

Knee arthroplasty assisted by augmented reality:

Case report

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Abstract

Background: Total knee arthroplasty (TKA) is a widely used procedure to treat advanced osteoarthritis, providing pain relief and functional improvement. However, the long-term success of the surgery depends on the precision in the positioning of the prosthetic components and the proper alignment of the operated limb. **Objective:** Describe the case of a 52-year-old patient, diagnosed with advanced gonarthrosis, who underwent TKA with the aid of augmented reality (AR). The patient had a history of hypertension, grade I obesity, and complaints of chronic pain in the right knee, with functional limitation and claudication. **Method:** The procedure was performed using prosthetic implants from the brand MicroPort Advanced®, with a navigation system assisted by AR, aiming for greater precision in correcting the mechanical axis and better adaptation of the components. **Results:** The surgery proceeded without complications, with a satisfactory postoperative evolution, including rapid functional recovery and significant symptom relief. **Conclusion:** The use of AR can offer significant advantages in surgical precision and functional outcomes, representing a promising alternative to optimize the longevity of implants in environments with limited infrastructure.

Keywords: Arthroplasty, replacement, knee; augmented reality; prostheses and implants.

BACKGROUND

The proper alignment of both the limbs and the components is one of the main determinants for the clinical success and longevity of the implants used in total knee arthroplasty (TKA)¹. In recent years, various computer-assisted surgical navigation (CAS) strategies have emerged, aimed at increasing the precision in the positioning of prostheses². Evidence suggests that the use of these technologies can reduce the rate of reoperations after TKA³.

However, many CAS techniques still face significant obstacles to their widespread adoption, such as high costs, complex operational structures, the need for specialized training, and increased surgical time—factors that hinder their implementation in daily practice. Among the technological innovations that have been gaining traction, augmented reality (AR) has stood out¹⁻⁴.

This technology allows virtual information to be projected into the surgeon's field of vision through smart glasses, providing real-time support during the procedure. With this, the surgeon can visualize, over the real image of the patient, important data such as anatomical axes, bone cutting angles, and implant orientation, without the need to divert their gaze to external monitors⁴. This integration between the physical and virtual worlds improves the surgical flow, reduces the dependence on bulky instruments or traditional mechanical guides, and potentially increases precision in the critical stages of the procedure.

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Moreover, being a less invasive technology in terms of structure, AR can represent a more accessible and practical alternative compared to complex computer-assisted navigation systems⁴.

METHODS

Patient, female, 52 years old, sought outpatient care with complaints of persistent pain and functional limitation in the right knee. The pain, described as mechanical, had progressively worsened in recent months, associated with claudication. In the past medical history, he reported systemic arterial hypertension, regularly using losartan 50 mg. Denied other relevant comorbidities. Previous surgery: tubal ligation. Weight of 76 kg, height of 1.51 m, with a body mass index (BMI) of 33.3, classifying as grade I obesity.

Upon physical examination, a varus mechanical axis of the right knee was observed, with preserved range of motion, evident crepitus in the femoropatellar joint during passive and active mobilization, as well as claudication during walking. There were no signs of inflammation or evident ligament instability. Given the clinical findings, the hypothesis of advanced gonarthrosis of the right knee was raised.

Considering the clinical picture, the failure of conservative treatment, and the functional impact on the patient's quality of life, TKA was indicated. The procedure was performed in March 2025, using prosthetic implants from the MicroPort Advanced® brand and with the aid of AR surgical navigation, aiming for greater precision in the positioning of the prosthetic components and correction of the mechanical axis.

The surgical procedure went smoothly without any complications. The patient was transferred to post-anesthesia recovery in good clinical condition, with a schedule for early physiotherapy and progressive rehabilitation.

The risks of producing this case report were related to the possible breach of confidentiality, thru the disclosure of data or unauthorized identification of the patient, which could result in psychological, moral, and/or material harm to the patient herself or to third parties. However, all precautions were taken to ensure that the patient's identity is not revealed, and the use of images will be conditioned upon express authorization thru the signing of the Free and Informed Consent Form (FICF). In this sense, the present report was reviewed and approved by the Research Ethics Committee – CAAE: 89244625.6.0000.5076, in compliance with the ethical and legal principles established in Resolution 466/2012 and Circular Letter 166/2018.

The benefits related to the production of this article refer to the contribution to the therapeutic approach of patients who have a pathology that requires knee arthroplasty, thus ensuring a better recovery and, consequently, quality of life for the patient.

RESULTS

The patient progressed satisfactorily in the immediate postoperative period, without clinical or surgical complications. At the postoperative follow-up on 02/14/2025, the patient showed good clinical progress, reporting gradual improvement in the function of the operated limb. The surgical wound was in an adequate healing process, with no signs of infection, dehiscence, or other local alterations.

At the time, I was undergoing physiotherapy sessions for postoperative recovery and functional rehabilitation, aimed at restoring the range of motion and muscle strengthening, according to the protocol established for rehabilitation after anterior cruciate ligament reconstruction.

The clinical response suggests a functional recovery within the expected range and reinforces the potential of the long fibular muscle tendon as a viable alternative graft for anterior cruciate ligament reconstruction.

DISCUSSION

Total knee arthroplasty (TKA) is considered one of the most effective treatments for patients with advanced osteoarthritis, providing pain relief and functional improvement. However, the longevity of the implants and long-term clinical outcomes are closely related to the precision in the positioning of the prosthetic components and the alignment of the operated limb. In this context, the introduction of intraoperative support technologies, such as augmented reality (AR), has gained prominence as a promising tool for improving surgical accuracy and, potentially, functional outcomes⁵.

Although osteoarthritis is not an inevitable consequence of aging, extensive evidence confirms age as the main risk factor for the development of the disease, especially in weight-bearing joints such as hips and knees. It was concluded that the female sex is the most prevalent among cases of knee osteoarthritis, in association with advancing age⁵. In this sense, the patient presented in this report—a 52-year-old woman with a diagnosis of advanced osteoarthritis in the right knee—meets criteria that predispose her to the disease, such as sex, age, and grade I obesity (BMI of 33.33). Obese individuals have up to three times higher chances of developing osteoarthritis compared to the population with an adequate weight, both due to the increased mechanical load on the joints and systemic inflammatory processes related to adipose tissue⁶.

The patient also had a history of hypertension. Among the main complaints were chronic joint pain, functional limitation, and claudication, with clinical findings of femoropatellar crepitus and varus alignment, which are classic indicators for TKA indication.

The choice to use AR during the procedure was motivated by its potential to integrate anatomical data and surgical guidance directly into the surgeon's visual field, without the need for bulky instruments or high-cost navigation systems.

Recent literature highlights that AR allows for better visualization of anatomical axes and improves the accuracy of bone cuts, a factor that directly contributes to the stability and durability of the implant. Studies highlight that, despite arthroplasty being a widely validated treatment, there is growing interest in alternative or complementary techniques that improve surgical precision and reduce complications, especially in younger or more active patients⁷.

AR emerges, in this scenario, as a viable proposal to refine the technique without the costs and complexities of robotic navigation, being particularly useful in environments with limited resources or lower technological infrastructure.

The experience described in this case also aligns with findings indicating that unsatisfactory functional outcomes after conventional arthroplasties may be related to low motor control complexity or inadequate muscle organization. Improvements in surgical technique, such as the one adopted here with the aid of AR, can positively influence neuromuscular recovery and the long-term gait pattern⁸.

Therefore, this report contributes to the growing literature that reinforces the value of AR as an ally in knee arthroplasty. Although larger-scale randomized studies are needed to confirm its benefits in terms of functionality and implant longevity, observational data and initial reports point to a promising future for the technology in reconstructive orthopedics.

CONCLUSION

The reported case and the publications raised elucidate the discussion of arthroplasty, which aimed to treat the patient's pain and functional limitation. This surgical intervention performed with Microport Advanced® prosthetic implants using AR navigation, when well-executed and in appropriately selected patients, based on medical history, physical examination, and complementary tests, demonstrates satisfactory results in terms of symptom relief, recovery time, and improvement in quality of life.

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