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Interesting Cases in Robotic Total Knee Arthroplasty

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Introduction

The success of total knee arthroplasty depends on precise bone cuts to provide a neutrally aligned knee. Malalignment has been shown to lead to decreased satisfaction and higher rates of failure (1-4). Ritter et al. found that varus malalignment of the tibia was associated with a 10.6 times greater risk failure compared to neutrally aligned knees, while excessive femoral valgus greater than 8 degrees was associated with a 5.1 times increased risk (2). In the face of severe deformity or prior knee surgery, conventional total knee arthroplasty (TKA) instrumentation may not be sufficient to provide consistent, accurate results. Along with severe deformity, cases unable to utilize intramedullary instrumentation or those with significant bone loss may require the preoperative planning and precise bone cuts that are associated with robotic-assisted total knee arthroplasty. Marchand et al. found that the robotic software was able to predict implants within one size for 98% of cases. (5). Robotic-assisted total knee arthroplasty (RATKA) allows for the execution of well-aligned knee arthroplasty regardless of the deformity. This case series is presented to show the utility of robotic-arm assisted TKA in achieving well-balanced, well-aligned results in a variety of challenging scenarios that can face the arthroplasty surgeon.

Methods:

We present six challenging cases of robotic-arm assisted total knee arthroplasty. There were two conversion TKAs following a previous surgery. One case featured a previous tibial plateau fracture treated with a plate and screws construct while another featured a prior femoral nail with significant bony overgrowth. Four cases of severe deformity were also identified, with two valgus knees and one patient with two varus knees due psoriatic arthritis treated with staged bilateral TKAs. Patient clinical history, physical examinations, intraoperative surgical techniques and postoperative courses were recorded.

Results:

The six cases presented in this series were able to utilize effective preoperative planning to obtain precise intraoperative bone cuts and component positioning. The first two cases presented featured valgus deformities of differing severity. These cases exhibited significant lateral condyle bone loss, which could have been worsened by conventional arthroplasty resections. The use of RATKA allowed for a neutrally aligned knee with minimal bone loss or soft tissue dissection. Cases 3 and 4 presented staged bilateral knee arthroplasties for severe varus deformity secondary to seronegative rheumatoid arthritis. Due to the accuracy of RATKA and minimal bone loss, a stable knee was provided without the need for constrained implants. In the final two conversion cases, use of the robot allowed for minimal bone loss and accurate alignment without the use of conventional, intramedullary instrumentation. Case 5 presented an extraarticular deformity with a prior tibial plateau plate. The deformity was able to be accounted for and the plate retained without the need for intramedullary instrumentation. Finally, case 6 showed a patient with a prior retrograde femoral nail and significant bony overgrowth (Figure 1). The nail prohibited conventional, intramedullary guided distal femoral resection. The use of RATKA allowed femoral nail retention (Figure 2). Additionally, intraoperative feedback allowed for the correction of a 13-degree preoperative flexion contracture by adjusting the planned femoral resections. There were no intraoperative or postoperative complications. At latest follow up, all patients showed significant improvements in pain and ambulation compared to preoperative exams.

Discussion:

The use of robotics in total knee arthroplasty enables surgeons to provide consistent results, even in the most difficult cases. The preoperative planning and intraoperative accuracy of RATKA allowed component alignment within 3 degrees of neutral with minimal soft tissue releases. In the four deformity cases, RATKA allowed for the correction of deformity through careful tibial and femoral resections. In the two conversion TKAs with prior hardware, the use of robotic technology ensured successful results in cases where conventional, intramedullary instrumentation was not feasible. Manual instrumentation would have required either the use of extramedullary referencing or complete removal of the prior hardware, which would increase surgical time, blood loss and morbidity for the patient. Additionally, manual instrumentation has been found to be associated with greater outliers in mechanical alignment, which in cases of severe deformity may not be acceptable. Liow et al. found that robot-assisted TKA provides more consistent restoration of the mechanical axis and joint line, with 3.23% outliers in robotics compared to 20.6% in conventional TKA (6). Similar to this case series, the use of robotic technology has been shown to be effective in these complex patients. Marchand et al. found that 64% of severe varus deformities (greater than 7 degrees) and all of the severe valgus deformities were corrected to neutral alignment (7).

Conclusions:

Robotic-arm assisted surgery allows for the integration of preoperative CT scans to establish and execute a surgical plan with precision. Despite the complexity of these cases, excellent results were achieved without the need for revision-type components. These cases display the ability of robotic-arm assisted surgery to achieve consistent well-aligned results with minimal bone loss in challenging total knee arthroplasty cases.

Figure 1. Preoperative anteroposterior radiographs showing femoral hardware and valgus deformity.

Figure 2. Postoperative anteroposterior radiograph

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