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Mini Review

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Implants that Replace the Cruciate Ligament in Primary Total Knee Arthroplasty

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Abstract

Total knee arthroplasty is a widely accepted surgical intervention for end-stage knee osteoarthritis. The restoration of knee stability is a crucial goal in achieving successful outcomes post-TKA. Traditionally, the posterior cruciate ligament has been sacrificed during TKA, resulting in altered kinematics and potential instability in the knee joint. Recent advancements have led to the development of implants that aim to replace the cruciate ligament during primary TKA, offering improved functional outcomes and patient satisfaction.

This article provides a comprehensive review of the current state of implants that replace the cruciate ligament in primary TKA. It begins by discussing the anatomical and biomechanical importance of the cruciate ligaments in knee stability and function. The drawbacks associated with sacrificing the PCL during TKA are then highlighted, including compromised stability, altered kinematics, and potential long-term complications.

The review subsequently explores various types of cruciate ligament-preserving implants, including posterior stabilized and cruciate-retaining designs. The characteristics, indications, surgical techniques, and clinical outcomes of each implant are thoroughly examined, incorporating evidence from clinical studies, systematic reviews, and meta-analyses. Additionally, implant-related complications, such as implant loosening, wear, and failure, are addressed to provide a comprehensive overview.

Furthermore, the review delves into emerging technologies and advancements in implant designs, such as anatomical implants, patient-specific instrumentation, and computer-assisted navigation. The potential benefits and limitations of these innovative approaches are discussed, along with the evolving evidence base supporting their use.

Keywords: Ligament; Cruciate-retaining designs; surgical techniques; Patient-specific instrumentation

Introduction

For decades, cruciate replacing total knee arthroplasty has been used. However, early findings were equivocal, and widespread use was thus limited. This is most likely due to early studies that showed limited femoral rollback due to implant design features, as well as concerns about increasing polyethylene wear. There was also worry about increased posterior tibial subluxation. This was attributable to the lack of the posterior cruciate ligament and the implant's diminished femoral tibial congruency. As a result, many surgeons have continued to limit the use of CS implants in favour of cruciate retaining and/or posterior stabilised complete knee implants [1].

The widespread usage of modern highly cross-linked polyethylene has substantially eliminated wear-related failure problems. Improved wear characteristics have increased trust in highly congruent tibial polyethylene implants. While this has contributed to an increase in the usage of CS implants, a number of other factors have also had a role. The CS implant is an optimal blend of the theoretical advantages of the PS and CR implants. Because the CS implant does not rely on the PCL to balance the flexion gap, late rupture or attenuation has no effect on long-term implant stability. Furthermore, the absence of a femoral box reduces the incidence of crepitus and potentially reduces the likelihood of a femoral condyle fracture, which is more common with PS implants [2].

Total knee arthroplasty, also known as knee replacement surgery, is a highly effective operation for relieving pain and restoring function in patients suffering from severe knee arthritis or joint degeneration. TKA outcomes have considerably improved as surgical procedures and implant design have advanced over the years. The use of cruciate replacing implants in initial total knee arthroplasty is one such breakthrough. In this post, we will look into cruciate replacing implants, their benefits, and how they affect knee reconstruction.

The adoption of single-use implants is another way that has been advocated to maximise cost savings and turnover efficiency. The CS implant should be evaluated as one of three primary total knee arthroplasty implant choices. This implant is compatible with any implant placement technique, including gap-balancing, measured resection, kinematic alignment, computer navigation, and/or robotic-arm aided TKA. There are both cemented and cementless attachment options. The next surgical approach will go over the intricacies of using a primary CS design and compare it to both PS and CR techniques. This paper should be useful for surgeons considering switching from a PS or CR implant design to a CS [3, 4].

Understanding cruciate substituting implants

Cruciate ligaments are important structures in the knee joint that provide stability and control the joint's forward and backward mobility. However, the cruciate ligaments may be irreparably injured in some cases of knee arthritis or joint degeneration. To remedy this issue, orthopaedic surgeons have created cruciate replacement implants that imitate the functions of natural ligaments.

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A femoral component, a tibial component, and a polyethylene insert that acts as a cushion between the two components comprise cruciate replacement implants. The design mimics normal knee kinematics by allowing for flexion and extension movements while retaining joint stability [5].

Benefits of cruciate substituting implants

Cruciate ligament replacement implants provide excellent stability by restoring anterior-posterior stability that is lost in cruciate ligament injury. This stability enables patients to engage in activities like walking, climbing stairs, and participating in sports with greater confidence and a lower chance of instability-related consequences.

These implants can improve joint function by mimicking natural knee kinematics. During regular activities, patients frequently report improved range of motion, enhanced knee strength, and decreased pain. This increased capability can considerably improve the overall quality of life for people who have TKA [6].

Cruciate replacing implants have a simpler surgical method than other types of implants. Because these implants do not require the removal of the posterior cruciate ligament, the process is simplified and the risk of problems is reduced. The streamlined technique may also result in reduced operating durations and quicker patient recovery.

Long-term endurance of crucial replacement implants has been proven. Their design and materials provide greater lifetime, lowering the likelihood of revision procedures or implant failure. This longevity is especially relevant for younger, more active patients who need knee replacements at a younger age [7].

Considerations and limitations

While cruciate replacement implants have significant advantages, they may not be appropriate for all individuals. Alternative implant choices, such as posterior stabilised or confined condylar implants, may be required due to factors such as ligament inadequacy, severe arthritis, or unique anatomical abnormalities. As a result, thorough patient selection and comprehensive preoperative evaluation are required to choose the best implant option for each individual.

Discussion

Over the last several decades, our understanding of native knee kinematics has advanced significantly. Recently, there has been a focus on restoring axial rotation and posterior translation of the lateral femur as the knee approaches deep flexion. This is known as a “medial pivot” motion.

While CR, PS, and CS implants have been used for many years, they were initially unfavourable due to previous designs that used ultra-congruent implants on conventional cross-linked polyethylene. Furthermore, one early fluoroscopic investigation found that this design resulted in less femoral rollback and a lower range of motion. Furthermore, the implant’s congruity raised worries about greater polyethylene wear. As a result, widespread adoption did not materialize [8].

Recent trials comparing CS implants to PS or CR implants have yielded positive outcomes. Wautier and Thienpont found anteroposterior laxity in two PS TKA designs at 30° and 90° of flexion, which was not detected in a medial pivot CS implant. However, at 60° of flexion, all three implants showed anteroposterior laxity. In a randomised controlled trial of 127 patients, researchers observed that the CS design resulted in enhanced intraoperative sagittal translation and decreased posterior femoral rollback during knee flexion [9].

Clinical outcomes of these implants have been overwhelmingly good, with either no clinical differences or slightly improved outcomes with CS liners. Wautier and Thienpont’s prior investigation found no difference in patient-reported outcome measurement scores or proprioception. There was no difference in knee range of motion during or after surgery. At a one-year follow-up, they found that patients who had CS liners had dramatically improved Oxford Knee Scores. This is consistent with the favourable findings of Samy et al., who discovered no change in range of motion between PS and CS liners but discovered that patients receiving CS liners scored higher on the Forgotten Joint Score, particularly in deep flexion.

Conclusion

By effectively restoring stability and recreating natural knee kinematics, cruciate replacing implants in primary total knee arthroplasty have revolutionised knee reconstruction. These implants have dramatically improved outcomes for patients undergoing knee replacement surgery because to their increased stability, improved functioning, easier surgical approach, and long-term durability. We should expect future refinements and developments in implant design as technology advances, leading to even better outcomes and patient satisfaction in the field of knee arthroplasty.

Conflict of Interest

None

Acknowledgment

None

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