



DEEP DISH TOTAL KNEE ARTHROPLASTY -IS IT A MYTH OR REALITY?

Orthopaedics

Prof. G. Mohan M. S. Ortho, Dnb Ortho, Mnam

Dr. E. Srinivas* M. S. Ortho, F.I.P.M, MRCS (Edinburgh) *Corresponding Author

Dr. Varadarajan M. S. Ortho

ABSTRACT

Background: Total Knee Arthroplasty (TKA) remains the gold standard for managing severe knee degenerative diseases, offering significant relief from pain and improved functionality. However, challenges persist in optimizing outcomes, particularly regarding the management of the Posterior Cruciate Ligament (PCL) during surgery. While traditional approaches involve substituting the PCL with post-cam mechanisms, concerns over bone integrity and stability have prompted exploration into alternative methods, such as ultra-congruent deep dished polyethylene inserts. **Materials and Methods:** This prospective study evaluated 20 patients who underwent primary TKA using a highly conforming deep dished polyethylene insert following PCL resection. Surgical techniques included the medial parapatellar approach and precise component fixation with cement. Pre-operative and post-operative Knee Society Score (KSS) and Functional Score (FS) were compared, and statistical analyses were conducted to assess correlations between various factors. **Results and Discussion:** The study demonstrated significant improvements in pain relief, functional ability, and knee stability postoperatively. Notably, there were no instances of anteroposterior instability observed, and the risk of supracondylar femur fracture was mitigated due to the elimination of bone resection. Furthermore, the deep dished polyethylene insert exhibited a lower rate of wear and tear compared to alternative designs, contributing to enhanced durability. Comparative analyses with existing literature support the efficacy of this approach, particularly in optimizing knee stability and range of motion. **Conclusion:** In conclusion, posterior substituting total knee replacement using ultra-congruent deep dished polyethylene inserts offers a promising avenue for effectively addressing knee degenerative diseases. However, careful patient selection is crucial, as this approach may not be suitable for morbidly obese patients or those with gross fixed flexion and varus deformity. Future studies with larger cohorts and longer follow-up periods are warranted to validate these findings and refine surgical techniques in TKA.

KEYWORDS

Total knee arthroplasty, deep dish, posterior stabilising, ultra-congruent polyethylene, cruciate retaining

INTRODUCTION:

Total Knee Arthroplasty (TKA) stands as the cornerstone in the management of severe degenerative knee diseases, providing patients with profound alleviation from debilitating pain, heightened joint stability, and enhanced mobility. Since the advent of total condylar prostheses in 1974, the field of TKA has undergone remarkable evolution^{1,2,3,4,5}. Advances in implant design and surgical techniques have contributed significantly to enhancing surgical outcomes, bolstering patient satisfaction, and elevating long-term implant survival rates to a decade-spanning survivorship ranging from 90% to 93%^{5,6}.

Despite these strides, the treatment landscape of TKA remains marked by ongoing debates and challenges, particularly concerning the management of the Posterior Cruciate Ligament (PCL) (Fig 1). The PCL, serving as a vital static



Fig 1 : Ligaments of the knee

stabiliser in normal knee physiology, faces significant compromise in the setting of degenerative knee diseases⁶. The decision regarding the management of the PCL during TKA is fraught with complexities, as surgeons must deftly navigate the delicate balance between preserving its native function and addressing its compromised state^{7,8,9,10}.

Conventionally, one approach to managing the compromised PCL involves substituting the resected ligament with a post-cam mechanism^{11,12,13} (Fig 2). This mechanism aims to replicate the function of the native PCL, thereby facilitating improved biomechanical properties such as stair-climbing ability and range of motion. However, the implementation of post-cam mechanisms introduces its own set of challenges⁴. Notably, the accommodation of these mechanisms necessitates the creation of a box-cut in the inter-condylar notch, potentially compromising bone integrity in the supra-condylar femur.

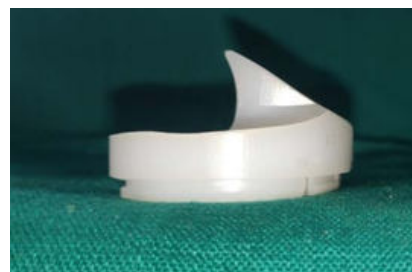


Fig 2 : Post-Cam polyethylene

In light of these challenges, an alternative approach has emerged, featuring the utilization of ultra-congruent deep dished polyethylene inserts in lieu of PCL-substituting post-cam mechanisms¹⁴ (Fig 3). While proponents argue for the superiority of deep dish implants in providing enhanced stability and functionality, skepticism persists regarding their purported benefits. This raises the critical question: Are deep dished implants genuinely a superior alternative in the realm of TKA, or are they merely a product of hype and conjecture?



Fig 3 : Ultra congruent polyethylene

In response to this question, this study seeks to evaluate the efficacy and merits of deep dish ultra-congruent implants in the context of TKA. Through an exploration of the challenges posed by traditional PCL-substituting post-cam mechanisms and the purported advantages offered by deep dish implants, this research endeavours to provide a comprehensive assessment of their clinical utility and substantiate their role in optimizing outcomes in total knee replacements.

MATERIALS AND METHODS:

Study Design: This prospective study evaluated patients who underwent primary Total Knee Arthroplasty (TKA) between October 2016 and October 2019 at VS Hospitals, Chennai, India, utilizing highly conforming deep dish polyethylene inserts.

Patient Population: The study included patients meeting stringent inclusion criteria: Grade IV primary osteoarthritis and rheumatoid arthritis knee, age > 50 years, and both male and female participants. Patients with prior tibial or femoral osteotomies or those undergoing revision total knee arthroplasty were excluded.

Surgical Technique: Among various surgical approaches available for TKA, the medial parapatellar approach was chosen based on the author's preference. This approach, while acknowledging the merits and demerits associated with each technique, was deemed preferable for its familiarity and surgeon comfort. Surgeries were performed under epidural with spinal anesthesia in a supine position on a routine operating table.

Exposure: A midline skin incision was made with the knee in 90 degrees of flexion (Fig 4). Dissection was meticulously carried out to expose the quadriceps tendon, patella, and ligamentum patellae.

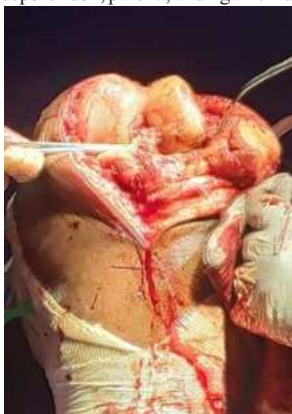


Fig 4 : Midline incision with medial parapatellar approach

Through the medial parapatellar approach, capsulotomy was performed. Osteophytes were excised, and soft tissue releases were meticulously performed as necessary.

Tibial and Femoral Cuts: Proximal tibial resection was executed using the extramedullary tibial cutting guide, with 9 mm of bone resected. Accurate rotation of the femoral component was meticulously obtained using epi-condylar instrumentation. Distal femoral cutting was meticulously performed along the trans-epicondylar axis (Fig 5).



Fig 5 : Bone cuts

Flexion and extension gaps were meticulously measured, and further cuts were meticulously made as needed to meticulously balance the gaps (Fig 6).

Component Fixation: Tibial and femoral components were meticulously fixed with cement. Multiple meticulously placed drill holes were made on the tibial condyle, and cement was meticulously applied



Fig 6 : Flexion-Extension gaps

before component fixation. The deep dish ultra-congruent polyethylene insert was meticulously fixed by a sliding mechanism in the tibial tray (Fig 7).



Fig 7 : Deep dish components

Post-operative Protocol: Post-operative care included meticulous deep vein thrombosis (DVT) prophylaxis with low-molecular-weight heparin, meticulous in-bed mobilization, deep breathing exercises, meticulous continuous passive movement (CPM), meticulous wound inspection, drain removal, and dressing. Patients were meticulously mobilized to stand/walk with walker support as tolerated.

Follow-up: Patients were meticulously followed up, and pre-operative and post-operative Knee Society Score (KSS) and Functional score (FS) were meticulously compared.

RESULTS:

Case -1 : Pre-op (fig 8.1, 8.2)



Fig 8.1



Fig 8.2

Post-op (fig 8.3, 8.4)



Fig 8.3



Fig 8.4

Case-2 : Pre-op (fig 9.1, 9.2)



Fig 9.1



Fig 9.2

Post-op (fig 9.3, 9.4)



Fig 9.3

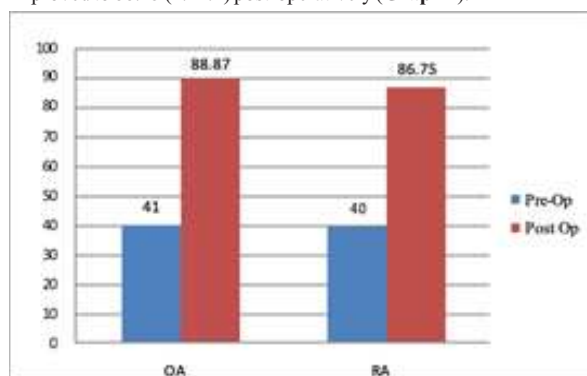


Fig 9.4

Demographic Characteristics: A total of 20 Total knee arthroplasties were included in the study. The age distribution showed that 12 cases were operated at a mean age of 53.5 years (± 6.2), while 8 cases were operated at a mean age of 66.1 (± 8.4) years. Among the cases, 12 were females and 8 were males. The majority of surgeries (13 out of 20) were performed on the left knee (65%), with the remaining 7 on the right knee (35%). The most common diagnosis was osteoarthritis, accounting for 16 cases (80%), while 4 cases were diagnosed as rheumatoid arthritis (20%).

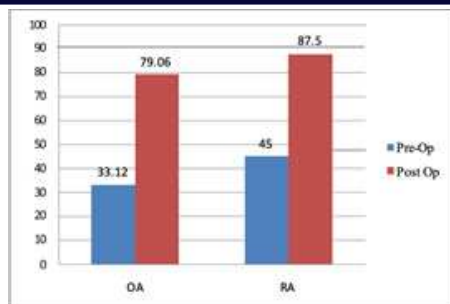
Pre-operative Characteristics: The mean pre-operative range of motion was 83.25 degrees (± 12.7). Among the knees, 6 (30%) had <75 degrees of motion, 12 (60%) had 76-90 (mean 84.9 ± 4.6) degrees, and 2 (10%) had >90 degrees of motion. Additionally, 7 (35%) knees had <10 degrees of fixed flexion deformity, while 5 (25%) knees had 10-20 (mean 14.3 ± 5.6) degrees of fixed flexion deformity.

Clinical Evaluation: Clinical evaluation included pre and post-operative Knee Society Score (KSS) and Functional Score (FS). Mean pre-operative KSS was 40.80 (± 26.90), which significantly improved to 88.45 (± 4.2) post-operatively (**Graph 1**).



Graph 1 : Knee society scores

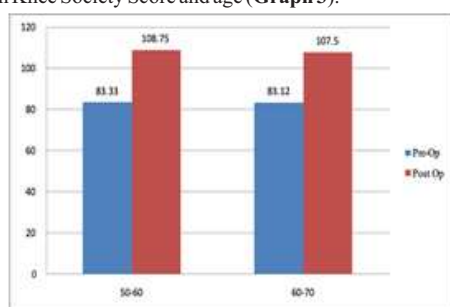
Similarly, the mean pre-operative FS was 35.50 (± 12.17), increasing to 80.75 (± 2.07) post-operatively (**Graph 2**). X-rays were taken pre-operatively and post-operatively, including standard antero-posterior weight-bearing view and lateral view X-rays.



Graph 2 : Functional scores

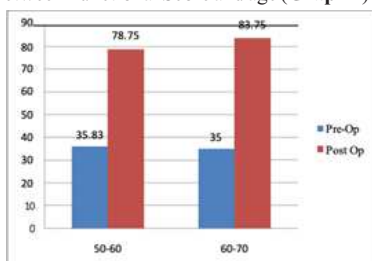
Statistical Analysis: Statistical analysis was meticulously performed to assess the correlation between various factors. The 't' test results are summarized below:

Post-operative range of motion vs age: No statistically significant correlation was found between range of motion and age. **Knee Society Score vs age:** No statistically significant correlation was found between Knee Society Score and age (Graph 3).



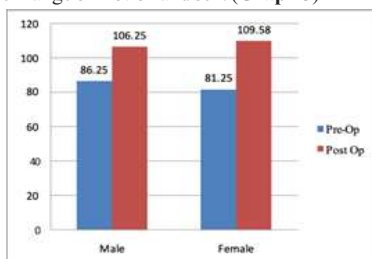
Graph 3 : Post-op ROM Vs Age

Functional Score vs age: There was a statistically significant correlation between Functional Score and age (Graph 4)

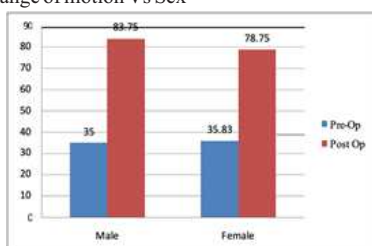


Graph 4 : Functional score Vs Age

Range of motion vs sex: No statistically significant correlation was found between range of motion and sex. (Graph 5)



Graph 5 : Range of motion Vs Sex

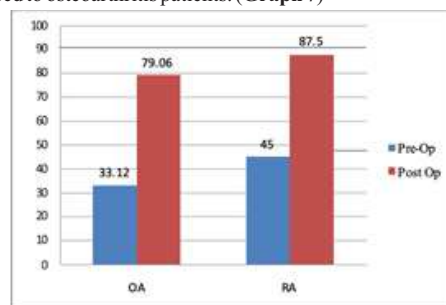


Graph 6 : Functional score Vs Sex

Functional Score vs sex: There was a statistically significant correlation between Functional Score and sex. (Graph 6)

Knee Society Score vs sex: No statistically significant correlation was found between Knee Society Score and sex.

Range of motion vs disease: There was a statistically significant correlation between range of motion and disease, with better post-operative range of motion observed in rheumatoid arthritis patients compared to osteoarthritis patients. (Graph 7)



Graph 7 : Rom Vs Disease

Knee Society Score vs disease: No statistically significant correlation was found between Knee Society Score and disease.

Functional Score vs disease: There was a statistically significant correlation between Functional Score and disease.

DISCUSSION:

Total knee arthroplasty (TKA) stands as the gold standard for addressing severe knee degenerative diseases, offering unparalleled relief when conservative measures are exhausted. However, its success hinges on meticulous patient selection and surgical execution. Our study delved into the functional outcomes of TKA with a focus on the use of a highly conforming deep dished polyethylene insert following posterior cruciate ligament (PCL) resection.

Factors Influencing TKA Outcomes: Numerous factors, including age, sex, and disease characteristics, influence TKA outcomes. The onset and progression of osteoarthritis are multifactorial, encompassing age, sex, genetics, obesity, and occupational factors. Controversy shrouds the management of the PCL during TKA, with debates surrounding cruciate-preserving versus cruciate-substituting systems. While the former may offer superior knee kinematics and stair-climbing ability, concerns regarding abnormal screw home motion and polyethylene wear persist. The adoption of highly conforming deep dished polyethylene inserts post-PCL resection addresses these concerns^{15,16}.

Clinical Implications of Surgical Approaches: Our study aligns with existing literature advocating for the use of deep dished polyethylene inserts, particularly in cases of PCL resection during TKA. Studies have highlighted the increased antero-posterior stability and reduced need for bony resection in the intercondylar notch with this design. Furthermore, comparative analyses have shown no significant differences in range of motion or knee scores between posterior stabilized and dished polyethylene inserts¹⁷.

Comparison with Existing Studies: Comparing our study findings with existing literature reveals similar trends in functional outcomes and surgical implications. Studies by Hoffman et al., Laskin et al.¹⁸, and Scott and Thornhill¹⁹ underscore the benefits of deep dished polyethylene inserts in enhancing knee stability and postoperative range of motion. Font-Rodriguez et al.²⁰ and Hirsch et al.¹² further support the long-term success and survivorship of such implants, minimizing concerns regarding polyethylene wear and knee kinematics.

Limitations and Complications: Despite the promising outcomes observed, our study is not devoid of limitations. Short-term follow-up and a relatively small sample size temper the generalizability of our findings. Additionally, complications such as mid-flexion instability and patellar maltracking in obese patients highlight the importance of vigilant intraoperative monitoring and tailored surgical approaches.

CONCLUSION:

In conclusion, our study provides valuable insights into the functional outcomes of TKA with deep dished polyethylene inserts following PCL resection. By addressing concerns surrounding knee stability, polyethylene wear, and surgical complications, this approach offers a promising avenue for optimizing TKA outcomes. Future studies with larger cohorts and long-term follow-up are warranted to corroborate our findings and further refine surgical techniques in TKA.

In our study of 20 cases of posterior substituting total knee replacement using ultra-congruent deep dished polyethylene insert, we draw the following conclusions:

- 1) **Pain Relief and Functional Improvement:** The procedure provides effective pain relief and significantly improves functional ability, enhancing the overall quality of life for patients.
- 2) **Anteroposterior Stability:** We observed no instances of anteroposterior instability postoperatively, indicating the stability of the implant and surgical technique.
- 3) **Reduced Risk of Fracture:** By eliminating the need for bone resection in the intercondylar notch of the femur, this approach reduces the risk of supracondylar femur fracture, enhancing the safety profile of the procedure.
- 4) **Reduced Rate of Wear and Tear:** The deep dished polyethylene insert demonstrated a lower rate of wear and tear compared to alternative implant designs, contributing to the longevity of the implant and improved durability.
- 5) **Applicability to Small Knees:** The elimination of bone resection allows for the use of this implant in smaller knees, expanding the pool of eligible candidates for the procedure.
- 6) **Limitations and Patient Selection:** However, it is important to note that this approach may not be suitable for morbidly obese patients or those with gross fixed flexion and varus deformity, who may benefit from alternative posterior stabilized implants.

In summary, posterior substituting total knee replacement using ultra-congruent deep dished polyethylene insert offers a promising avenue for effectively addressing knee degenerative diseases. Its benefits include pain relief, improved functional outcomes, enhanced stability, and reduced risk of complications. Careful patient selection and surgical technique optimization are essential for maximizing the success of this procedure.

Conflict of interest : The authors have no conflicts of interests to declare.

Informed consent : Informed consent was obtained from all patients included in this study.

REFERENCES

1. Ranawat CS, Flynn WF, Saddler S, Hansraj KK, Maynard MJ et al. Long term results of the total condylar knee arthroplasty. A 15 years survivorship study. Clin Orthop Relat Res, Jan 1993;(286): 94-10
2. Ritter MA, Campbell E, Faris PM, Keating EM et al. Long term survival analysis of PC condylar total knee arthroplasty: a ten year evaluation. J Arthroplasty 1989;4:293-296
3. Ritter MA, Herbst SA, Keating EM, Faris PM, Meding JB et al. Long term survival analysis of a PCR total condylar knee arthroplasty. Clin Orthop Relat Res. 1994; 309:136-145
4. Cobb AC, Ewald FC, Wright J, Sledge CB et al. The Kinematic Knee: survivorship analysis of 1943 knees. J Bone Joint Surg 1990;72B:532
5. Stern SH, Insall JN et al. Posteriorly stabilized results after follow up of nine years. J Bone Joint Surg. 1992;74A:980-986
6. Ashok rajagopal, Kim C Bertin, Chitranjan S Ranawat. Knee surgery, ISBN : 978-93-5152-225-6, 2014
7. JB Stiehl, RD Komistek, DA Dennis et al; Detrimental kinematics of a flat on flat total condylar knee arthroplasty ClinOrthop Relat Res 1999 365; 139
8. Lewis P, Rorabeck CH, Bourne RB, et al. Postero-medial tibial polyethylene failure in total knee replacements ClinOrthop 1994;11
9. Makulak SA, Mahoney OM, dela Rosa MA et al. Loosening and osteolysis with the press fit condylar posterior cruciate substituting total knee replacement. J Bone Joint Surg Am 2001;83-A:398
10. Soundry M, Walker PS, Reilly DT et al. Effects of total knee replacement design on femoro-tibial contact conditions. J Bone Joint Surg. 1986;1:25
11. Dennis DA, Komistek RD, Stiehl JB et al. Range of motion after total knee arthroplasty: the effect of implant design and weight bearing conditions. J Arthroplasty 1998;13:74
12. Hirsch HS, Lotke PA, Morrison LD et al. The posterior cruciate ligament in total knee surgery. Save, sacrifice or substitute? Clin Orthop 1994;64
13. Tanzer M, Smith K, Burnett S et al. Posterior stabilized versus cruciate retaining total knee arthroplasty: balancing the gap. J Arthroplasty 2002;17:813
14. Aaron A, Hofmann, Thomas K, Tkach, Christopher J, Evanich and Marcelo P. Camrago et al; Posterior Stabilization in Total Knee Arthroplasty with use of an ultra-congruent Polyethylene Insert; J Arthroplasty 2000; 15:576
15. Brain S, Parsley, Michael A, Conditt, Roberto Bertolusso, Philip C, Noble et al; Posterior Cruciate Ligament Substitution is not Essential for Excellent Postoperative Outcomes in Total Knee Arthroplasty. Indian journal of Orthopaedic. 2002 Vol36;No 2
16. Daniilidis K, Skwara A, Vieth V, et al. Highly conforming polyethylene inlays reduce the in vivo variability of knee joint kinematics after total knee arthroplasty. Knee 2012;19:260-5
17. Lützner J, Firmbach FP, Lützner C, et al. Similar stability and range of motion between

- cruciate-retaining and cruciate-substituting ultra-congruent insert total knee arthroplasty. Knee Surg Sports Traumatol Arthroscopy 2015;23:1638-43
18. RS Laskin, Y. Maruyama, M. Villanueva et al; Deep-dish congruent tibial component use in total knee arthroplasty: a randomized prospective study; Clin Orthop Relat Res 2000 380;36
 19. Scott, Thomas S, Thornhill et al; Posterior Cruciate Supplementing Total Knee Replacement Using Conforming Inserts and Cruciate Recession; Clin Orthop Relat Res 1994; 309:146
 20. Font-Rodriguez DE, Scuderi GR, Insall JN et al; Survivorship of cemented total knee arthroplasty; Clin Orthop Relat Res 1997; 345:79