

## Case Report

# Arthrodesis following persistent periprosthetic knee infection using femoral condyle allograft: a case report and review of literature

Gonçalo Vaz Pinto<sup>1\*</sup>, Nuno Marques Luís<sup>2</sup>, João Ribeiros Cabral<sup>2</sup>, Mario Vale<sup>2</sup>,  
Ricardo Telles de Freitas<sup>2</sup>, J. Ricardo Varatojo<sup>2</sup>

<sup>1</sup>Hospital do Litoral Alentejano, Santiago do Cacém, Portugal

<sup>2</sup>Hospital Cuf Descobertas, Lisbon, Portugal

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### \*Correspondence:

Dr. Gonçalo Vaz Pinto,

E-mail: [goncalovazpinto1@gmail.com](mailto:goncalovazpinto1@gmail.com)

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## ABSTRACT

Periprosthetic joint infections (PJI) of the knee are difficult to treat and can require costly and prolonged hospital stays, weeks or months of antibiotic therapy, and multiple surgical procedures. Knee arthrodesis is considered a last resort for persistent knee joint infections and provides stability and pain relief by fusing the knee joint. The authors describe a case of a persistent and difficult to treat periprosthetic total knee arthroplasty (TKA) infection, subjected to multiple surgeries and revisions, where an arthrodesis was performed as a last resort. The arthrodesis was performed using a femoral-tibial endomedullary nail with interposed femoral condyle allograft. Complete graft integration and consolidation was achieved without complications. The patient performed well post-operatively and is currently ambulatory with walking aids and has no knee pain. The removal of well-fixed metaphyseal sleeves in TKA can be challenging and associated with complications such as damage to the surrounding bone and soft tissue during the removal process. Taking special care and not rushing this step can present an extremely meaningful difference in the final outcome. In cases with large bone defects, especially after sleeve removal, allograft usage can be extremely useful for managing dead space and limb-length discrepancies while promoting faster bone healing. When successful, as was the case described, arthrodesis using allografts can have beneficial outcomes with high patient satisfaction and deliver function to previously very unhealthy joints and limbs.

**Keywords:** Arthrodesis, Periprosthetic knee infection, Allograft, Case report

## INTRODUCTION

Periprosthetic joint infections (PJI) of the knee are difficult to treat and can require costly and prolonged hospital stays, weeks or months of antibiotic therapy, and multiple surgical procedures.<sup>1,2</sup> Treatment options for PJI include suppressive antibiotics, open debridement with insert exchange, single-stage or two-stage revision surgery, and knee arthrodesis.<sup>1-4</sup> Knee arthrodesis is considered a last resort for persistent knee joint infections and provides stability and pain relief by fusing the knee joint.<sup>5</sup> However, knee arthrodesis eliminates the possibility of future joint motion and may require the use of assistive devices for mobility.<sup>5</sup> The best management of PJI is still highly

debated, and the success rates of different treatment options vary.<sup>1-4</sup> Factors that can affect treatment success include the severity of the infection, the patient's overall health, and the presence of comorbidities.<sup>1,2</sup>

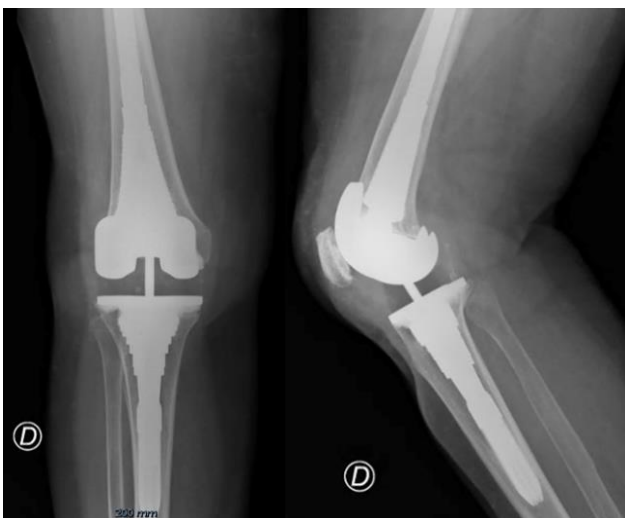
The authors describe a case of a persistent and difficult to treat periprosthetic TKA infection, subjected to multiple surgeries and revisions, where an arthrodesis was performed as a last resort. The arthrodesis was performed using a femoral-tibial endomedullary nail with interposed femoral condyle allograft. Complete graft integration and consolidation was achieved without complications. The patient performed well post-operatively and is currently ambulatory with walking aids and has no knee pain.

## CASE REPORT

The authors present a case that involves an 82 year old female patient. Of relevant history she had bilateral TKA, and her right knee already submitted to a two-stage revision TKA for chronic PJI due to a Meticillin-Resistant *Staphylococcus aureus* (MRSA) infection in another institution (Figure 1). At nearly 3 years of disease-free post-implantation of the revision TKA, which included femoral and tibial metaphyseal sleeves (Figure 2), the right knee became newly symptomatic and after biochemical, cytological and microbiologic confirmation of an infection, a debridement, antibiotics and implant retention (DAIR) procedure was performed in which a Meticillin-Sensitive *Staphylococcus aureus* (MSSA) was identified. The patient underwent PJI antibiotic (AB) protocol with 2 weeks IV flucloxacillin, 1 week IV rifampicin and another 10 weeks of oral flucloxacillin and rifampicin.



**Figure 1: AP long-leg radiograph showing a left primary TKA and a right revision TKA.**

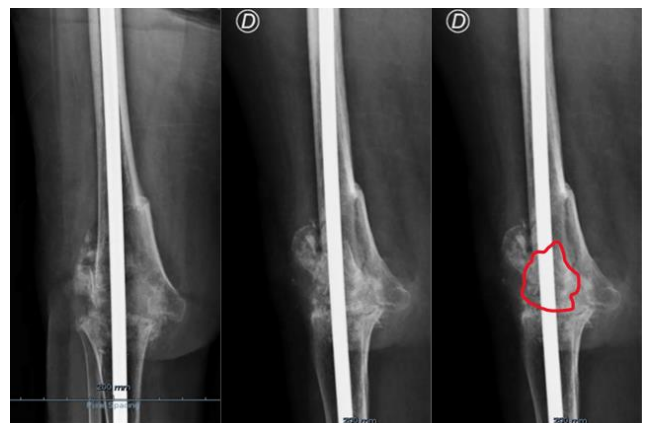


**Figure 2: AP and lateral right knee radiograph showing a revision TKA with femoral and tibial sleeves.**



**Figure 3: AP and lateral right knee radiograph showing an antibiotic-coated cement spacer.**

At nearly 4 months post operatively, and supposedly 1 week after concluding the oral AB scheme the patient reappeared with persistent knee pain, swelling and a limited range-of-motion (ROM). After a thorough history and examination, the patient revealed she did not comply with her clinicians' recommendations and decided to stop oral AB treatment without previous notice. A new arthrocentesis revealed persistent infection with the same MSSA. A two-stage revision surgery was then performed with a 3-month interval-at first implant removal and an AB coated cement spacer was placed (Figure 3), and the following definitive surgery was an arthrodesis. The arthrodesis was performed after laborious and careful removal of femoral and tibial sleeves, using a femoral-tibial endomedullary nail with interposed femoral condyle allograft, 90mg of allograft chips and autologous iliac crest bone graft (Figure 4). The allograft chips and the autograft were mixed with vancomycin before application. These were used due to the large bony defect left by removal of the metaphyseal sleeves. The allograft was previously reamed before passing the endomedullary nail through its center in hopes that it would provide structural stability and reduce limb-length discrepancy.



**Figure 4: Femoral condyle allograft highlighted on the right.**

At 9 months post-operatively the patient is ambulatory with walking aids and no knee pain. On AP and lateral x-ray view the arthrodesis is fully healed (Figure 5) and the patient has a ~5 cm leg-length discrepancy. Currently the infection seems to have been eradicated.



**Figure 5: AP long-leg, lateral and AP radiographs of the final result of the knee arthrodesis with a femoral-tibial nail.**

## DISCUSSION

Knee arthrodesis, the fusion of the knee joint, is indicated in several clinical scenarios of failed TKA as a salvage procedure, especially in cases of associated complications and problems.<sup>5,6</sup> Periarticular tumors affecting the knee joint, post-traumatic arthritis in young patients chronic sepsis, metaphyseal bone loss, ligamentous instability, multiple failed revisions, loss of the extensor mechanism, and infection with highly resistant organisms.<sup>5,6,8,10</sup>

Contraindications to knee arthrodesis include bilateral knee disease, ipsilateral hip and ankle disease, severe bone loss, and contralateral amputation.<sup>5</sup> Additionally, indications for arthrodesis as a primary treatment for arthritis have been limited, with traditional indications including high-demand patients, monoarticular disease, loss of the extensor mechanism, soft tissue deficiency, immunodeficiency, virulent infection, and young age.<sup>5,9</sup>

Important to consider at any point in treating patients with TKA are the use of metaphyseal sleeves, which help manage patients with severe bone loss and deliver robust stability in the setting of revision or primary complex TKA, but may also compromise salvage surgeries, such as arthrodesis, by leaving an even greater defect when removed. The removal of well-fixed metaphyseal sleeves in TKA can be challenging and associated with complications such as damage to the surrounding bone and soft tissue during the removal process. Additionally, the risk of metallosis as a result of the broaching technique in preparing the metaphysis for the sleeve is a known risk

factor.<sup>7,8</sup> However, the risks associated with removing well-fixed metaphyseal sleeves in TKA are not extensively documented. Their removal creates dead space, increases limb-length discrepancy and requires higher amounts of bone graft which may increase the infection risk and costs of future interventions.

The process of removing well-fixed femoral and tibial metaphyseal sleeves in revision TKA can be challenging. Several techniques and surgical procedures have been described in the literature about disrupting the cement-bone interface (CBI), which is key to loosen the sleeve. This can be achieved using specialized tools such as a disimpacting punch on the femoral side or a specially designed separator on the tibial side. The authors preferred method centers around using small diameter k-wire tapping at the CBI, always aiming at the sleeve so to not risk wire skiving and cortical damage. This is followed by careful, patient and selective osteotome dissection and implant separation. Taking special care and not rushing this step can present an extremely meaningful difference in the final outcome.

Allografts have several advantages in knee arthrodesis, particularly in cases of PJI or high-grade osteosarcomas.<sup>14</sup> The first advantage allografts present is the potential to promote bone formation and wound healing, as they provide a scaffold for new bone growth and guide the new bone to the graft site. By doing so, and by restoring bone stock, this may aid in the long term success of the procedure.<sup>11</sup> Allografts are also quite versatile and can be used in various forms, such as block grafts or particulated grafts, to adapt better to different bone defects and provide a solution for large bone defects resulting from resection of tumors or trauma.<sup>12,13</sup> It is also important to discuss costs when mentioning allografts. Although expensive, allografts can be more cost-effective than other treatment options, such as prosthetic joint replacements and revision equipment, which may require multiple revisions and can be more expensive long term.<sup>11</sup> Finally, in knee arthrodesis, where minimizing limb length inequality is a concern, allografts are a helpful resource used to minimize this.<sup>13</sup> In the presented case instead of breaking down the graft, the authors chose to keep it intact and used the condyle's rigid structure to fill space and lessen the risk of collapse. This alone is not enough to eliminate limb length disparity but may be useful in reducing it.

The advantages of combining allografts and autografts include leveraging the unique benefits of each graft type. Autologous bone, or autograft, is readily available, poses no risk of disease transmission, and is cost-effective. On the other hand, allografts are osteoconductive, providing a scaffold for new repair, and can be donated from another patient or a cadaver. The combination of these graft types allows for the compensation of their respective disadvantages and has been employed in various surgical procedures, especially in musculoskeletal reconstructions, to achieve favorable clinical outcomes.<sup>15-17</sup>

Mixing antibiotics with allografts before using them has several documented benefits. Firstly, antibiotic-impregnated allograft bone can help reduce the need for multiple treatments by targeting and eliminating bacteria responsible for infections.<sup>18,19</sup> It provides an optimal solution for dead space management, enhanced biology, and infection control.<sup>22</sup> Both allograft bone and bone substitute materials can be packed with antibiotics that undergo a controlled release as they are implanted, helping to lower infection rates.<sup>23</sup> However, literature shows that when mixing bone allografts with antibiotics, their storage capacity and release profile vastly exceed that of other materials, such as polymethylmethacrylate (PMMA).<sup>22</sup>

Research has achieved promising results when using lyophilized bone allografts mixed with antibiotics, both in vitro and in vivo studies.<sup>20</sup> However, it is essential to note that randomized controlled trials are still needed to prove the benefits of mixing antibiotics through bone grafts.<sup>21</sup>

The success rate of allografts in knee arthrodesis can vary depending on the study and the specific patient population. A two-center study involving 92 patients with knee arthrodesis using allografts found an infection rate of 20%, a fracture rate of 25%, and a nonunion rate of 44%. The success rate for patients without an infection was 64%.<sup>23</sup> Another study on osteochondral allograft transplantation in the knee reported a survival rate of 78.7% at 10 years.<sup>24</sup> However, significant variability still exists among clinicians regarding parameters for graft acceptance, surgical technique, and rehabilitation.<sup>17,25</sup>

It is important to note that the success rate for knee arthrodesis using allografts in the presence of infection may be lower compared to cases without infection. A study reported a success rate of 11% for patients with infection, whereas the success rate was 64% for patients without infection.<sup>24</sup> Additionally, the infection recurrence rate after knee arthrodesis varies between 0 to 26% in the literature.<sup>26,27</sup> Therefore, while knee arthrodesis using allografts may be considered in cases of periprosthetic joint infection, the potential for reinfection and the overall success rate should be carefully evaluated when making treatment decisions.

**Table 1: Surgical pearls for arthrodesis with a femoral condyle allograft.**

| Surgical pearls  |   |
|--|---|
| <b>Use of combined allograft and autograft</b>         | Higher probability of bone healing  |
| <b>Mixing antibiotics with graft</b>                   | A local delivery system with higher concentration of local AB, better dead space management |
| <b>Previous reaming in center of condyle allograft</b> | Allows better graft fit to defect without fragmenting graft and a stronger support frame    |

## CONCLUSION

Knee arthrodesis using allografts may be considered in cases of PJI after TKA as a salvage procedure when other treatment options have failed. Arthrodesis may also be performed in the presence of infections by highly-resistant bacteria and in immunocompromised patients due to the high risk of infection recurrence after reimplantation of a revision TKA as in the presented case. In cases with large bone defects, especially after sleeve removal, allograft usage can be extremely useful for managing dead space and limb-length discrepancies while promoting faster bone healing. When successful, as was the case described, arthrodesis using allografts can have beneficial outcomes with high patient satisfaction and deliver function to previously very unhealthy joints and limbs.

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