Postoperative Length of Stay: Comparing Kinematic and Mechanical Knee Alignments in Knee Arthroplasties

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Unicompartmental knee arthroplasty (UKA) and total knee arthroplasty (TKA) can be technically accomplished by either traditional mechanical alignment or by an alternative kinematic alignment. The purpose of this study is to compare postoperative length of hospital stay between these two approaches. A retrospective study at Medstar Washington Hospital Center from 2015 – 2024 identified 167 cases of UKAs, of which 69 were kinematic and 98 were mechanical. During the same period, 420 TKAs were identified where 244 were kinematic and 176 were mechanical. Postoperative length of hospitalization and physical therapy recommendations was then compared with two-sample T-tests and Chi-square tests. Patients undergoing a UKA kinematic procedure were discharged a half day earlier than their mechanical counterparts ($p = 0.029$), and TKA kinematic patients were discharged nearly a full day earlier ($p = 0.0001$). Additionally, TKA kinematic patients were more likely to be discharged home with home services rather than to a rehabilitation facility for physical therapy ($p < 0.00001$). UKA patients of both kinematic and mechanical alignment were recommended to be discharged home ($p = 0.312$) Postoperative length of stay is significantly decreased by up to a day in patients receiving a knee arthroplasty by kinematic alignment approach. TKA kinematic patients also benefit from a discharge recommendation to home for physical therapy, rather than requiring transfer to a rehabilitative facility. These findings highlight how kinematic alignment may contribute to early improved patient satisfaction, restore early functionality, and decrease disease burden. (Journal of Surgical Orthopaedic Advances 34(3):124-127, 2025)

Key words: unicompartmental knee arthroplasty, total knee arthroplasty, postoperative outcomes, kinematic alignment, hospitalization:

Osteoarthritis (OA) is a degenerative joint disease that inhibits daily functionality and continues to increase in frequency as our population lives longer. Over the last thirty years, the prevalence has increased by 132.2%, and epidemiologic projections expect an additional 60 – 100% increase by 2050.[1] Treatment of knee OA is first with lifestyle modifications, and then with surgery for cases refractory to other interventions. Giving the rising prevalence of knee OA and thus rising need for surgical management, it is important to study if the surgical techniques offer the best clinical outcomes, restore functionality, and reduce the burden of disease for both individuals and healthcare systems.

Joint replacement technique for management of OA is either with total knee arthroplasty (TKA) or unicompartmental knee arthroplasty (UKA). During traditional TKA and UKA procedures, the replacement components are aligned perpendicularly to the mechanical axis of the lower extremity. Known as mechanical knee alignment, this has been the gold-standard approach among orthopaedic surgeons to maximize implant longevity.[2] However, several studies have demonstrated how anatomic variations between individuals leads to acute and chronic complications with mechanical knee alignment, including ligament instability and gait kinematics.[3,4] In fact, up to 30% of patients who had undergone a knee arthroplasty reported some degree of dissatisfaction with the joint.[5-7]

An alternative alignment approach, known as kinematic alignment, is gaining popularity for its ability to maintain the inherent anatomy of the patient's knee.[8,9] Recent studies have demonstrated kinematic alignment may offer improved pain relief and early mobility, and overall have greater patient satisfaction, than mechanical alignment.[9–11] Given the relatively new implementation of kinematic alignment within orthopaedic practices, it is important to understand short and long term postoperative effects on both the patient and the hospital system.

Postoperative length of stay (LOS) is one such measure that can be studied to reduce the overall burden of disease OA places on healthcare systems and improve patient outcomes such as decreased rate of readmission and decreased time to mortality.[12–14] To date, several small studies within kinematic patients have demonstrated decreased LOS, faster mobility, and decreased use of opioids.[10,11] Previous limitations to these studies included the narrow time frame and small sample size. Additionally, studies thus far have investigated postoperative outcomes for patients receiving a TKA but have not included UKA patients in analysis. To the authors' knowledge, this is the first study to investigate the LOS for both TKA and UKA patients over a 10-year time scale. This is also the first study to investigate how physical therapy (PT) referrals to home versus a sub-acute rehab (SAR) or equivalent facility compares between the two approaches.

The study hypothesis is that the individualized nature of kinematic alignment will result in shorter LOS and decreased referral to SARs or equivalent facilities.

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Methods

A retrospective cohort analysis was designed to identify UKAs and TKAs of both kinematic and mechanical approach. Cases that were done between December 2012 and December 2024 on a unilateral knee were included for review. Cases that underwent back-to-back knee replacements or had significant postoperative complications requiring interventions of a different service (such as medicine, psychiatry, general surgery) were excluded from review. Additionally, cases for which discharge was complicated by homelessness were not included. One hundred and sixty-seven cases of UKAs and 420 cases of TKAs were identified as meeting inclusion criteria, and chart review for surgical approach, discharge date, intraoperative and postoperative complications, and PT-recommended discharge facility was performed by three separate reviewers. Kinematic alignment was done in 69 UKA cases and 244 TKA cases, whereas mechanical alignment was done in 98 UKA cases and 176 TKA cases.

Surgical Technique

A single surgeon performed all procedures. Mechanical arthroplasty was done using the standard technique. A standard anterior knee incision was made following by a parapatellar arthrotomy. After the distal femur was cut, the proximal tibia was cut 90 degrees perpendicular to the lower extremity mechanical axis. This was performed by use of an extramedullary tibia cutting jig. Once these cuts were made, soft-tissue manipulation was performed to obtain ligament balance in flexion and extension. Implants were trialed and then cemented or press-fit into place.

Kinematic arthroplasty was performed using Linked Anatomic Kinematic Arthroplasty (LAKA) technique, which was originally written for TKAs in 2020, but was redesigned for UKAs in 2021.[15] Of note, the tibia was cut perpendicular to its kinematic axis, perpendicular to its native pre-arthritic joint line. Balance was achieved through bone cuts only, and no soft-tissue release-balancing was performed. Implants were trialed and then cemented or press-fit into place. This study reviewed and evaluated DePuy Synthes implants comparing kinematic and mechanical knee alignment in knee arthroplasties.

Statistical Analysis

For demographic data, mean age, percent female, and percent male between kinematic and mechanical patients was calculated for each UKA and TKA. Percent race was also calculated between groups.

The average POD of discharge was calculated between kinematic and mechanical patients for each UKA and TKA. A two-sample *t*-test was run to compare the mean of these groups. The number of patients who received an inpatient versus an outpatient procedure was compared between kinematic and mechanical patients for each UKA and TKA. Then the number of patients who were referred to home with outpatient PT versus home with home health versus a tertiary facility, such as SAR, National Rehab Hospital (NRH), or skilled nursing facility (SNF) was calculated between kinematic and mechanical groups for each UKA and TKA. A Chi-square test of independence was run for these categorical variables.

Results

Population demographics can be found in Table 1 and Table 2. Combining UKA and TKA, 66.1% of kinematic patients were female with a mean age of 63.1 and 65.3% of mechanical patients were female and at a mean age of 59.6. Most patients were African American for both kinematic (66.1%) and mechanical (76.3%) patients across UKA and TKA populations.

TABLE 1. UKA Demographic data between kinematic and mechanical patients

	Kinematic (n = 69)	Mechanical (n = 98)
Gender and Age		
% Female	60.9	52.0
% Male	39.1	48.0
Mean Age (sd)	58.6 (10.5)	55.8 (9.1)
Race		
% African American	59.4	68.4
% White	20.2	22.4
% Other	13.0	7.14
% Unknown	4.35	2.04
Operation Setting		
Inpatient	47	88
Outpatient	22	10

UKA, unicompartmental knee arthroplasty

TABLE 2. TKA demographic data between kinematic and mechanical patients.

	Kinematic (n = 244)	Mechanical (n = 176)
Gender and Age		
% Female	68.0	72.7
% Male	32.1	27.2
Mean Age (sd)	64.4 (9.25)	61.7 (9.94)
Race		
% African American	68.0	80.7
% White	11.1	7.95
% Other	17.6	10.8
% Unknown	3.28	0.568
Operation Setting		
Inpatient	210	176
Outpatient	34	0

TKA, total knee arthroplasty

TABLE 3. UKA length of stay between kinematic and mechanical patients

	Kinematic (n = 69)	Mechanical (n = 98)	*p*-value
Avg. POD of discharge (sd)	1.64 (1.49)	2.14 (1.43)	0.029*

* Indicates statistical significance.
UKA, unicompartmental knee arthroplasty; POD, postoperative day; sd, standard deviation

In patients undergoing a UKA operation, the length of stay between kinematic and mechanical patients differed by half a day, with a *p*-value of 0.029 (Table 3). For both kinematic and mechanical patients, the predominant PT recommendation was home discharge with outpatient PT, at 65.2% and 54.0%, respectively (Table 4).

For TKA procedures, kinematic patients were discharged nearly a full day earlier than mechanical patients with a resulting *p*-value of 0.0001 (Table 5). A statistical difference was found in discharge recommendations, as most kinematic patients were discharged with home health services (58.1%), whereas most mechanical patients were discharged to a rehabilitation facility (57.0%) (Table 6).

Discussion

It is theorized that kinematic joint replacement offers distinct advantages compared to the traditional, mechani-

TABLE 4. UKA operation location and discharge location for physical therapy between kinematic and mechanical patients

	Kinematic (n = 69)	Mechanical (n = 98)	Chi square value	*p*-value
# Discharged to home	45	53	2.33	0.312
# Discharged with home health	18	32		
# Discharged to SAR or SNF or equivalent	3	8		

UKA, unicompartmental knee arthroplasty; SAR, subacute rehab; SNF, skilled nursing facility

TABLE 5. TKA length of stay between kinematic and mechanical patients

	Kinematic (n = 244)	Mechanical (n = 176)	*p*-value
Avg. POD of discharge (sd)	2.81 (1.96)	3.75 (1.66)	0.0001*

* Indicates statistical significance
TKA, total knee arthroplasty; POD, postoperative day

TABLE 6. TKA operation location and discharge location for PT between kinematic and mechanical patients

	Kinematic (n = 244)**	Mechanical (n = 176)**	Chi square value	*p*-value
# Discharged to home	52	17	56.7	< 0.00001*
# Discharged with home health	136	48		
# Discharged to SAR or SNF or equivalent	46	86		

* Indicates statistical significance.
***Of note, 10 kinematic patients and 25 mechanical patients did not have discharge notes on PT recommendations, so they were excluded from analysis*
TKA, total knee arthroplasty; PT, physical therapy; SAR, subacute rehab; SNF, skilled nursing facility

cally aligned arthroplasty. Although mid- and long-term clinical outcomes take time to study and evaluate, there maybe distinct short-term advantages for kinematic technique. This study demonstrates a statistically significant difference in postoperative length of stay between kinematic and mechanical patients, with kinematic patients undergoing UKA operation staying on average, a half day less in the hospital than mechanical patients. More impressively, kinematic patients undergoing TKA operation were discharged almost a full day earlier than their mechanical counterparts. Aligned with other studies that demonstrated decrease length of stay and improved mobility, our data shows significant support of this trend across a larger population.[10,11]

Additionally, there is a statistically significant difference in where patients are discharged for PT rehabilitation between TKA kinematic and mechanical patients, with the majority of kinematic patients being discharged to home with PT services, rather than a tertiary care center like a SAR or SNF. For UKA patients, although the difference was not statistically significant, there is still evidence that the overall percentage of referrals to rehabilitation centers is less in kinematic compared to mechanical patients.

A full and half day discharge difference has important implications. In addition to less exposure to nosocomial infection, a reduction is hospital time saves resources and costs. Therefore, techniques that lead to reduction in length of stay may lead to less expensive outcomes that minimize risk. Other studies among orthopaedic patients have found that a home discharge results in lower readmission rates and postoperative complications compared to patients discharged to an institutional facility.[16,17] While confounding variables such as being healthier at baseline certainly are contributing factors, these results highlight how a kinematic approach might improve immediate postoperative mobility and, therefore, allow patients to be discharged safely to home.

Strengths of this include the relatively large sample size and study length of time. With a calculated power of 0.88 and 0.99 for UKA and TKA populations, respectively, it is likely that the findings represent statistical differences and are not limited by power. Additionally, a single surgeon performed all surgeries in the same academic inner-city hospital, reducing variability in surgical techniques.

Limitations of the study include the single center and a single surgeon, which reduces the generalizability to other demographics and other surgeons. Additionally, although all patients were of similar age, race, and gender background, and were all healthy enough to undergo a knee arthroplasty to regain functional mobility, there are variations in patient's underlying medical conditions that was not controlled for in our data analysis. There are certainly many factors that contribute to discharge, and these patient specific factors including baseline health, education level, social support, and intrinsic motivation are not specifically accounted for. The hope was that looking at a large population at a single center may mitigate these patient-related factors. However, it is conceivable that this study is underpowered to identify the true reason for accelerated discharge with kinematic arthroplasty. It should be known that the lead surgeon theorized that, anecdotally, patients who reported a decrease in postoperative pain would correlate to faster discharges to home.

Future research should continue to investigate how patient outcomes compare between a kinematic approach and mechanical approach. More evidence is needed to determine the generalizability of these findings to surgeons at other hospitals and to patients of other demographics. Given the respective novelty of the kinematic approach, future research should determine how failure rates compare between kinematic and mechanical joint on a longer time scale, as well as overall patient satisfaction and perceived change in mobility.

Conclusion

Knee osteoarthritis is a common problem that often requires surgery. Traditional techniques are not always optimal, and there is an opportunity for improvement. Based upon this study, full and partial kinematic alignment is an alternative arthroplasty technique that improves outcomes and reduces significantly the length of stay.

References

1. Courties A, Kouki I, Soliman N, et al. Osteoarthritis year in review 2024: epidemiology and therapy. Osteoarthritis Cartilage. 2024;32(11):1397-1404.
2. Karasavvidis T, Pagan Moldenhauer CA, Haddad FS, et al. Current Concepts in Alignment in Total Knee Arthroplasty. J Arthroplasty. 2023;38(7):S29-S37.

3. Blakeney W, Clément J, Desmeules F, et al. Kinematic alignment in total knee arthroplasty better reproduces normal gait than mechanical alignment. Knee Surg Sports Traumatol Arthrosc Off J ESSKA. 2019;27(5):1410-1417.
4. Almaawi AM, Hutt JRB, Masse V, et al. The impact of mechanical and restricted kinematic alignment on knee anatomy in total knee arthroplasty. J Arthroplasty. 2017;32(7):2133-2140.
5. Scott CEH, Howie CR, MacDonald D, et al. Predicting dissatisfaction following total knee replacement: a prospective study of 1217 patients. J Bone Joint Surg Br. 2010;92-B(9):1253-1258.
6. Bourne RB, Chesworth BM, Davis AM, et al. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop. 2010;468(1):57-63.
7. Parvizi J, Nunley RM, Berend KR, et al. High level of residual symptoms in young patients after total knee arthroplasty. Clin Orthop. 2014;472(1):133-137.
8. Roussot MA, Vles GF, Oussedik S. Clinical outcomes of kinematic alignment versus mechanical alignment in total knee arthroplasty: a systematic review. EFORT Open Rev. 2020;5(8):486-497.
9. Gulati J, Fernandez C, Ricci J, et al. A retrospective comparison of mechanically vs. kinematically aligned unicompartmental knee arthroplasties. J Orthop. 2024;52:33-36.
10. Lung BE, Donnelly MR, McLellan M, et al. Kinematic alignment may reduce opioid consumption and length of stay compared to mechanically aligned total knee arthroplasty. Orthop Surg. 2023;15(2):432-439.
11. Dossett HG, Estrada NA, Swartz GJ, et al. A randomised controlled trial of kinematically and mechanically aligned total knee replacements: two-year clinical results. Bone Joint J. 2014;96-B(7):907-913.
12. Han TS, Murray P, Robin J, et al. Evaluation of the association of length of stay in hospital and outcomes. Int J Qual Health Care. Published online December 17, 2021:mzab160.
13. Kaboli PJ, Go JT, Hockenberry J, et al. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. Ann Intern Med. 2012;157(12):837-845.
14. van Vliet M, Huisman M, Deeg DJH. Decreasing hospital length of stay: effects on daily functioning in older adults. J Am Geriatr Soc. 2017;65(6):1214-1221.
15. Stake S, Fassihi SC, Gu A, et al. Linked anatomic kinematic arthroplasty: a unique approach to balancing in total knee arthroplasty. J Orthop. 2020;20:198-203.
16. Burke RE, Canamucio A, Medvedeva E, et al. Association of discharge to home vs institutional postacute care with outcomes after lower extremity joint replacement. JAMA Netw Open. 2020;3(10):e2022382.
17. Deemer AR, Ganta A, Leucht P, et al. Home discharge location is safest following fracture of the hip. Eur J Orthop Surg Traumatol Orthop Traumatol. 2023;33(8):3539-3546.