MENTORS IN ORTHOPEDICS

SUCCESSFUL TREATMENT OF ACTIVE SEPTIC KNEE ARTHRITIS WITH SEVERE CHONDROLYSIS OR END STAGE OA WITH A TWO STAGE TKA CONCEPT

https://doi.org/10.71165/z2n0-73s4

AUTHORS

Siegfried Hofmann - LKH Murtal-Stolzalpe, Stolzalpe, Austria
Michael Eder-Halbedl - Orthopedic Hospital Murtal-Stolzalpe, Stolzalpe, Austria
Oliver Djahani - Orthopedic Hospital LKH Murtal-Stolzalpe, Stolzalpe, Austria
Markus Hochegger - Orthopedic Hospital Murtal-Stolzalpe, Stolzalpe, Austria
Martin Pietsch - LKH Murtal-Stolzalpe, Stolzalpe, Austria

SUMMARY

Background: Native septic arthritis of the knee is a complex surgical challenge, with up to 50% of cases involving this joint. Traditional treatments such as lavage and debridement fail in approximately 10% of patients, often leading to progressive chondrolysis and secondary osteoarthritis. While primary total knee arthroplasty (TKA) was historically contraindicated in the presence of active infection, recent evidence suggests that a staged approach may provide a viable alternative to arthrodesis or resection arthroplasty.

Objective: This article describes a standardized two-stage TKA protocol for treating active septic knee arthritis characterized by severe chondrolysis or advanced degenerative changes.

Key Points: The procedure involves radical synovectomy, debridement of the posterior capsule, and the removal of cruciate ligaments to ensure infection eradication. A temporary articulating spacer is constructed using a metal femoral component and a modified all-polyethylene tibial insert, fixed with high-dose antibiotic-loaded bone cement (3–4 g per 40 g of powder). Systemic antibiotic therapy is administered for six weeks based on culture results. Clinical data from 16 patients demonstrated a 100% infection eradication rate and significant functional improvement, with mean Knee Society Scores increasing from 58/17 preoperatively to 96/86 at a mean 6.1-year follow-up.

Conclusion: A two-stage TKA protocol utilizing an articulating antibiotic-loaded spacer is an effective strategy for managing active septic arthritis in the degenerate knee. This approach achieves high rates of infection clearance while restoring joint function and improving quality of life compared to salvage procedures.

KEYWORDS

Arthroplasty, Replacement, Knee; Arthritis, Infectious; Bone Cements; Anti-Bacterial Agents; Reoperation

INTRODUCTION

Native septic knee arthritis (SA) is rare with an incidence of 10 per 100.000, but the knee is involved in 50% of the cases [1]. Knee SA represents a constantly evolving surgical issue and diagnosis and therapy remains complex [2]. SA might occur after surgery, posttraumatic or hematogenous spread [3]. A second scenario includes patient with already existing OA which develop iatrogenic infection after intraarticular injection [4]. Therapeutic options include arthroscopic or open lavage and debridement combined with long term AB therapy [1]. Still up to 10 % of this therapy fails especially in posttraumatic cases and these patients develop progressive severe chondrolysis due to not controlled infection [5]. Furthermore, 25 to 50 % of patients who had knee SA in the past develop severe OA during their life span [6] .

Since these patients have severe pain and lost there QuoL arthrodesis or resection arthroplasty were the only therapeutic options in the past [3]. Arthrodesis with a well-functioning extensor mechanism is not a good option and resection arthroplasty of the knee can be recommended for wheelchair bound patients only. On the other hand, TKA was not an option in the past since an acute or persistent infection of a native knee was regarded as a classical contraindication for primary TKA [2]. The septic failure rate for primary TKA in SA shows a wide range from 3 to 36 % which depends on several risk factors and must be separated between active and quiescent SA [7]. Quiescent SA had the infection in the past and currently there are no signs of infection and lab tests are negative. Primary TKA after quiescent SA still has a 6.1 increased risk of PJI when compared with a control group [8]. The ideal time interval for implantation of a primary TKA after quiescent SA remains controversial [9]. We regard a two-year interval as safe to reduce the higher infection risk for quiescent SA as proposed by a multicenter study [10].

Two stage treatment of infected TKA with a special temporary AB spacer prosthesis has proven excellent function and a high infection eradication rate of 90% for the last two decades [11,12]. It was therefore logical that this two stage TKA concept might make sense to treat active SA with severe chondrolysis or OA [3]. We already started this therapeutic AB spacer concept 20 years ago in carefully selected patients and have recently published excellent functional results and an eradication rate of 100 % [13]. Using this two-stage concept infection eradication rates between 90 and 100 % could be confirmed for active SA by several other authors also [14–18].

In this paper we will focus on the indications, planning, AB therapeutic regime and details of the surgical technique to successfully treat native infected knees with severe chondrolysis or OA using a two stage TKA concept.

INDICATIONS

- Active septic knee arthritis with severe chondrolysis or OA
- Chronic osteomyelitis in epi- metaphyseal bone
- Quiescent septic arthritis with less 2 years after infection

CONTRA- INDICATIONS

- No severe chondrolysis or OA
- Young patient who prefers arthrodesis
- Older patient with high risk for two stage procedure (relative)
- Insufficient extensor mechanism (relative)
- Severe bony defects AORI type 3 (relative)

PLANNING

Full history should include pain and function before infection, cause of infection, all conservative and surgical therapies, microorganism, AB therapy as well as profession, sporting activities and expectations. Clinical examination should include skin, swelling, ROM, stability, and extensor mechanism function. Standard radiographs including special views, MRI and CT are summarized in table 1. Lab tests to exclude high risk factors and confirm infection are summarized in table 2.

Standard AP, lateral and skyline views
Plus Rosenberg view if AP normal
AP full leg HKA radiograph
Lateral full leg HKA with extraarticular deformity
Gd- enhanced MR imaging to exclude osteomyelitis
CT scan with severe bony defects

ESR and CRP
Hb and red blood cell counts
Hb1C in diabetes, liver, and kidney function
Knee aspiration (macroscopic, cell count and PMN)
Aerob and anaerob long term incubation

AB regime should be based on the current existing microorganism identified with aspiration and the co-morbidities of the patient must be addressed also. We recommend working in a team with infection specialists and microbiologists to identify the best personal AB treatment for the patient. AB regime includes high dose local

AB cement and systemic combined AB therapy. Table 3 summarizes currently used local AB for the cement. For the temporary AB spacer prosthesis 3 to 4 g AB/40 g powder is used for the cement. The systemic therapy includes combined microorganism specific AB with rifampicin or cephalosporine for 6 weeks. If no germ could be identified an empirical concept of combined AB therapy should be used local for the cement and the systemic therapy. For final implantation we use industrial prepared therapeutic AB cement with 2 g of AB/40 g powder in combination with combined systemic AB therapy according to the latest culture results. Systemic AB therapy is continued until the wound has healed completely and the results of the intraoperative biopsies are reported to be negative.

After the patient had been identified to be a reasonable candidate for this two stage AB spacer approach an intensive discussion with the patient on risks as well as pro- and cons to alternative treatment options, including arthrodesis, should be performed (Fig 1).

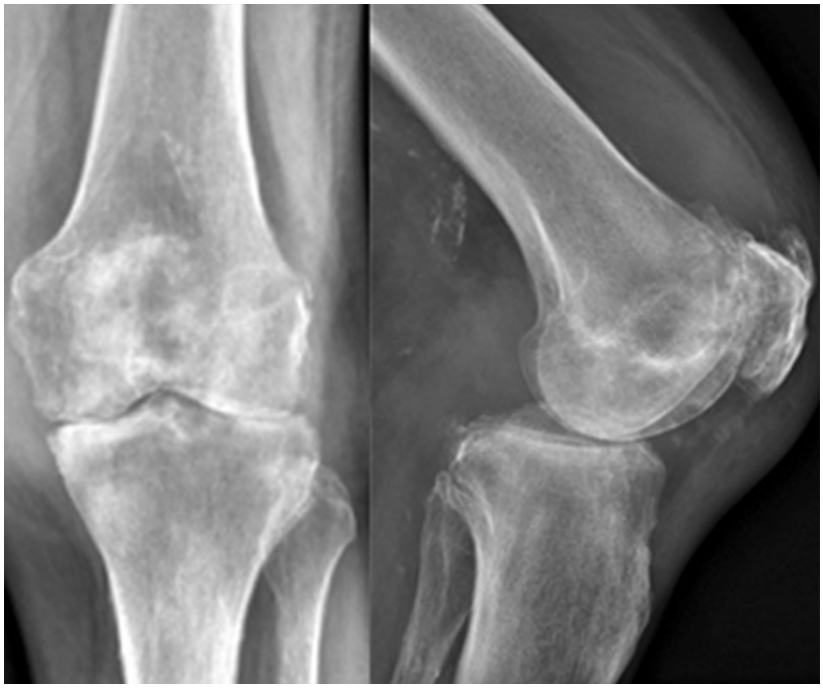

Figure 1: Case acute SA - 46-year male 1 year after infected ACL reconstruction, 3 failed DAIR procedures, persistent infection with severe chondrolysis in all three compartments and progressive pain

We offer the patient a 90% chance to eradicate the infection and 80% excellent to good functional outcome with this two stage TKA concept. When infection is cured reimplantation is planned after 6 to 12 weeks. If the first spacer fails a second spacer might be possible or arthrodesis will be an option as final solution. Since all our cases had been eradicated after the first spacer these options were not necessary so far. Finally, the patient should be able to understand the concept and must sign a consensus form that we will implant foreign material in an existing infected environment to prevent any legal conflicts for the future.

DEBRIDEMENT AND BONE CUTS

In general, this is no emergency and should be well planned and done by the most experienced team dealing with PJI. Type of anesthesia should be adopted to the patients' co-morbidities and must work for 60-90 min. Since there will be more blood loos 1 g tranexamic acid should be given before skin incision and before opening the tourniquet. After capsule closure additional 2 g of tranexamic acid is injected intraarticular and the deep drain

will be closed for 6 hours. Normally we do surgery without tourniquet, but in infected cases we prefer to use the tourniquet since there will be much bleeding during the radical debridement. 2 units of blood donation will be prepared although patients with HB > 11 normally don't need blood transfusion after surgery.

We perform all our knee surgeries with an electrical leg holder, which allows moving the knee from extension to full flexion and working in the back side of the knee in a hanging position without using additional retractors (Fig 2).

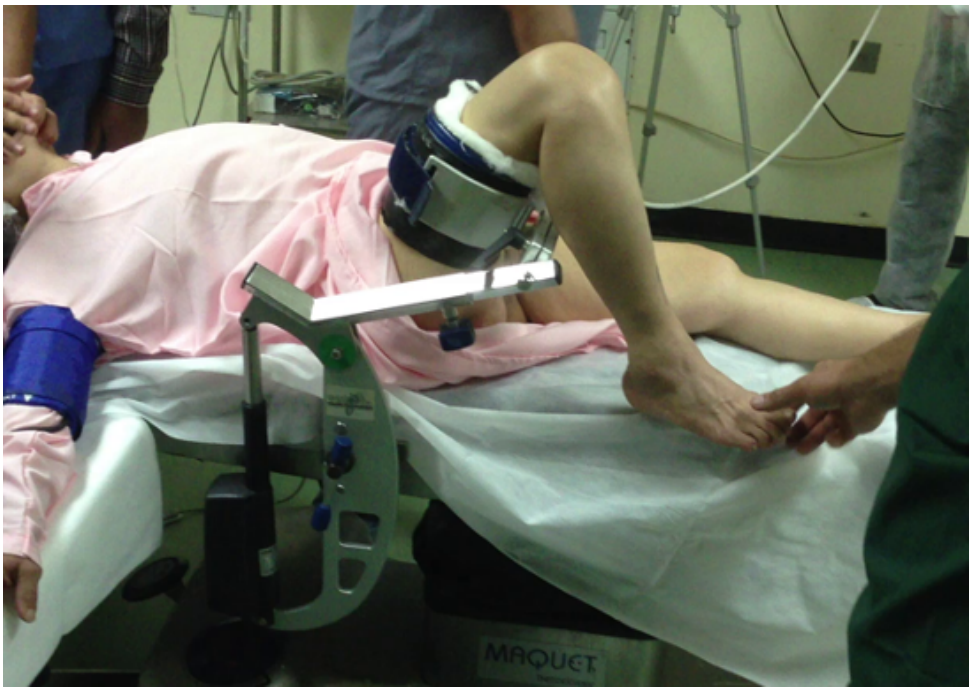

Figure 2: Electrical leg holder -Allows extension to full flexion and working in the back side of the knee in hanging position without addition retractors needed

Standard skin and medial parapatellar capsular incision is performed in flexion but might be adapted when additional scars are present. In patient with very bad skin conditions or already having a muscular flap consultation of a plastic surgeon is helpful. In extension the suprapatellar pouch is visualized by two sharp retractors. Sometimes the proximal skin incision and arthrotomy must be extended to get full view on the suprapatellar pouch. A quadriceps snip should be avoided and is not necessary in our experience. The first biopsy is taken from the suprapatellar pouch for microbiology. We start incubating in the OR by cross out the probes on an agar plate and additionally put the probe in a transfer tube under sterile conditions (Fig 3).

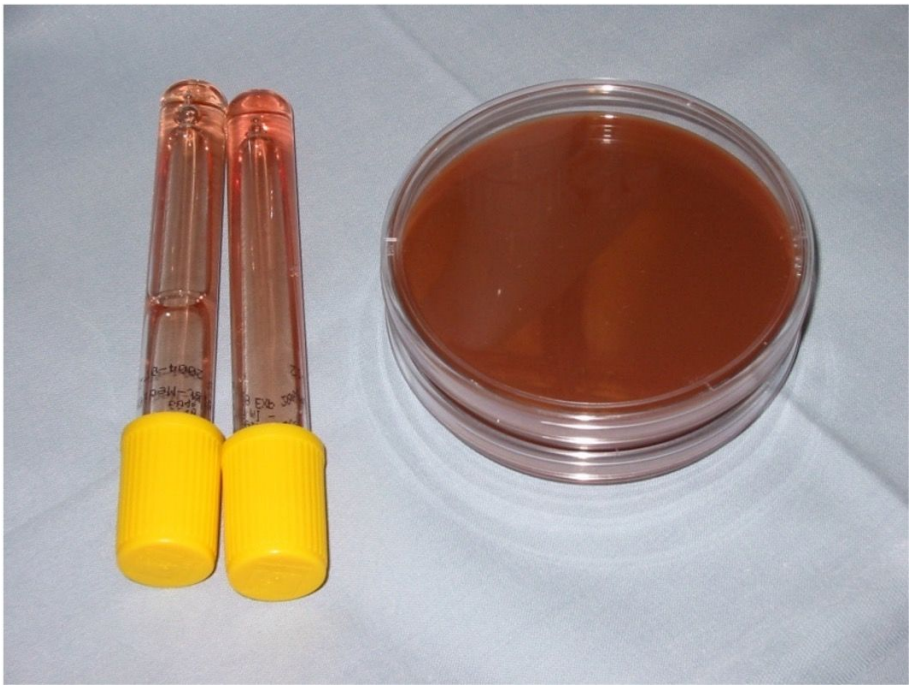

Figure 3: Incubation of the probes in the OR - Cross out on agar plate and biopsy transfer in sterile tube

The radical debridement starts with the medial suprapatellar pouch first (Fig 4).

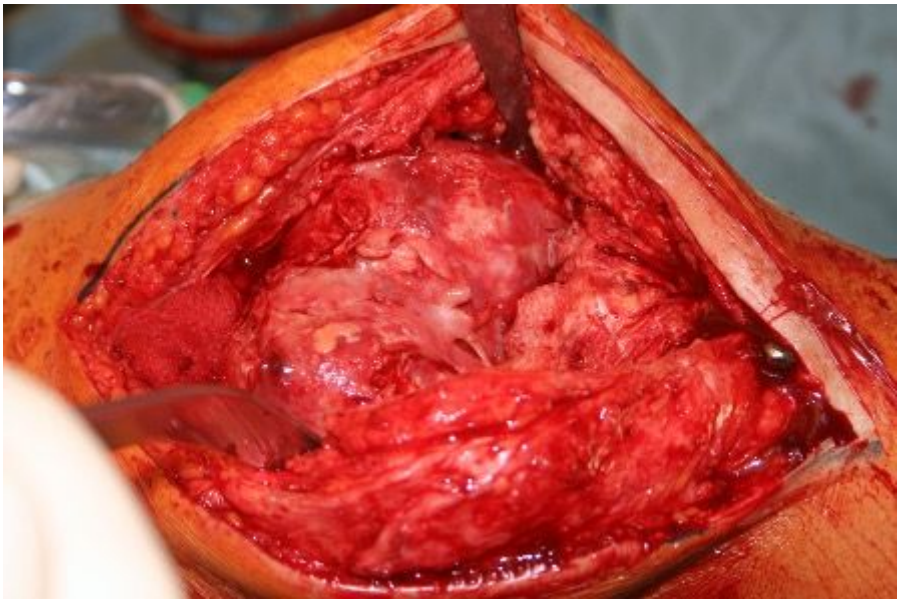

Figure 4: Radical debridement suprapatellar pouch - Try to get the thickened capsule out in one peace

Beginning from the proximal end, medial insertion at the femur but should stop distal at the level of the medial epicondyle to not resect the medial collateral ligament. When the right layer between the thickened capsule and the healthy soft tissue can be identified removal of the thickened medial capsule can be done in one piece After finishing the medial suprapatellar pouch and part of the medial gutter the superior genicular artery should be identified and coagulated at the medial femur diaphysis. The lateral suprapatellar pouch and part of the lateral gutter should be debrided in the same manner, but this might be more challenging distally since the extensor mechanism will be in the way. Next the Hoffa fat pad and any soft tissue inflammation or scarring behind the ligament patella should be excised completely. This will allow to free the ligamentum patella and prevent additional tension on the extensor mechanism during further surgery. The patella will be now everted in full extension to add debridement of the parapatellar tissue and the rectus tendon.

In 30° of flexion the medial deep MCL is released from the proximal tibia. In very stiff knees, where the approach might be difficult this can be extended to a full medial sleeve technique. This includes the posterior medial capsule and all five semimembranosus heads and allows to anteriorly dislocated and external rotate the tibia out to protect the extensor mechanism. The knee is now flexed to about 70° with the patella in a sliding position and ACL and part of the PCL is resected. A second tissue probe is taken from the dorsal capsule. Further tissues probe must be taken (min 3 up to five) from any suspicious region. As next step the radical debridement of the medial and lateral distal gutter is finalized in flexion by protecting medial the superficial MCL and lateral the LCL and popliteus tendon.

According to the preoperative planning the bone cuts are performed as in primary TKA using the "extension gap first" technique. The distal femur is cut perpendicular to the mechanical axis using an individual valgus correction angle. Care is taken that any bone loss or osteolysis is taken into to account to not resect more than 9mm. We us a simple caliper to control the correct depth and medial/lateral resection level for alignment correction with a caliper (Fig 5).

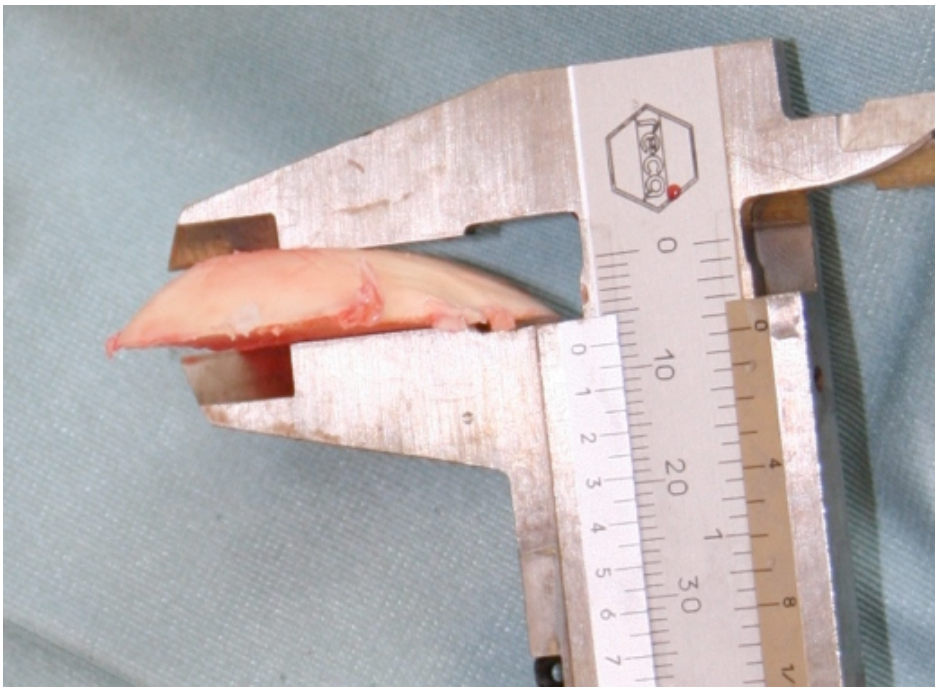

Figure 5: Verification of distal femur cut using a caliper to confirm proper resection

Next the proximal tibia cut is performed by using an extramedullary alignment system perpendicular to the mechanical axis. If there will be no severe bony deformity or bone loss a resection height of 10 – 12 mm on the healthy side should be used.

In full extension the all over alignment can be double checked and residual medial meniscus and thickened medial capsule should be resected using a laminar spreader in the lateral joint space. The medial MCL should be protected since it can be clearly seen and palpated in extension. The debridement should stop at the posterior-medial corner since the dorsal capsule will be done later in 90° flexion in hanging position. The lateral meniscus and capsule should be debrided in the same manner by positioning the laminar spreader in the medial joint space. The lateral posterior genicular artery should be cauterized. The balanced extension gap can now be checked with the 12 mm spacer block (this should be gone in otherwise you will not have enough space for the AB spacer prosthesis). At this stage we will accept any extension gap asymmetry for the AB spacer prosthesis and will not perform further soft tissue releases.

The knee is now brought in 90° of flexion and hanging position. For sizing and rotation of the femur 4in1 cutting block we prefer to use the combined technique by using landmarks and the soft tissue frame. Once the 4in1 cuts are made the knee is brought in full flexion and hanging position to allow save removal of any posterior osteophytes or soft tissue in the posterior superior pouch (Fig 6).

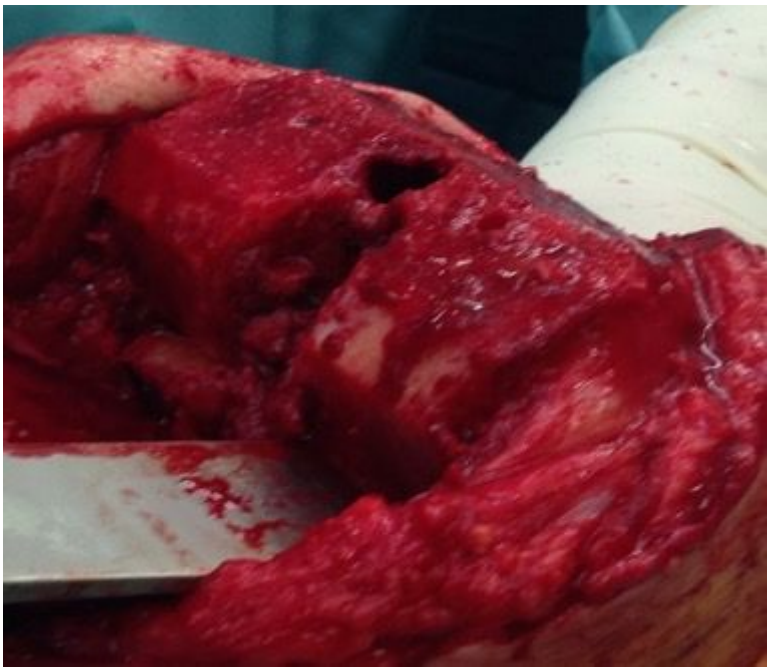

Figure 6: Removal of posterior osteophyte and soft tissue in the posterior superior pouch - Can be easily done in 120° flexion and hanging position by using an osteotome

This allows now further debridement of the dorsal capsule under tension in hanging position (Fig 7).

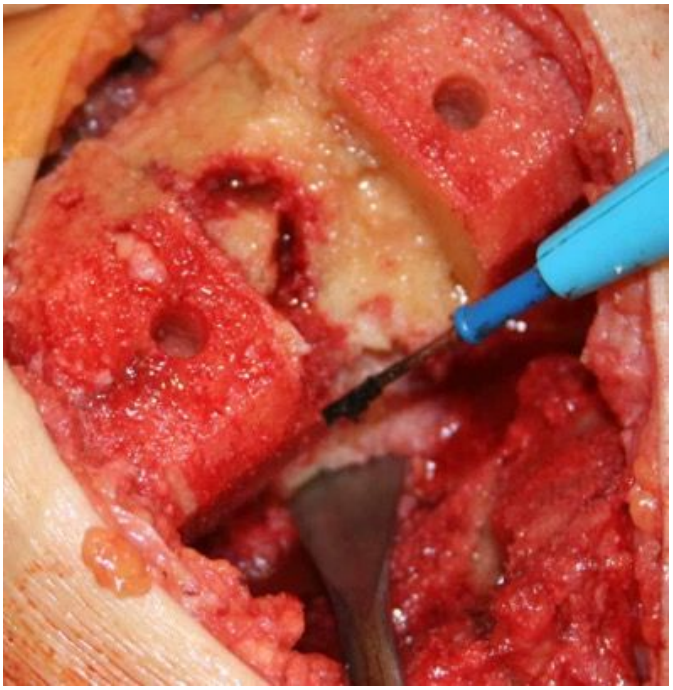

Figure 7: Debridement dorsal capsule - Should be performed from anterior to posterior under tensioning the dorsal capsule in hanging position

Any tightness in the center of the notch will still be residual PCL which has to be removed first. The dorsal capsule debridement starts with the medial side from anterior to the PCL in one layer like we have done already for the

suprapatellar pouch and gutters. Once you will see fat tissue you are too deep and should stop the debridement. If you are not sure if you have already removed the dorsal capsule, we recommend going back in full extension and feel the intact dorsal capsule. The same should be done for the lateral dorsal capsule but protecting the LCL and popliteus tendon and be aware that the neurovascular bundle is running slightly lateral to the PCL.

The complete debridement of the dorsal capsule and posterior superior pouch is the key point and makes the huge difference to the debridement with arthrotomy only. Without removing the cruciate ligaments and performing the bone cuts it is not possible to approach the posterior part of the knee for a radical debridement. If the infection has destroyed the dorsal capsule and extended already into the fossa poplitea the radical debridement must be extended beyond the dorsal capsule by protecting the neurovascular bundle. This is rare and should be planned before surgery and it is helpful to have a vascular surgeon to help or at least to be on call.

Any osteomyelitis bone must be removed completely according to the preop planning on MRI. The remaining contained defects will be filled with autologous bone chips from the bone cuts before cementing of the AB prosthesis. These bone chips should be soaked in vancomycin fluid (5 g vancomycin in 15 ml of saline) for 30 min (fig 8)

Figure 8: Impacting grafting for closed bony defects - with autologous bone chips soaked in vancomycin

TEMPORARY AB SPACER PROSTHESIS

After extensive pulslavage (5 to 9 liters) with normal saline new draping and gloves are necessary. For the temporary spacer prosthesis, we us one size larger standard PS femur and PS 10 mm PE insert fitting to the size of the proximal tibia. Using the trial components, it can be checked if there will be enough space in the flexion/ extension gap to allow a thicker cement mantle (Fig 9).

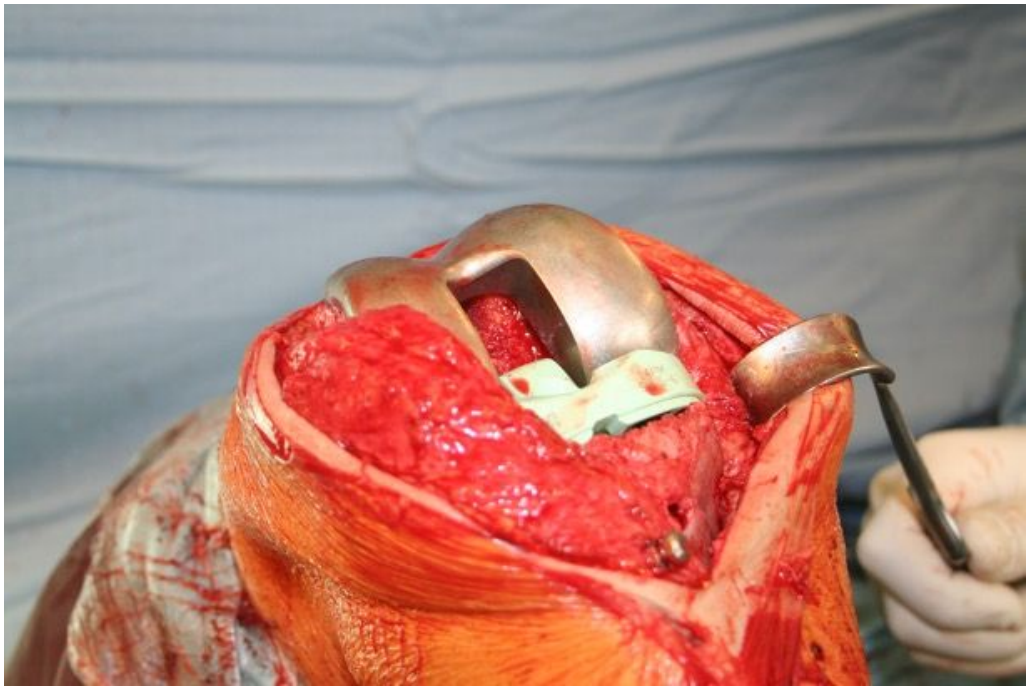

Figure 9: Trial component - Allows to check if the gaps are symmetric and big enough

Since we use a modified “all poly tibia without a keel” cement fixation holes are drilled into the backside of the poly insert with the 9 mm sharp drill. Therapeutic AB cement with 3 to 4 g of AB powder is hand mixed with the 40 g of PMMN powder (Fig 10 and Table 3). The AB cement is mixed for the tibia and femur separately and used for implantation once he is a doughy phase.

NFigure 10: Handmixing of AB cement - Using “pharmaceutical” mixing, AB powder first and step by step adding the cement powder

Situation	Antimicrobials	Fixation cement	Spacer cement
		Dose: per 40g PMMA cernent Black: industrially admixed antimicrobials Red: manuallv admixed antimicrobials	
Standard situation			
Susceptible or unknown pathogen(s)	Gentamicin + Clindamycin	1 g 1 g	1 g 1 g (+2 g vancomycin)
Special situation			
Staphylococcus spp. (oxacillin-/methicillin - resistant) or enterococci	Gentamicin + Vancomycin or +Daptomycin	0,5 g 1 g 2 g	0,5 g 2 g (+2 g[d]) 3 g
Vancomycin-resistant enterococci (VRE)	Gentamicin + Linezolid or Daptomycin or Fosfomycin-sodium	0,5 g 1 g 2 g 2 g	0,5 g - 1 g 2 g 3 gw 2-4 g
Resistant gram-negative pathogens (e.g. E. coli, Klebsiella, Enterobacter, Pseudomonas spp.)	Gentamicin + Colistin[b] or Fosfomycin-sodium or Meropenem or Ciprofloxacin	0,5 g 5-10 Mio IU 2 g 2 g 2 g	0,5 g - 1 g 10-20 Mio IU 2-4 g 3 g[c] 2-4 g
Yeasts (Candida spp.) or molds (e.g. Aspergillus spp.)	Gentamicin + (Amphotericin B liposomal (Ambisome®) or Voriconazol)	0,5 g 0,2 g[e] 0,2 g	0,5 g - 1 g 0,4 g[d,e] 0,4 g[d]

a. Fosfomycin-sodium is preferred over fosfomycin-calcium due to better mechanical properties of PMMA.
b. Available as colistin-sodium or colistin-sulfate (equal efficacy).
c. Improved efficacy and antimicrobial release in combination with gentamicin 1 g and clindamycin 1 g, which can be used as basis for admixing additional antimicrobials.
d. These AM concentrations do not fulfill the mechanical ISO requirements for fixation cement.
e. Literature is still controversial regarding minimal effective concentrations.

First the “all poly tibia” is implanted in flexion with full view on the proximal tibia surface. AB cement is but into the prepared keel and on the tibia surface with a layer of 1 cm. Any additional structural bone defect will be filled with AB bone cement. The poly insert is then carefully pressed into the proximal bone cut and the extra AB cement will fill the fixation holes and extrude to edges of the bone (Fig 11).

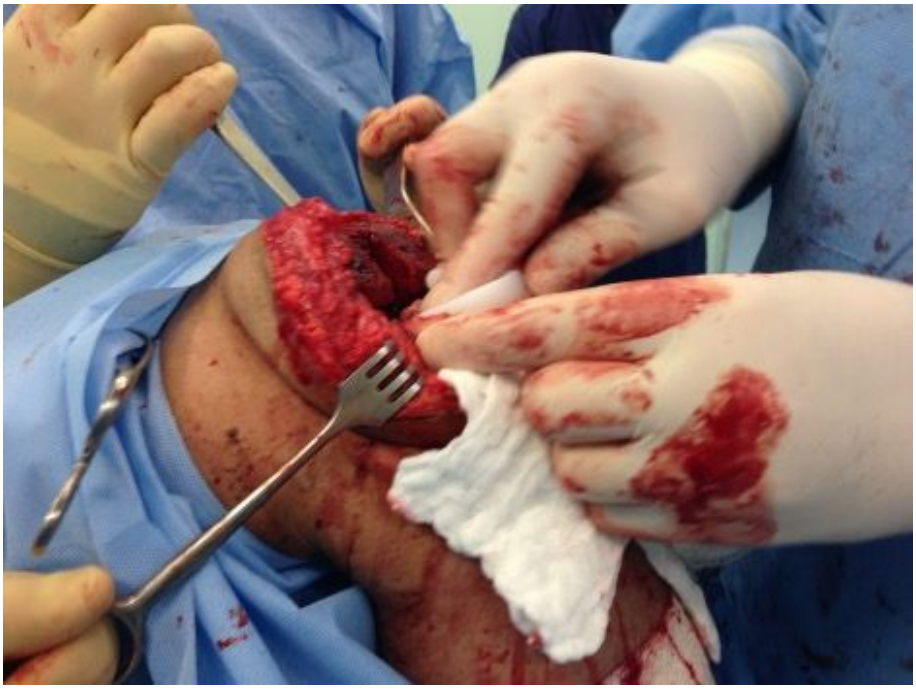

Figure 11: Insertion of the all-poly tibia -Carefully insertion by hand with control of the alignment and positioning. Extra cement should come out at the borders

This extra cement at the edges should now be modulated to achieve an additional circumferential fixation of the poly insert. The cementing technique should be the worst possible to prevent locking with the trabecular bone which will allow easy removal after 6 weeks. This includes using the cement in a doughy phase, no use of tourniquet, bloody and not clean bony surfaces and lifting the whole construct for a few cementers to allow lavage of the cement-bone interface before complete hardening of the AB cement. This allows a “press cementation” and

after complete hardening the tibia component might be taken out completely to guarantee that there will be no extra cement posterior (Fig 12).

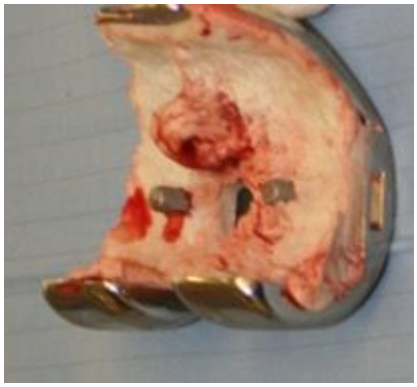

Figure 12: Press-fit cementation of components - After hardening of the cement, the components should be removed easily

Figure 12: Press-fit cementation of components - After hardening of the cement, the components should be removed easily

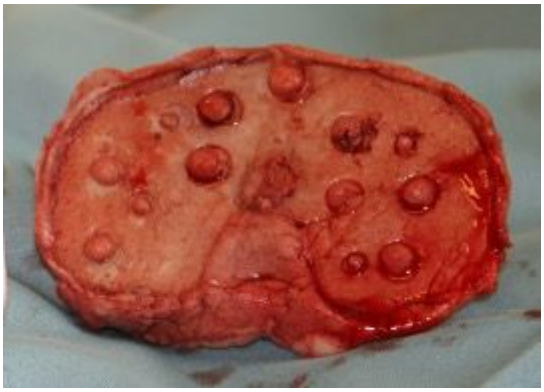

Figure 12: Press-fit cementation of components - After hardening of the cement, the components should be removed easily

After the tibia is completely done the femur will be cemented in full flexion by using the same “bad cementing technique” as described before for the tibia. The femur should not be fully seated, and some extra cement mantle should be left. The tibia is now connected to the femur cam will get behind the tibia post without dislocating the tibia or femur component. If you choose a CR tibia insert this maneuver will be less difficult, but you will lose sagittal stability for the AB spacer prosthesis. Balancing and alignment of the spacer prosthesis is now performed by the assistant standing at the end of the table and pulling on the leg and bringing the leg from flexion to full extension. In full extension the alignment should be clinical straight and by forced pulling the extension gap should be stable. Any correction of the alignment or to establish stability can still now be performed by changing the position of the femur and filling the interface with cement. Like at the tibia extra cement should be used to

stabilize the edges of the component and before complete hardening of the cement the construct should be lifted in flexion to lavage the interface.

After final hardening the femur component might be taken out completely to prove “press fit cementation” (Fig 11). With the temporary AB prosthesis in place (Fig 13) a final check for proper alignment, ROM and stability in extension and flexion should be checked. If there will be any doubt that the knee is not stable enough a brace should be used for mobilization.

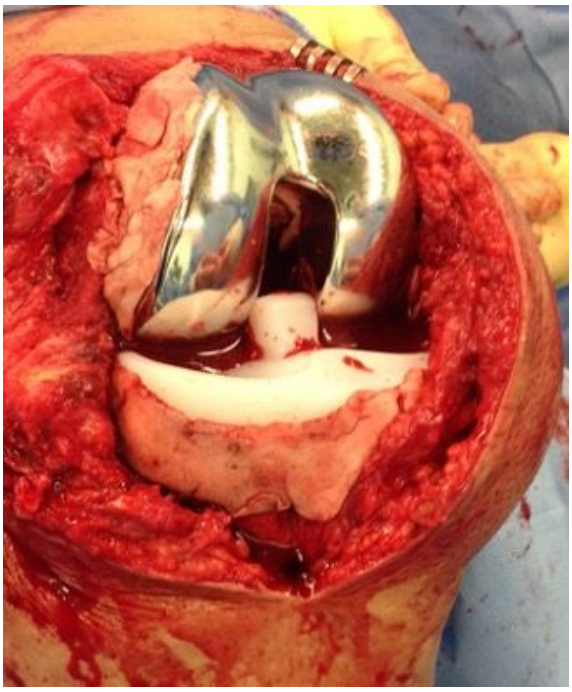

Figure 13: Temporary AB spacer construct - Consists of metal femur component, modified all-poly tibia and thick cement mantle of AB cement

The knee is closed in a standard fashion with one deep drain, which is closed for the first 6 hours. Systemic AB therapy is started in the OR. A long brace which allows flexion is added only if the knee would not be stable enough. X-rays in two layers are performed either intra OR ore before mobilization to confirm proper positioning of the implant (Fig 14)

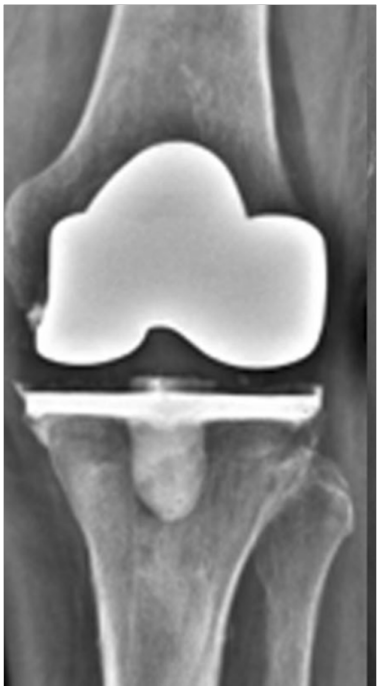

Figure 14: Spacer post OP radiograph - This shows proper alignment, thick cement mantle and proper positioning of the spacer

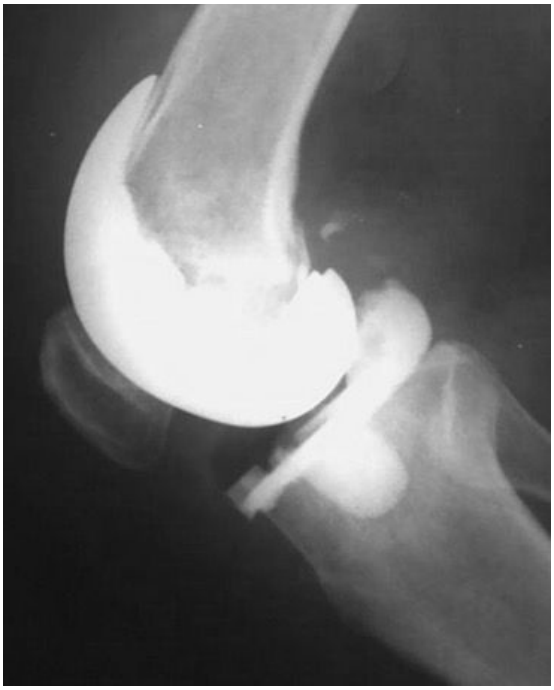

Figure 14: Spacer post OP radiograph - This shows proper alignment, thick cement mantle and proper positioning of the spacer

INTERVAL TO FINAL IMPLANTATION

Removal of the deep drain is performed after 24 hours, and standard wound care is performed. The patient is discharged on day five when the wound is dry, patient is fully mobilized with two crutches with partial weight bearing, flexion more 60° and AB therapy is changed to oral treatment. The patient is instructed that full weight-bearing is possibly for a few steps but otherwise the crutches should be used. Daily exercises performing muscle strengthening, coordination training and increasing flexion to 90° like we do for primary TKA are prescribed.

Once a week the physiotherapist should control the program. Final implantation is planned in 6 weeks, and every two weeks a lab test with CRP, Hb, electrolytes, kidney and liver function should be performed. The additional lab tests also depend on the type of AB therapy used. The final implantation is verified at the 6 weeks control where the wound must be well healed, patient report no night pain and the CRP curve is showing no signs of persistent infection (Fig 15).

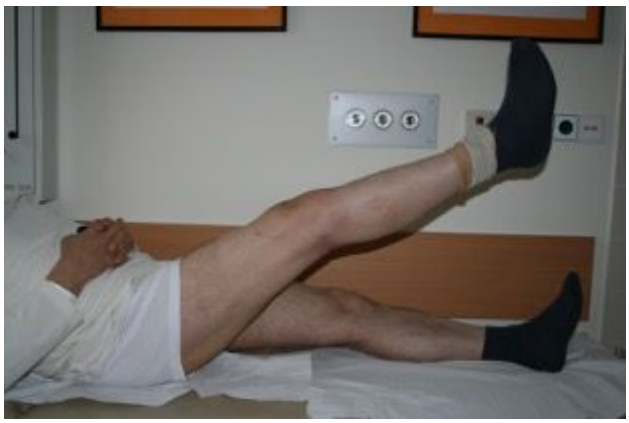

Figure 15: Clinical 6 weeks control - Shows normal wound healing, stable joint with good ROM

Figure 15: Clinical 6 weeks control - Shows normal wound healing, stable joint with good ROM

We do not aspirate the joint at 6 weeks to confirm healing of the infection. If the infection is not cured after 6 weeks, we would go for another AB spacer or arthrodesis, but all patient in our serious the infection was healed after 6 weeks.

FINAL IMPLANTATION

After planning and preparing the revision implant with stems, metal blocks, and metaphyseal fixation options the final implantation is done in a standard way as described in a previous study [12]. Although depending on bony defects and ligament situation a primary implant might be possible, we routinely use a revision implant which allows additional stem fixation and higher constraint when needed. “Less constrained possible” is used for the final implantation therefore, our favorite implant is a varus/valgus constrained design which allows the use of a PS insert in balanced knees (Fig 16).

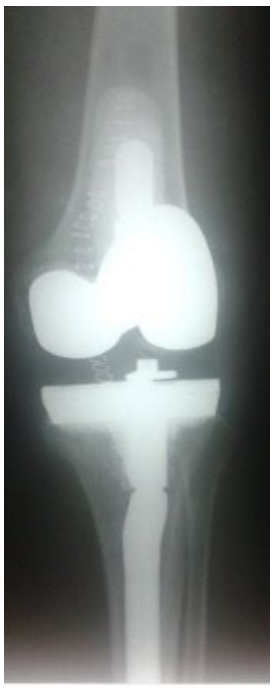

Figure 16: X-ray after final implantation - Shows a varus/valgus constraint implant with stems, but PS insert (note the AP x-ray is externally rotated)

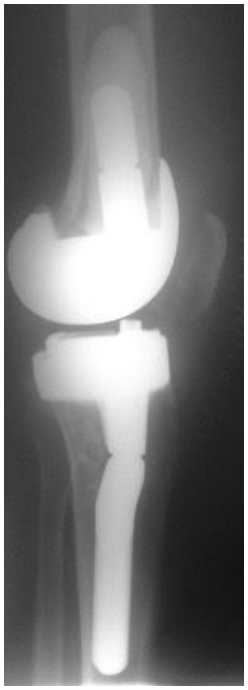

Figure 16: X-ray after final implantation - Shows a varus/valgus constraint implant with stems, but PS insert (note the AP x-ray is externally rotated)

RHK would be used only in knees with insufficient extensor mechanism, global instability, severe bone defects AORI type 3, recurvatum or joint line changes > 8 mm. This is very rare in this scenario with SA knees. Removal of the AB prosthesis should be possible very easy, otherwise the implantation was not done “press fit” (Fig 17).

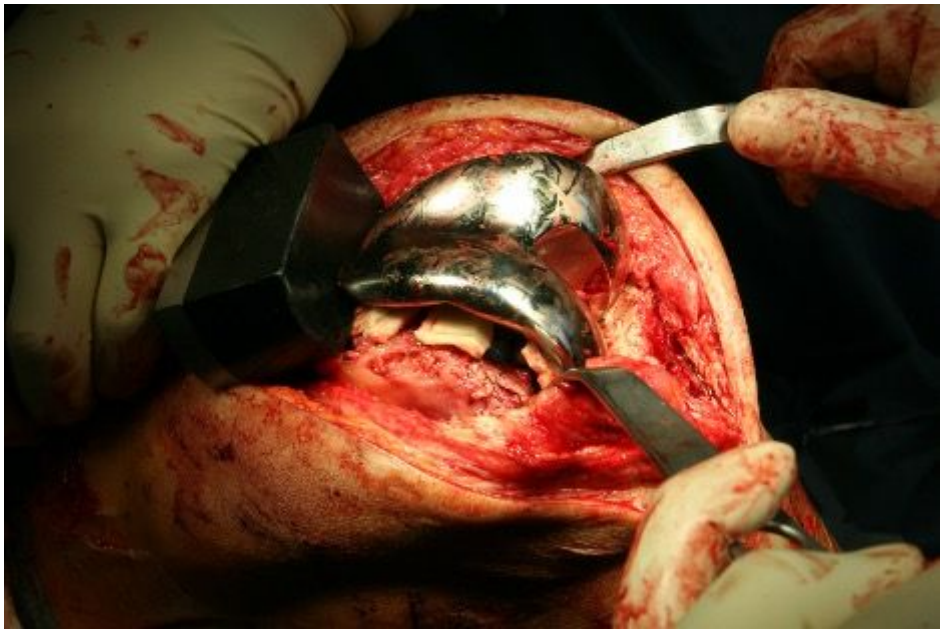

Figure 17: Spacer removal - Should be easy otherwise the “press fit” fixation was not done well

A second radical debridement and taking 3 to 5 probes is performed again. Postoperative management is the same as with standard revision TKA patients with partial weightbearing, daily exercises, multimodal pain management and 6 weeks clinical and radiographic control.

OWN RESULTS

16 consecutive patients with active SA had been treated with a two stage TKA procedure between 2006 and 2016. Mean FU was 6.1 years (range 2.0 to 9.9 years) and no patient was lost for FU. The median number of prior open or arthroscopic debridement before the two-stage procedure was 2 (range 1 to 6). All patients showed clinical and laboratory sign of a septic arthritis with severe chondrolysis or OA. The infection was cured after 6 weeks for all knees. Final implantation was performed between 6 to 12 weeks in all patients with a varus/valgus constraint implant (NexGen LCCK, Zimmer, Warsaw). Only three knees needed a CCK insert, whereas 13 knees were stable enough for using a PS insert only. For the AB spacer and final implantation no intra- or postoperative complications occurred.

No patient needed a brace for mobilization and all patients where highly satisfied with their pain and function in the interval. They reported residual pain only, were able to walk without crutches with good ROM and many of them even ask if the final implantation will be necessary. After final implantation the patients showed comparable outcome to normal primary knees. The mean KSS objective and function score increased significantly from preop situation (58/17) to after spacer implantation (75/46) and further improved after TKA implantation at the final FU (96/86). The mean VAS score was 6.5 preop, decreased to 2.1 after the spacer and 1.2 after TKA at final FU. At final FU no clinical or radiographic signs of infection, loosening or osteolysis could be identified in all patients.

REFERENCES

1. Acosta-Olivo C, Vilchez-Cavazos F, Blázquez-Saldaña J, Villarreal-Villarreal G, Peña-Martínez V, Simental-Mendía M. Comparison of open arthrotomy versus arthroscopic surgery for the treatment of septic arthritis in adults: a systematic review and meta-analysis. Int Orthop 2021;45(8):1947–1959.

2. Mathews CJ, Weston VC, Jones A, Field M, Coakley G. Bacterial septic arthritis in adults. Lancet 2010;375(9717):846–855.

3. Davis CM, Zamora RA. Surgical Options and Approaches for Septic Arthritis of the Native Hip and Knee Joint. J Arthroplast 2020;35(3):S14–S18.

4. Elsissy JG, Liu JN, Wilton PJ, Nwachuku I, Gowd AK, Amin NH. Bacterial Septic Arthritis of the Adult Native Knee Joint: A Review. Jbjs Rev 2020;8(1):e0059.

5. Tahmasebi MN, Vaziri AS, Miresmaeili SH, Bozorgmanesh MR, Mirkarimi S, Zehtab MJ, et al. Two-stage Total Knee Arthroplasty for Treatment of Surgical Failure of Septic Arthritis in Degenerative Knee Joints. Archives Bone Jt Surg 2020;8(4):524–530.

6. Chen C-M, Lin H-H, Hung S-C, Huang T-F, Chen W-M, Liu C-L, et al. Surgical Treatment for Septic Arthritis of the Knee Joint in Elderly Patients: A 10-year Retrospective Clinical Study. Orthopedics 2013;36(4):e434-43.

7. Tan T, Xu C, Kuo F-C, Ghanem E, Higuera C, Parvizi J. Risk Factors for Failure and Optimal Treatment of Total Joint Arthroplasty for Septic Arthritis. J Arthroplast 2020;

8. Bettencourt JW, Wyles CC, Fruth KM, Osmon DR, Hanssen AD, Berry DJ, et al. Outcomes of Primary Total Knee Arthroplasty Following Septic Arthritis of the Native Knee: A Case-Control Study. J Bone Joint Surg 2021;103(18):1685–1693.

9. Bezwada HP. CORR Insights®: Patients with a History of Treated Septic Arthritis are at High Risk of Periprosthetic Joint Infection after Total Joint Arthroplasty. Clin Orthop Relat R 2019;1.

10. Sultan AA, Mahmood B, Samuel LT, George J, Faour M, Pelt CE, et al. Patients with a History of Treated Septic Arthritis are at High Risk of Periprosthetic Joint Infection after Total Joint Arthroplasty. Clin Orthop Relat R 2019;477(7):1605–1612.

11. Kuzyk PRT, Kuzyk P, Dhotar HS, Sternheim A, Gross AE, Safir O, et al. Two-stage revision arthroplasty for management of chronic periprosthetic hip and knee infection: techniques, controversies, and outcomes. J Am Acad Orthop Sur 2014;22(3):153 164.

12. Pietsch M, Hofmann S, Wenisch C. Zweizeitiger Prothesenwechsel bei infizierter Knieendoprothese. Operative Orthopädie Und Traumatologie 2006;18(1):66–87.

13. Pietsch M, Hochegger M, Djahani O, Hofmann S, Mlaker G, Eder-Halbedl M, et al. A two-stage approach to primary TKA using articulating antibiotic-loaded spacers improve function and eradicate infection in septic arthritic knees. Knee Surg Sports Traumatology Arthrosc 2021;29(10):3186–3194.

14. Bauer T, Lacoste S, Lhotellier L, Mamoudy P, Lortat-Jacob A, Hardy P. Arthroplasty following a septic arthritis history: A 53 cases series. Orthop Traumatology Surg Res 2010;96(8):840 843.

15. Nazarian DG, Jesus D de, McGuigan F, Booth RE. A two-stage approach to primary knee arthroplasty in the infected arthritic knee. J Arthroplast 2003;18:16–21.

16. Seo J-G, Moon Y-W, Park S-H, Han K-Y, Kim S-M. Primary Total Knee Arthroplasty in Infection Sequelae About the Native Knee. J Arthroplast 2014;29(12):2271–2275.

17. Shaikh AA, Ha C, Park Y, Park Y. Two-stage Approach to Primary TKA in Infected Arthritic Knees Using Intraoperatively Molded Articulating Cement Spacers. Clin Orthop Relat R 2014;472(7):2201–2207.

18. Xu C, Kuo F-C, Kheir M, Li X, Chai W, Chen J-Y. Outcomes and predictors of treatment failure following two-stage total joint arthroplasty with articulating spacers for evolutive septic arthritis. Bmc Musculoskelet Di 2019;20(1):272.