Annals of Clinical and Medical Case Reports

Research Article ISSN 2639-8109 | Volume 9

The 'Forklift' Cement-Nail Construct: A Technical Note for Creating a Highly Stable Antibiotic-Impregnated Static Cement Spacer in Complex First Stage Revision TKA

Shai Shemesh, Maria Vitenberg, Uri Barak and Nir Cohen

Department of Orthopedic Surgery, Rabin Medical Center, Petach Tikva 49100 and Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv 69978, Israel

***Corresponding author:**

Shai S Shemesh,
Department of Orthopedic Surgery Rabin Medical Center, Beilinson Campus 39 Jabotinski St., Petach Tikva 49100, Israel, Tel: 972-3-9376150/8,
Fax: 972-3-9376153,
E-mail: shemesh.shai@gmail.com

Received: 10 Apr 2022
Accepted: 25 Apr 2022
Published: 30 Apr 2022
J Short Name: ACMCR

Citation:

Shai Shemesh, The 'Forklift' Cement-Nail Construct: A Technical Note for Creating a Highly Stable Antibiotic-Impregnated Static Cement Spacer in Complex First Stage Revision TKA. Ann Clin Med Case Rep. 2022; V9(2): 1-4

1. Summary

Two-stage re-implantation, involving initial debridement and antibiotic delivery using a cement spacer followed by definitive reconstruction, provides effective treatment for knee Periprosthetic joint infection. Presented here is a simple and practical surgical technique for creating an antibiotic-impregnated cement-nail construct. A Küntscher nail together with two 3.5mm cortical screws are used as a reinforcing element, centered in the cement spacer and spanning from the femoral medullary canal to the tibial medullary canal, thus providing a framework for the spacer's construction. We have been using this technique for cases of chronically infected Total Knee Arthroplasties (TKA) with compromised soft tissue envelope, or as a bridge to arthrodesis or in cases of complications associated with conventional cement spacer blocks. This construct enables keeping the knee in extension without the need for a brace, allowing the soft tissue envelope around the knee to heal. Furthermore, it keeps the spacer centered in the knee joint, eluting antibiotics to the distal femur and proximal tibia.

2. Background

As the demand for primary total knee arthroplasty (TKA) increases, so is the need for revision is expected to be on the rise [1]. The use of antibiotic-impregnated polymethylmethacrylate (PMMA) bone-cement spacers, as a part of a two-stage revision re-implantation, is considered to be the standard of care for patients with a chronic periprosthetic joint infection (PJI) involving a primary TKA [2]. Cement spacer blocks came into use to maintain joint space and stability, prevent collateral ligament retraction, relieve knee pain from instability, and safely elute local antibiotic release [3]. Several clinical studies have shown antibiotic-impregnated cement to be effective in the two-stage re-implantation process recommended in the management of PJI [2,4-15]. Several complications have been associated, however, with the use of cement spacer blocks, including migration and invagination of the cement spacer and bone loss [2,16]. Deep infection rate following revision TKA is higher (up to 6%) than the deep infection rate following primary TKA [2,17], making the management of deep infection after revision TKA even more challenging. In cases of unsalvageable infected TKA, a knee arthrodesis can be considered [18,19]. This option may provide this challenging group of patients with a painless functional gait with low complication and reoperation rates [18]. Since Knee arthrodesis with nails or plates are probably best performed with a two-stage approach [19], an initial operative treatment consisting of debridement and insertion of an antibiotic- impregnated spacer is necessary. We have been advocating the use of intramedullary devices in conjunction with PMMA, to create a temporary construct with the knee fixed in extension. We have used this technique in cases of chronically infected TKA after several revision procedures, in patients with a compromised soft tissue envelope, as a bridge to arthrodesis, or in cases of complications associated with conventional cement spacers such as spacer dislocation and breakage.

3. Surgical Technique

A Küntscher nail (Biomet, Warsaw, Indiana) is utilized for building this cement-nail construct. Nail length and diameter should be estimated pre-operatively, considering the amount of bone loss and size of joint space. We found that a straight Küntscher Cloverleaf 11mm diameter and 36cm in length suitable for most cases. The midpoint of the nail is marked with a marking ink or scored using a diamond metal-cutting wheel. The procedure is performed through the parapatellar approach through previous skin incision (Figure 1). After a thorough debridement, medullary canal preparation, and obtaining multiple cultures, the knee is flexed, and the nail is inserted into the femoral medullary canal and excessively advanced retrogradely up the femur while its longitudinal slot facing anteriorly. This allows the knee to be extended in order to insert the nail into the tibial medullary canal. With the knee in extension, the nail is anterogradely advanced into the tibia using a vice-grip clamp and mallet as needed, to ensure its placement equidistant in the joint space, using the previous marking as a reference. The nail length should span for at least ten centimeters of each side of the joint. At this point, two laminar spreaders are used to open the joint space to create a quadrangular space to be later filled with antibiotic impregnated cement. Subsequently, we use two 3.5-4.5mm cortical screws, inserted into the longitudinal slot. The screws are inserted at the superior and inferior edges of the quadrangular joint space, against the femoral and tibial surfaces, respectively. Once inserted, the screws provide stability and maintenance of the quadrangular space after removal of the laminar spreaders and during cementation, preventing it from collapsing. Subsequently, antibiotic-loaded polymethylmethacrylate is prepared and poured into the space and around the nail, filling the joint space and areas of bone loss. We allow cement to fill the retropatellar space to prevent soft tissue adhesion and provide a larger surface area of cement for antibiotic elution. Partial weightbearing is allowed from post-operative day one, and there is no need for further knee immobilization. Implant removal is simple and requires breaking the spacer using osteotomes, removing the remaining cement around the nail, cutting the nail using a metal-cutting diamond wheel or manual metal cutter, followed by pulling out the femoral and tibial halves with the knee flexed. We used the Forklift technique in 8 cases between January 2015 and January 2020. The technique was specifically reserved for cases of chronically infected TKA after several revision procedures, in patients with a compromised soft tissue envelope such as: anterior sinuses, chronic wounds with skin breakdown, significant bone loss, or in cases of conventional cement spacers dislocation and breakage (Figure 2). All patients were allowed to ambulate and either second stage revision reimplantation or arthrodesis were finally carried out.

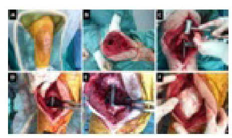

Figure 1: The cement nail construct preparation during first stage revision for a 186 chronic periprosthetic joint infection. (A) Preparing and draping the entire lower 187 extremity, preferably using a sterile drape with a pouch for circumferential fluid 188 collection. (B) Following a thorough debridement and synovectomy, the knee is 189 brought into flexion, and a Küntscher nail with the appropriate length and diameter is 190 excessively inserted in a retrograde fashion into the femoral canal, until extension of 191 the joint is possible. (C) With the knee in extension, the nail is advanced into the tibia 192 using a vice-grip clamp and mallet as needed, to ensure its placement equidistant in 193 the joint space. (D) A laminar spreader is used to open the joint space to create a 194 quadrangular space. (E) Two 3.5mm cortical screws, inserted into the longitudinal 195 slot using a screwdriver. The screws are inserted at the superior and inferior edges of 196 the quadrangular joint space, against the femoral and tibial surfaces, respectively. (F) 197 Cement is applied to the joint space around the nail as well as the retropatellar space, 198 and both medial and lateral gutters to reduce soft tissue adhesion.

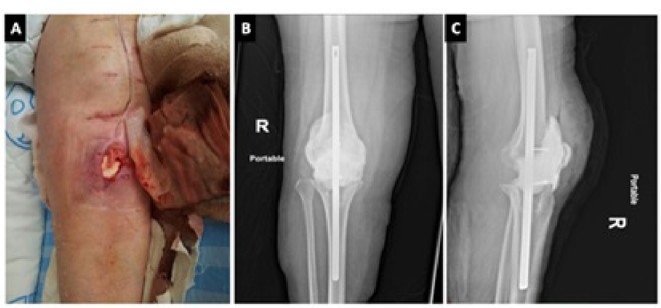

Figure 2: A 74-year-old female who presented with a chronic periprosthetic joint 201 infection in her right knee twelve months after her primary knee arthroplasty. She 202 then underwent a first stage revision with a cement spacer that eventually broke 203 through her skin leaving a large anterior soft tissue defect (A). A decision was made 204 to treat her with a repeat two-stage revision re-implantation, using the static cement-205 nail construct. Immediate anteroposterior (B) and lateral (C) postoperative 206 radiographs at the first-stage operation show the antibiotic-impregnated cement nail 207 construct in situ. Following her first stage revision, the patient was able to ambulate 208 using a walker.

4. Discussion

The choice of the spacer should be based on several factors, including the amount of bone loss, the condition of the soft tissues, the need for joint motion and the selection of the antibiotics [2]. The use of static spacers was found to be coincident with impaired function in the interim between stages owing to movement restriction and the frequent need of brace immobilization, quadriceps and collateral ligament shortening and arthrofibrosis, and challenging surgical exposure in the second-stage reconstruction [3]. Tibial bone loss was also reported to occur with the use of non- articulating spacers in about 50% of the cases, and the bone defect size was found to positively correlate with the length of the interim period [16]. On the other hand, articulating spacers have been shown to provide an increased post-operative range of motion, minimized pain, improved function, and facilitated the second-stage procedure by maintaining soft-tissue planes [2,11]. However, non-articulating knee spacers are considered a better option for knees with severe bone loss, as the mobile spacers cannot maintain stability in these settings [11]. Advocates of static spacers also claim placing the wound at rest as a basic principle of infection treatment [3]. The technique described here should be reserved for specific clinical situations in which a staged revision with the use of a conventional articulating spacer is unlikely to yield favorable results. It has been effectively used in cases of repeat revisions because of recurrent infections with a considerable bone loss, precluding the use of an articulating cement spacer. It is also appropriate in cases of complications of a conventional spacer, such as anterior migration of the spacer breaking through the skin, allowing the soft tissues around the knee to heal without undue tension. We found several advantages for this spacer technique. First, using a long Küntscher nail provides supplementary stability to the construct and facilitates weight bearing with the knee in extension. Further stability is achieved by the expansion of the articular space. Second, the ‘forklift’ simply created with screws spans the joint space and creates a quadrangular space to hold the cement in place, preventing it from migrating anteriorly. This allows a larger volume of cement to remain inside the joint space, potentially eluting more antibiotics. Third, the stability achieved by the cement nail construct prevents additional bone loss seen in simple static cement spacer blocks, that was shown to occur especially in undersized cement blocks [16]. Since bone spacer motion as well as scarring within the knee joint may lead to decreased ultimate range of motion [20,21], we believe that eliminating spacer motion may prevent that from happening. Lastly, this quadrangular gap keeps the medial and lateral collateral ligament complexes taught until the second stage revision is performed. Although static spacers using intramedullary pins and commercially available rods have been previously described [22-24], we found the Küntscher nail to be more adequate for the purpose as it is stiff, symmetrical on both ends, does not require canal preparation with reaming, and is inexpensive. Furthermore, it allows screw placement into the longitudinal slot [25] to create joint distraction during the cementation, thus eliminating the need for manual distraction by the assistant during the entire cementation. We found this technique to be simple and reproducible, and had no complications such as dislocation, fracture, or fragmentation of the spacer in the interim between the first and second stages of revision TKA for PJI. Implant removal is simple and requires breaking the spacer using osteotomes, removing the remaining cement posterior and anterior to the nail, cutting the nail using a metal-cutting diamond wheel followed by pulling out the femoral and tibial halves with the knee brought into flexion. We strongly recommend that this technique will be used in conjunction with aggressive debridement, appropriate antibiotic therapy, and vigilance of inflammatory markers.

References

1. Suarez J. Why do revision knee arthroplasties fail? J Arthroplasty. 2008; 23: 99-103. 214.
2. Cui Q. Antibiotic-impregnated cement spacers for the treatment of infection 215 associated with total hip or knee arthroplasty. The Journal of Bone & Joint Surgery. 2007; 89(4): 871-882.
3. Romano CL. Two-stage revision of septic knee prosthesis with articulating 218 knee spacers yields better infection eradication rate than one-stage or two-stage 219 revision with static spacers. Knee Surg Sports Traumatol Arthrosc. 2012; 20(12): 220 2445-53.
4. Anderson JA. An articulating spacer to treat and mobilize patients with 222 infected total knee arthroplasty. The Journal of arthroplasty. 2009; 24(4): 631-635.
5. Cuckler JM. The infected total knee: management options. The Journal of 224 arthroplasty. 2005; 20: 33-36.
6. Durbhakula SM. Antibiotic-loaded articulating cement spacer in the 2-stage 226 exchange of infected total knee arthroplasty. The Journal of arthroplasty. 2004; 227 19(6): 768-774.
7. Garvin KL, BS Konigsberg. Infection following total knee arthroplasty: 229 prevention and management. Instructional course lectures. 2012; 61: 411.
8. Hart W, R Jones. Two-stage revision of infected total knee replacements using 231 articulating cement spacers and short-term antibiotic therapy. Journal of Bone & 232 Joint Surgery, British Volume. 2006; 88(8): 1011-1015.
9. Joseph TN, AL Chen, PE Di Cesare, Use of antibiotic-impregnated cement in 234 total joint arthroplasty. Journal of the American Academy of Orthopaedic Surgeons. 2003; 11(1): 38-47.
10. Meek RD. Patient satisfaction and functional status after treatment of 237 infection at the site of a total knee arthroplasty with use of the PROSTALAC 238 articulating spacer. The Journal of Bone & Joint Surgery. 2003; 85(10): 1888-1892.
11. Pitto R, I Spika. Antibiotic-loaded bone cement spacers in two-stage 240 management of infected total knee arthroplasty. International orthopaedics. 2004; 241 28(3): 129-133.

12. Pitto RP. Pre-formed articulating knee spacer in two-stage revision for the 243 infected total knee arthroplasty. International orthopaedics. 2005; 29(5): 305-308.
13. Stevens CM. An articulated antibiotic spacer used for infected total knee 245 arthroplasty: a comparative in vitro elution study of Simplex® and Palacos® bone 246 cements. Journal of orthopaedic research. 2005; 23(1): 27-33. 247.
14. Takahira N. Treatment outcome of two-stage revision total hip arthroplasty 248 for infected hip arthroplasty using antibiotic-impregnated cement spacer. Journal of 249 orthopaedic science. 2003; 8(1): 26-31.
15. Tsukayama DT, VM Goldberg, R Kyle. Diagnosis and management of 251 infection after total knee arthroplasty. The Journal of Bone & Joint Surgery. 2003; 252 85: S75-S80.
16. Calton TF, TK Fehring, WL Griffin. Bone loss associated with the use of 254 spacer blocks in infected total knee arthroplasty. Clinical orthopaedics and related 255 research. 1997; 345: 148-154.
17. Hanssen AD, RT Trousdale, DR Osmon. Patient outcome with reinfection 257 following reimplantation for the infected total knee arthroplasty. Clinical 258 orthopaedics and related research. 1995; 321: 55-67.
18. reinfection Pow. Arthrodesis of the knee with a long intramedullary nail 260 following the failure of a total knee arthroplasty as the result of infection. The 261 Journal of Bone & Joint Surgery. 2006; 88(3): 553-558.
19. Conway JD, MA Mont, HP Bezwada, Arthrodesis of the knee. The Journal of 263 Bone & Joint Surgery. 2004; 86(4): 835-848.
20. Emerson RH. Comparison of a static with a mobile spacer in total knee 265 infection. Clin Orthop Relat Res. 2002; 132-8.
21. Haddad FS. The PROSTALAC functional spacer in two-stage revision for 267 infected knee replacements. Prosthesis of antibiotic-loaded acrylic cement. J Bone 268 Joint Surg Br. 2000; 82(6): 807-12.
22. Antoci V. Using an antibiotic-impregnated cement rod-spacer in the 270 treatment of infected total knee arthroplasty. Am J Orthop (Belle Mead NJ). 2009; 271: 31-3.
23. Kotwal SY. Intramedullary rod and cement static spacer construct in 273 chronically infected total knee arthroplasty. J Arthroplasty. 2012; 27(2): 253-259.
24. Yoo J. The modified static spacers using antibiotic-impregnated cement rod in 276 two-stage revision for infected total knee arthroplasty. Clin Orthop Surg. 2011; 3(3): 277.
25. Boopalan PR, The efficacy of single-stage open intramedullary nailing of 279 neglected femur fractures. Clin Orthop Relat Res. 2014; 472(2): 759-64.