: e166–174.

11. Verburg AD. Retrograde nailing of femoral fracture below a hip prosthesis: a case report. *J Bone Joint Surg Br* 1998; 80: 282–283.

12. Gheiti AJC, Baker JF, Brown TE, et al. Management of total femoral bone loss using a hybrid cement spacer surgical technique. *J Arthroplasty* 2013; 28: 347–351.

13. Corey Richards, Chris J Bell, Sameer Viswanathan, et al. Use of a cement-loaded Kuntscher nail in first-stage revision hip arthroplasty for massive femoral bone loss

secondary to infection: a report of four cases. *J Orthop Surg (Hong Kong)* 2010; 18: 107–109.

14. Zuurmond RG, Pilot P, Verburg AD, et al. Retrograde bridging nail in periprosthetic femoral fracture treatment which allows direct weight bearing. *Proc Inst Mech Eng H*. 2008; 222: 629–635.

15. Morrey ME, Sanchez-Sotelo J, Abdel MP, et al. Allograft-prosthetic composite reconstruction for massive bone loss including catastrophic failure in total elbow arthroplasty. *J Bone Joint Surg Am* 2013; 95: 1117–1124.

16. Sanchez-Sotelo J, O'Driscoll S, Morrey BF. Periprosthetic humeral fractures after total elbow arthroplasty: treatment with implant revision and strut allograft augmentation. *J Bone Joint Surg Am* 2002; 84: 1642–1650.

17. Ross AC, Sneath RS, Scales JT. Endoprosthetic replacement of the humerus and elbow joint. *J Bone Joint Surg Br* 1987; 69: 652–655.

18. Torbert JT, Fox EJ, Hosalkar HS, et al. Endoprosthetic reconstructions: results of long-term followup of 139 patients. *Clin Orthop Relat Res* 2005; 438: 51–59.

19. Gathen M, Norris G, Kay S, et al. Recalcitrant distal humeral non-union following previous Leiomyosarcoma excision treated with retainment of a radiated non-angiogenic segment augmented with 20 cm free fibula composite graft: A case report. *World J Orthop* 2019; 10: 212–218.

20. Melvin JS, Smith JL, Sims SH, et al. The use of an interference fit retrograde nail as an adjunct to plate fixation of a complex Vancouver B1 periprosthetic femoral fracture. Injury. 2012; 43: 1779–1782.

Figure legends

Figure 1. Case 1. Preoperative AP (A) and lateral (B) radiographs showing nonunion after multiple surgery. AP (C) and lateral (D) X-rays 30 months postoperatively showing solid union with stable fixation of stem–nail construct.

AP: anteroposterior

Figure 2. Checking the distal fit and adequate overlapping up to 5 cm between the nail and stem.

Figure 3. Case 1. Painless elbow with nearly full range of motion at 5 months postoperatively.

Tables

Table 1. Patient characteristic following total elbow arthroplasty with periprosthetic fracture

Table 2. Variable treatment methods of periprosthetic fracture following total elbow arthroplasty

Figure 1

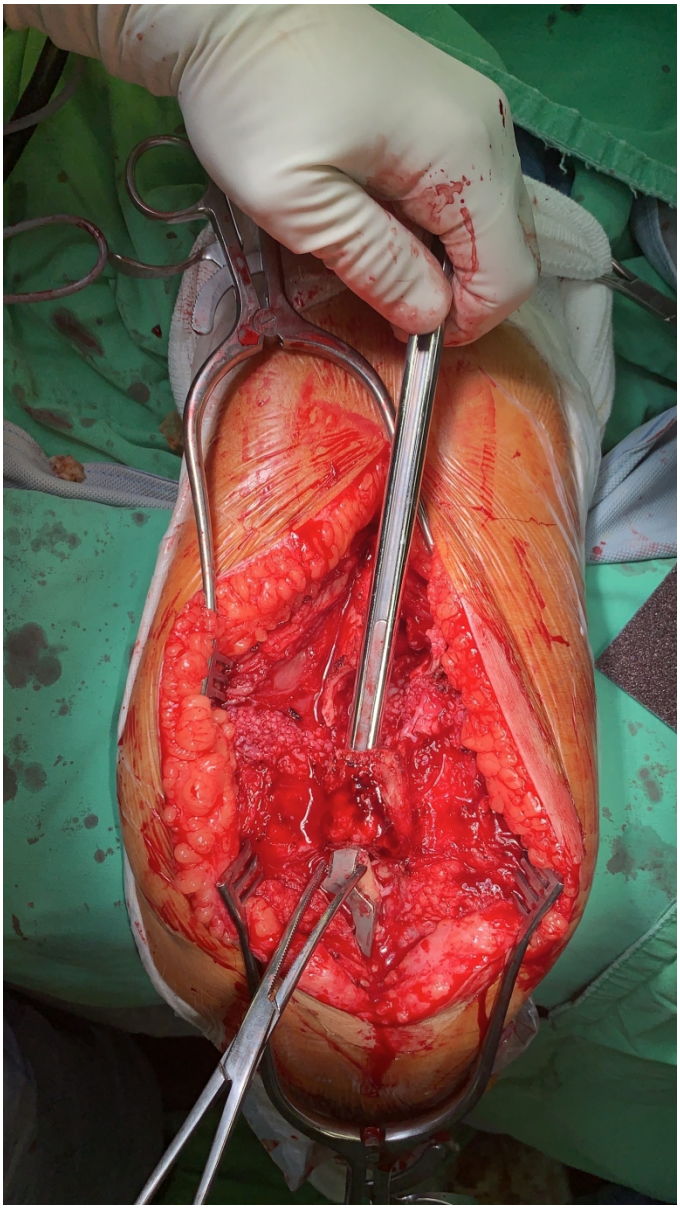

Figure 2

Figure 3

Table 1. Patient characteristic following total elbow arthroplasty with periprosthetic fracture

	Age	Gender	Previous operation times (exclude nail-stem construct)	Reason for *TEA	Primary *TEA to the Nail-stem construct	*Mayo classification	Blood loss	Operation time	Mean hospital stay	Pre/Post op VAS	Union	Follow time
Case 1	73 y/o	Female	5 times	*RA	12 years	II3	500 cc	2 hours 15 minutes	12 days	6/1	Solid union	30 months
Case 2	76 y/o	Female	4 times	*RA	10 years	II3	400 cc	2 hours 9 minutes	7 days	7/1	Solid union	24 months
Case 3	87 y/o	Female	1 time	*TOA	10 years	II3	300 cc	2 hours 8 minutes	7 days	7/1	Solid union	16 months
Case 4	81 y/o	Female	4 times	*TOA	10 years	II3	350 cc	4 hours 9 minutes	6 days	6/1	Solid union	12 months
average	79.3 y/o	-	3.5 times		10.5 years	-	387.5 cc	2 hours 40 minutes	8.5 days	6.5/1	-	-

*TEA : Total elbow arthroplasty, *RA : rheumatoid arthritis, *TOA : traumatic osteoarthritis

* Mayo classification: Humeral fractures, H-I : Fracture of the column or the condyles, H-II : Fracture around the stem (II1:Implant well fixed, II2: Implant loose with acceptable bone stock, II3: Implant loose with severe bone loss), H-II3 : Fracture proximal to the stem

Table 2. Variable treatment methods of periprosthetic fracture following total elbow arthroplasty

	Representative origin	Disadvantage	Advantage
Allograft-prosthetic composites	Morrey et al	limit functional outcome / unavailable in allograft shortage hospital	recreate a bone stock
Onlay allograft bone plating	Sanchez-Sotelo J	technique demanding procedure / substantial complication rate	satisfactory result
Endoprosthetic arthroplasty	Torbert JT	poor outcome / high complication rate	easy procedure / low technique demanding
Vascular graft + plating	Martin et al	difficulty with vessel end to end due to fibrosis and scarring	vascularity brings bone regeneration ability
Nail-stem construct	JT chien	technique demanding procedure / need longer follow time	Inexpensive/ innovative / durable alternative procedure