SURGICAL TECHNIQUES

RESURFACED ALLOGRAFT-PROSTHETIC
COMPOSITE FOR PROXIMAL TIBIAL
RECONSTRUCTION IN CHILDREN

Marco Manfrini, MD, Davide Donati, MD, Marco Colangeli, MD, Laura Campanacci, MD

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Introduction

Reconstruction of the proximal part of the tibia in children with use of an unconstrained tibial component cemented in an allograft-prosthetic composite after proximal tibial resection spares the distal femoral physis and articular cartilage, maintains the bone stock of the tibia, and allows the allograft to be adapted to the small tibial dimension in very young patients¹⁻⁶.

Patients considered for this technique are children or adolescents with a metaphyseal-epiphyseal sarcoma of the proximal part of the tibia, without tumor extension into the knee ligaments or capsule, and with a satisfactory clinical response to preoperative chemotherapy. Multiplanar and multi-sequence magnetic resonance imaging (MRI) studies are performed to exclude any joint contamination and to determine the level of the distal osteotomy^{7,8}. The allograft is selected preoperatively on the basis of comparative patient and donor imaging and is matched as closely as possible to the host tibia, erring on the side of oversizing.

Surgical exposure providing longitudinal access to the knee and the proximal part of the tibia is performed medially or laterally, depending on the side of the biopsy (usually medial). After capsulotomy, the cruciate ligaments are cut close to the femoral attachment, while the capsule and the patellar tendon are cut close to the tibial attachment. If possible oncologically, the posterior cruciate ligament is cut close to the tibial insertion and is later sutured to the posterior capsule of the allograft. The origin of the gastrocnemius muscle is retracted or detached, and the popliteal artery trifurcation is explored. The tibiofibular joint and the common peroneal nerve are exposed by raising the lateral flap. An intra-articular or extra-articular resection of this joint, as decided on the basis of the preoperative imaging, is performed.

The osteotomy of the tibia is performed at the level determined on the basis of the preoperative imaging. The specimen is freed, with a cuff of tibialis anterior, popliteus, and posterior compartment muscles maintained as required.

The allograft is processed on a separate table, leaving the capsule and the patellar tendon attached to the graft. The polyethylene spacer trials,

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available in various sizes, are placed on the exposed femoral condyles, and the size that most closely matches the condyles is chosen.

The allograft is prepared for the tibial prosthesis according to the instructions provided by the implant manufacturer. The tibial component of an unconstrained total knee prosthesis is cemented into the allograft. As the distal part of the femur in a child is generally smaller than that in an adult, we use prosthetic implants that allow the surgeon to choose the appropriate size of polyethylene spacer and proximal tibial prosthesis that will fit the femoral epiphysis of the patient. In patients treated between 1996 and 2005, we used the LCS COMPLETE Mobile-Bearing Total Knee System (DePuy Synthes), which offers revision tray components available in nine sizes. Since 2006, we have used the TC-PLUS SB (Tricompartamental Knee Prosthesis with Self-aligning Bearing; Smith & Nephew), which has six sizes for the tibial component and ultracongruent polyethylene.

A plate (4.5 or 3.5 mm, depending on the size of the bone) is molded to fit the contour of the bone. The plate should be long enough to cover the entire length of the allograft and accommodate three or four holes in the host bone.

Sutures are placed on the host and grafted capsules. The prepared composite is then fixed to the host bone.

A trial spacer is inserted through the medial opening in the capsule, and the one that fits most snugly is chosen and ultimately implanted. The sutures on the most posterior part of the capsule are tied first, followed by those on the lateral capsule and the patellar tendon. If the posterior cruciate ligament can be cut close to the tibial insertion, it is sutured to the posterior capsule of the allograft. Finally, sutures on the medial part of the capsule are tied to enclose the implanted joint snugly. Mediolateral stability, knee range of motion, and patellar tracking are checked. A medial gastrocnemius flap is prepared and is used to cover the composite, whenever such an application is justified because of a lack of satisfactory soft-tissue coverage.

The prosthesis usage in this new surgical technique represents off-label use of an implant as it is not intended for use in modular segmental reconstruction after bone resection in limb salvage; therefore, this so-called salvage technique is not approved by the U.S. Food and Drug Administration.

Step 1: Make the Incision

Make a longitudinal incision medially or laterally, depending on the side of the biopsy (usually medial), encompassing and encircling the biopsy site (Fig. 1).

- Place the patient in the supine position.
- Place a bump under the ipsilateral hip and/or midway between the knee and the foot (for assistance when the knee is flexed).
- Begin the incision in the parapatellar region of the knee.
- Continue the incision distally enough for the resection length required by the tumor extension in the proximal part of the tibia.

Fig. 1

Fig. 1 The surgeon approaches the proximal part of the tibia through a longitudinal incision on the anterior aspect of the leg (medial or lateral side, depending on where the biopsy was performed), starting in the parapatellar region and continuing distally for the resection length required.

Step 2: Perform the Arthrotomy

A parapatellar arthrotomy is performed, and the cruciate ligaments are cut close to the femoral attachment.

- Make a parapatellar arthrotomy.
- Cut the capsule and patellar tendon as close to their tibial attachments as possible while still allowing for adequate surgical margins (Fig. 2).
- Tag the capsule and patellar tendon with a suture to later facilitate reconstruction (Fig. 3-A).
- Cut the cruciate ligaments as close to the femur as possible (Fig. 3-B). Sometimes, if the tumor is far enough from the tibial insertion of the posterior cruciate ligament, the ligament can be cut close to its tibial insertion and left continuous with the posterior capsule. This allows the posterior cruciate ligament to be sutured to the allograft capsule and provide greater stability of the knee.

Fig. 2

Fig. 3-A

Fig. 3-B

Fig. 2 The capsule and the patellar tendon are cut as close as possible to their tibial attachments, if allowed by adequate margins.

Fig. 3-A A parapatellar arthrotomy is done and the anterior cruciate ligament is cut close to its femoral attachment.

Fig. 3-B The capsule is cut as close as possible to its tibial attachment, and the anterior cruciate ligament is cut close to its femoral attachment.

Step 3: Isolate the Vascular Bundle

Retract the medial gastrocnemius muscle and then isolate and protect the popliteal and posterior tibial vessels.

- Retract or detach the origin of the gastrocnemius muscle.
- Explore the popliteal artery trifurcation by further detaching the origin of the soleus on the tibia.
- Isolate the vessels from the posterior aspect of the proximal part of the tibia, dissecting the collateral vessels directed to the tumor.
- Place a gauze pad to protect the vessels during further surgical maneuvers.

Step 4: Perform an Osteotomy of the Tibia

Perform an osteotomy of the tibiofibular joint and the tibial shaft at the appropriate level as determined on the basis of the preoperative imaging, and then complete the resection.

- Expose the tibiofibular joint and the common peroneal nerve by raising the lateral flap.
- Perform an intra-articular or extra-articular resection of this joint, as determined on the basis of the preoperative imaging assessment of the proximal extent of the tumor.
- Expose the tibial shaft subperiosteally at the level of the planned osteotomy.
- Perform the osteotomy perpendicular to the long axis of the tibia (Fig. 4).
- As the specimen is freed, maintain a cuff of tibialis anterior, popliteus, and posterior compartment muscles as required by the tumor extension
- If necessary, ligate the anterior tibial or peroneal vessels, depending on the tumor extension in the soft tissues (Fig. 5-A).
- Free the proximal tibial specimen and place it on a separate table, where it is precisely measured (Fig. 5-B).
- Sample the marrow from the osteotomy site and send it for frozen-section analysis.

Fig. 4

Fig. 5-A

Fig. 5-B

Fig. 4 An osteotomy is performed perpendicular to the long axis of the tibia, at the level determined according to preoperative imaging.

Fig. 5-A Anterior tibial or peroneal vessels may need to be ligated, depending on tumor extension in the soft tissues.

Fig. 5-B The specimen is freed, keeping the tumoral tissue covered by a cuff of normal muscle, according to oncologic principles.

Step 5: Prepare the Allograft on a Separate Table

Cut and prepare the allograft according to the specimen dimensions.

- On a separate table, process the allograft, thawing it in warm saline solution containing antibiotic.
- It is important to save the capsule and the patellar tendon attached to the graft.
- Cut the allograft to the required length, with the osteotomy perpendicular to the long axis of the allograft.
- If the allograft has a diameter larger than the host bone, shape the distal end of the osteotomy with a medial or lateral step so that the allograft will fit snugly around the host diaphysis, which is shaped accordingly (Fig. 6 and Video 1).

Fig. 6

Fig. 6 The allograft is cut to the required length, with the osteotomy being perpendicular to the long axis of the allograft. If the allograft has a diameter larger than the host bone (which is usually the case in reconstructions in children), the distal osteotomy is shaped with medial or lateral steps meant to fit around the host diaphysis.

Video 1 Distal osteotomy of the allograft. When possible the distal osteotomy is shaped with medial or lateral steps meant to fit around the host diaphysis.

Step 6: Prepare the Composite Device

Cement the tibial component of an unconstrained total knee prosthesis in the allograft and place the trial device.

- Place the polyethylene spacer trials, available in various sizes, on the exposed femoral condyles (Fig. 7 and Video 2).
- Choose the size of prosthesis that most closely matches the distal end of the femur. A stem length that traverses the entire length of the allograft is selected (see discussion below). Match the tibial plate size to the host tibia; the plate provides the osteosynthesis between the allograft and the tibia.
- Mount the allograft on a holder attached to the edge of the table, and prepare it according to the instructions provided by the manufacturer of the chosen prosthesis (Fig. 8 and Video 3).
- Make the proximal cut on the tibial plateau at 5° of valgus and cement the prosthesis in the allograft in neutral or 3° of external rotation (although any slight malrotation can be corrected at the time of fixation of the allograft to the host diaphysis). A slight valgus of the implant is preferable, to reproduce the physiological valgus of the knee joint. If the composite device has a varus deformity, there will be a varus deformity of the proximal part of the tibia, even with natural valgus of the distal end of the femur.
- Once negative marrow margins have been confirmed, perform a trial placement of the allograft in the patient, paying close attention to the contour of the plate against the allograft and host bone, congruency at the osteotomy site, and overall length, alignment, and rotation. As these patients are still growing, one can lengthen the construct to mitigate an eventual leg-length discrepancy. It is better to avoid lengthening of >1 cm because of the risk of compartment syndrome, which is higher in pediatric patients than in adults and in the leg more than in the thigh.
- Make minor modifications to the allograft as necessary.

- Mold a plate (4.5 or 3.5 mm, depending on the size of the bone) to fit the contour of the bone (the plate should be long enough to cover the entire length of the allograft and accommodate three or four holes on the host bone) (Fig. 9 and Video 4).
- The screw-holes are predrilled and screw length is measured in the allograft. If a long- stemmed tibial prosthesis is used, fix the plate with short monocortical screws or screws placed obliquely around the implant stem in the area occupied by the stem.
- Fill the entire allograft with polymethylmethacrylate and, before the cement sets, implant the final tibial component and fix the plate to the allograft using the previously prepared screw-holes (Video 5).

Fig. 7

Fig. 8

Fig. 9

Fig. 7 Polyethylene spacer trials are available in various sizes (even very small) and are matched on the exposed femoral condyles so that the best size for the tibial prosthesis can be selected.

Video 2 The polyethylene spacer trials, available in various sizes, are placed on the exposed femoral condyles, and the size of prosthesis that most closely matches the distal end of the femur is chosen.

Fig. 8 A fresh-frozen massive allograft is processed on a separate table. It is important to preserve the capsule and the patellar tendon attached to the graft. The allograft is then prepared with a proximal cut according to the technique of the chosen prosthesis.

Video 3 The massive allograft is prepared according to the technique of the chosen prosthetic system.

Fig. 9 A plate (4.5 or 3.5 mm, depending on the size of the bone) is contoured to the bone (the plate should be long enough to cover the entire length of the allograft and accommodate three or four holes in the host bone). The screw-holes are prepared in the allograft. The tibial component is cemented into the allograft, and before the cement sets, the plate is fixed to the allograft using the screw-holes already prepared.

Video 4 Trial of the composite device to the host tibia. The plate should be long enough to cover the whole length of the allograft and accommodate three or four holes in the host bone.

Video 5 Insertion of the tibial prosthesis, cemented into the allograft. In the latter patients in our series we used a longer tibial stem to reduce the risk of metaphyseal allograft fracture.

Step 7: Fix the Composite Device and Suture the Capsule and Ligaments

Place the trial composite device and then fix the composite device to the host tibia and suture the capsule and ligaments.

- Sutures are placed on the host and allograft knee joint capsules (Video 6).
- The trial construct is placed again in the patient to assess for final length, alignment, rotation, and osteotomy site congruency. Any necessary modifications are made.
- The construct is then fixed to the host bone, using standard plate-and-screw compression techniques (Fig. 10 and Video 7).
- The posterior capsule is reconstructed first by suturing host capsular tissue to the allograft capsule (Figs. 11-A and 11-B and Video 8). The capsular tension is determined by the trial polyethylene insert. There should be sufficient tissue because this type of reconstruction is done only if the preoperative MRI has shown that it is possible to spare the capsule. During resection, care must be taken to preserve the capsule, which has to be cut close to the tibial insertion. When the allograft is prepared, its capsule must be preserved as well.
- This reconstruction then proceeds anteriorly and includes the patellar tendon, which is reconstructed end to end. Nonabsorbable sutures are passed around the patella, which is sutured again on the tendon. Nonabsorbable sutures are used in the posteromedial, posterolateral, and lateral portions of the capsule (Video 9).
- Place trial spacers through the remaining anteromedial opening and choose the thickness that fits best and provides enough tension of the soft tissues (Fig. 12). The chosen definitive insert is then ultimately inserted.
- Complete reconstruction of the anteromedial part of the capsule so it snugly encloses the implanted joint (Video 10). Check knee stability, range of motion, and patellar tracking.
- Drains are placed and a meticulous layered closure is performed.

Fig. 10

Fig. 11-A

Fig. 11-B

Fig. 12

Video 6 Sutures are placed on the host and graft capsules.

Fig. 10 The prepared composite is then fixed to the host bone, using standard plate-and-screw compression techniques.

Video 7 Synthesis of the device to the host tibia with compression at the osteotomy.

Fig. 11-A Sutures are placed on the host and graft capsules and on the patellar tendon of the patient.

Fig. 11-B The sutures on the most posterior aspect of the capsule are tied first, followed by those on the lateral capsule and the patellar tendon.

Video 8 Suture of the allograft capsule to the host. The sutures on the most posterior capsule are tied first.

Video 9 Suture of the posteromedial and then of the anterolateral capsule. Then the final spacer is inserted through the anterior opening.

Fig. 12 Trial spacers are placed through the anterior opening and the thickness that fits best is chosen and ultimately inserted. Finally, sutures on the medial part of the capsule are tied to snugly enclose the implanted joint. Mediolateral stability, knee range of motion, and patellar tracking are checked.

Video 10 Suture of the anteromedial capsule is completed, and stability of the knee is checked.

Step 8: Postoperative Care

Immobilize the knee with an above-the-knee plaster cast, which is worn for four weeks, and then have the patient perform progressive functional rehabilitation.

- Remove the drains by the second postoperative day.
- Monitor the patient closely for signs and symptoms of compartment syndrome.
- Manage the patient with postoperative immobilization in an above-the-knee plaster cast with the knee in full extension.
- Discharge the patient from the hospital once the clinical condition is acceptable, and then follow the patient in an outpatient setting.
- Manage the patient with a cast for four weeks and then with a splint that is removed at intervals for the initiation of isometric quadriceps exercises and passive flexion.
- Remove the splint at six weeks and have the patient initiate active flexion.
- Have the patient progressively bear weight according to radiographic evidence of initial healing (immature callus seen on radiographs).
- At two weeks, allow the patient to start non-weight-bearing walking with crutches.
- At six weeks, manage the patient with a Thomas ischium-bearing brace, which maintains partial weight-bearing with progression according to the weight of the patient.
- Once there is radiographic evidence of substantial bone-healing, allow the patient to bear complete weight.

Results

The rate of postoperative infection after proximal tibial reconstruction with a resurfaced allograft composite in children has been found to be no higher than that with other reconstructive techniques for the proximal part of the tibia^{5,6,9,10}; our series had a 5% rate of deep infection¹¹.

The major complication of osteoarticular allografts is subchondral or metaphyseal fracture of the graft^{5,6,12-14}. With the current technique, the prevalence of allograft fracture in our series was 32% (six patients)¹¹; however, in our series involving osteoarticular allografts in the proximal part of the tibia⁶, the prevalence of graft fracture was 80% (eight patients)⁶. In two of the six patients, the implant was revised using a long-stemmed tibial component of an unconstrained knee prosthesis, cemented in the graft, which maintained the distal end of the femur intact. Since the time when these revisions were performed, we realized that using a long-stemmed tibial component as the initial device should decrease the rate of eventual fracture of the graft. Also, in the later cases (not included in the series because they were treated recently), we modified our technique to implant a long-stemmed tibial implant. We used the Innex Total Knee System (Zimmer). The tibial stem is cemented in the allograft, but it does not extend into the host tibia: the composite implant is fixed to the host bone as usual, with a plate and screws. If a long-stemmed tibial prosthesis is used, the plate is fixed with short monocortical screws or screws placed obliquely around the implant stem in the area occupied by the stem. We believe that cementing the long stem into the host tibial diaphysis sacrifices bone stock and is too aggressive for a child's tibial shaft, which is usually small, and eventually delays fusion of the osteotomy. To prevent an allograft fracture, it is also important to use a long plate, which extends very far proximally in the allograft, preventing any point of weakness in the allograft.

In our recent study¹¹, eight (62%) of the thirteen patients who had retained the original reconstruction at their latest follow-up evaluation (average, eighty-five months) had a good or excellent functional outcome according to the Musculoskeletal Tumor Society scoring system¹⁵. These patients walked without support or limitations, with an active knee range of motion of >90°. Of the ten patients with insufficient soft-tissue coverage, two had active flexion of the knee up to 90°; all ten had full active extension of the knee. Four patients had a clinically stable knee, and four had a mild valgus instability.

Fig. 13

Fig. 14

Fig. 15

Figs. 13-A through 13-D A seven-year-old girl with high-grade osteosarcoma of the proximal part of the tibia. **Fig. 13-A** Standard radiograph made after preoperative chemotherapy. **Fig. 13-B** Preoperative T2-weighted MRI scan showing the extension of the tumor in the proximal metadiaphyseal region of the tibia, with no involvement of the joint, the capsule, or the cruciate ligaments. **Fig. 13-C** Postoperative radiograph showing the reconstruction obtained with a massive allograft and the tibial component of a standard unconstrained knee prosthesis; the composite device is fixed to the host tibia with a long plate. **Fig. 13-D** Standard radiograph made after eight years of follow-up.

Figs. 14-A through 14-E A fourteen-year-old girl with high-grade osteosarcoma of the proximal part of the tibia. **Figs. 14-A and 14-B** Preoperative radiograph and T1-weighted MRI scan. **Fig. 14-C** Postoperative radiograph showing the composite device as described in the surgical technique. **Fig. 14-D** Radiograph, made after sixty-two months of follow-up, showing a fracture of the metaphyseal part of the allograft. **Fig. 14-E** Radiograph made after treatment of the fracture of the allograft with removal of the composite device and reconstruction with a rotating hinged modular prosthesis of the proximal part of the tibia.

Figs. 15-A through 15-D A twelve-year-old boy with high-grade osteosarcoma of the proximal part of the right tibia. **Figs. 15-A and 15-B** Preoperative radiograph and T1-weighted MRI scan. **Fig. 15-C** Radiograph made after resection and reconstruction with a composite endoprosthesis. In this patient, the composite device consisted of a long-stemmed tibial component of an unconstrained knee prosthesis cemented into the massive allograft, to obtain a greater-strength device and reduce the risk of a late fracture of the allograft. **Fig. 15-D** Radiograph made one year postoperatively.

In three patients (23%), the functional result at the time of follow-up was fair, with varus-valgus laxity, which required the use of a brace and occasionally a cane to avoid mediolateral instability when walking. The two patients who had surgical revision to a long tibial stem, but again resurfacing of only the tibial surface of the knee, presented at the time of final follow-up (at sixty and twenty-four months, respectively, after the last surgery) with an excellent functional score (24 and 26 points). Both had a range of motion of 90° of active flexion and a stable knee. In all of these cases, there was active extension of the knee.

Radiographic evaluation at the time of follow-up showed slight arthritis of the distal end of the femur in the fourteen patients in whom the device was retained for <100 months. Five patients in whom the implant had been retained for >100 months showed radiographic evidence of degenerative changes in the distal end of the femur. In one of these patients, the tibial prosthesis was undersized for the distal end of the femur, and this was the only patient who presented with severe arthritis in the distal end of the femur at the time of follow-up.

At the latest follow-up, thirteen patients still had the original implant.

In our series of nineteen patients, the sixteen long-term survivors presented at the end of growth with a mean limb-length discrepancy of 1.9 cm (range, 0.5 to 4 cm)¹¹; nine of them were managed with an epiphysiodesis of the contralateral limb, and one patient was treated with the Ilizarov technique to elongate the tibia. In the latter patient, the tibial osteotomy was performed through the distal metadiaphyseal region of the tibia, with two rows of pins placed

proximally and two placed distally to the osteotomy; the Ilizarov device was removed after six months, after ossification of the newly generated bone.

The main problem in children is the small size of bone and soft tissues. Moreover, in the knee, the challenge resides in maintaining sound function of the affected limb and minimizing a limb-length discrepancy at the end of growth. The initial rationale for the reported surgical technique in children was to avoid a substantial loss of bone stock and to preserve the growth plate of the distal end of the femur, as occurs when osteoarticular allografts are used, but also to try to have a more solid and durable implant. Osteoarticular allografts can potentially create anatomical mismatching and joint instability because of the size of the allograft (as the majority of donors are adults), and the long-term results of the procedure are disappointing because of mechanical failure and allograft fracture (in our series, 80% of the osteoarticular allografts of the proximal part of the tibia had a fracture)⁶.

Alternatively, the use of a megaprosthesis instead of an allograft damages both the femoral and tibial epiphyses, with permanent changes in the normal anatomy, substantial length discrepancy, and questionable long-term durability in patients with several decades of life expectancy⁴.

Our first goal was to avoid these problems in children, although we still consider the present technique an attempt to prolong the functional life of the knee and delay a total knee replacement (Figs. 13, 14, and 15).

The indication to perform a hemiarthicular reconstruction with a composite device was related to the oncologic indication of an intra-articular resection of the proximal part of the tibia that could allow the maintenance of capsule and ligaments. This reconstruction did not affect the growth plate of the opposite side of the joint. On the basis of our previous series with osteoarticular allografts in the proximal part of the tibia⁶, which had a high prevalence of graft fracture, the main goal was to avoid or delay mechanical failure with a more resistant and durable device.

What to Watch For

Indications

- Young age, i.e., less than fifteen years old
- A resectable bone tumor of the proximal part of the tibia
- No involvement of the capsule
- No involvement of cruciate ligaments
- No intra-articular expansion of the tumor

Contraindications

- Children who are too young (less than six years old)
- An intra-articular pathological fracture
- Expansion of the tumor in the articular space
- Involvement of the capsule or ligaments

Pitfalls & Challenges

- Increased arthritis of the distal end of the femur occurred when there was a mismatch in size between the tibial prosthesis and the distal end of the femur. In younger children, therefore, a mildly oversized tibial insert may be acceptable.
- Care should be taken in suturing the allograft capsule and the patellar tendon to the residual structures of the knee.
- Even in our latest patients, in whom we used a long-stemmed unconstrained tibial prosthesis, we preserved the native tibial shaft by not reaming or inserting the stem in the host tibial shaft; instead, the stem was

cemented in the allograft without passing the osteotomy. Our aims were to avoid aggressive treatment of the child's small tibial shaft and to maintain his or her bone stock as much as possible.

- The allograft-host bone synthesis was always obtained by a long plate.
- The plate should be long enough to cover the whole length of the allograft and to accommodate three or four holes on the host bone.

Clinical Comments

- The use of a long-stemmed unconstrained tibial prosthesis cemented in the graft seems to be more suitable than cementing a standard short-stemmed unconstrained tibial prosthesis and prevents fracture in the proximal part of the allograft.
- Coverage of the composite device with a medial gastrocnemius rotation flap reduces the risk for early infection.
- The size of the tibial prosthesis should match as much as possible the size of the femoral condyles. It is better if the prosthesis is slightly oversized than undersized to reduce the risk of late arthritis of the distal end of the femur.
- Postoperative immobilization in a long leg cast for thirty to forty days is important to obtain joint stability and then have a better functional result.
- The main complication in our recent study¹¹ was allograft fracture (32%); however, the prevalence of this complication was much lower than that in our series of osteoarticular allografts (80% had an allograft fracture)⁶. We think that the use of a long-stemmed tibial prosthesis as the initial implant and the use of a long plate will lead to a decrease in the prevalence of this complication among our patients.

Marco Manfrini, MD

Davide Donati, MD

Marco Colangeli, MD

Laura Campanacci, MD

Department of Musculo-Skeletal Oncology, Rizzoli Orthopedic Institute, Bologna, Italy

E-mail address for M. Manfrini: marco.manfrini@ior.it

E-mail address for D. Donati: davide.donati@ior.it

E-mail address for M. Colangeli: marco.colangeli@ior.it

E-mail address for L. Campanacci: laura.campanacci@ior.it

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