Robotic total knee arthroplasty safely reduces length of stay in an Asian public healthcare system

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Aims

Around the world, the emergence of robotic technology has improved surgical precision and accuracy in total knee arthroplasty (TKA). This territory-wide study compares the results of various robotic TKA (R-TKA) systems with those of conventional TKA (C-TKA) and computer-navigated TKA (N-TKA).

Methods

This is a retrospective study utilizing territory-wide data from the Clinical Data Analysis and Reporting System (CDARS). All patients who underwent primary TKA in all 47 public hospitals in Hong Kong between January 2021 and December 2023 were analyzed. Primary outcomes were the percentage use of various robotic and navigation platforms. Secondary outcomes were: 1) mean length of stay (LOS); 2) 30-day emergency department (ED) attendance rate; 3) 90-day ED attendance rate; 4) 90-day reoperation rate; 5) 90-day mortality rate; and 6) surgical time.

Results

A total of 8,492 knees from 7,746 patients were included in the study. Overall robotic use had risen to 20.4% (2023 Q3 to Q4: 355/1,738) by the end of 2023, with Mako being the most popular at 10.3% (179/1,738). R-TKA had the shortest mean LOS compared with N-TKA and C-TKA (5.5 vs 6.3 and 7.1 days, respectively; $p < 0.001$). Only Mako (9.7%) demonstrated reduced 90-day ED attendance compared to C-TKA (13.1%; $p = 0.009$), Cori/Navio (15.0%; $p = 0.005$), and Rosa (16.4%; $p < 0.001$). No differences in 90-day reoperation rate and mortality were observed between all groups. Mean surgical times were longer in R-TKA groups by 20.6 minutes ($p < 0.001$).

Conclusion

R-TKA use has increased in recent years, and has been shown to reduce hospital stay despite having a slightly longer surgical time, proving a promising candidate to alleviate the burden on healthcare systems. Individual differences between R-TKA systems contributed to variable clinical outcomes.

Take home message

- Robotic total knee arthroplasty (R-TKA) use has been rising for the past two years, but conventional TKA has remained the primary treatment modality.
- Hospital stays were safely reduced with R-TKA, which is crucial for Asian public healthcare systems, owing to socioeconomic factors and the prevalence of osteoarthritis in Asian regions.
- Despite longer surgical times in R-TKA, there were no increases in emergency department attendance, reoperation, or mortality rates.

Bone & Joint Open

Table I. Patient demographic data and use rate 2021 to 2023.

Surgical system	C-TKA	Mako	Cori/Navio	Rosa	ASM	Orthalign	i-Assist	p-value*
Proportion of female patients, %	70.5	69.9	67.9	70.0	68.7	70.8	74.3	0.340
Mean age, yrs (SD)	71.1 (6.7)	68.8 (6.2)	70.6 (6.9)	70.6 (6.9)	71.4 (6.7)	71.9 (6.5)	71 (6.3)	0.001
Patients, n (%)								
Total = 7,746	3,434 (44.3)	623 (8.0)	412 (5.3)	203 (2.6)	2,273 (29.3)	646 (8.3)	155 (2.0)	
Knees, n (%)								
Total = 8,492	3,715 (43.7)	752 (8.9)	486 (5.7)	220 (2.6)	2,388 (28.1)	773 (9.1)	158 (1.9)	
Operative diagnosis, n (% within group)								
Primary OA	3,655 (98.4)	734 (97.6)	480 (98.7)	220 (100)	2,344 (98.2)	764 (98.8)	153 (96.8)	
Secondary OA	28 (0.8)	10 (1.3)	1 (0.2)	0 (0)	13 (0.5)	4 (0.5)	2 (1.2)	
Rheumatoid arthritis	30 (0.8)	4 (0.5)	4 (0.8)	0 (0)	13 (0.5)	2 (0.3)	3 (1.9)	
Gouty arthritis	1 (0.03)	0 (0)	0 (0)	0 (0)	16 (0.7)	2 (0.3)	0 (0)	
Psoriatic arthropathy	1 (0.03)	2 (0.3)	1 (0.2)	0 (0)	1 (0.04)	0 (0)	0 (0)	
Others	0 (0)	2 (0.3)	0 (0)	0 (0)	1 (0.04)	1 (0.1)	0 (0)	

*One-way analysis of variance.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; OA, osteoarthritis.

Introduction

Joint arthroplasties impose an enormous burden on healthcare systems worldwide. In Hong Kong (HK), the Hospital Authority (HA) is the sole provider of public healthcare services to residents, at a minimal cost. A total of 4,570 total joint replacement surgeries were performed across all HA hospitals in 2023, including total knee arthroplasty (TKA) and total hip arthroplasty (THA),[1] yet the supply of resources cannot match demand. By the end of 2023, there were 35,784 arthroplasty bookings in the public sector, with 90th percentile waiting time exceeding 83 months in certain public hospitals.

The introduction of computer-navigated systems has marked a significant technological advancement in the field. In addition to improving implant and limb alignment during surgery,[2] there was optimism that these new technologies could help improve postoperative outcomes and reduce mean length of stay (LOS). Subsequently, robotic-assisted systems emerged as a promising tool, prompting their use and gradual implementation in various surgical fields. The first robotic TKA (R-TKA) system (Mako; Stryker, USA) was introduced in HK in January 2019, followed by Cori/Navio (Smith & Nephew, USA) and Rosa (Zimmer Biomet).

While advances in computer navigation and robotic technologies have increased surgical precision, there is still ongoing debate on the efficacy of these technologies, particularly in terms of improving clinical outcomes and reducing hospital stay. In Asia, robotic usage has become more prevalent over time. This study aimed to evaluate the use trends and clinical results of R-TKA, comparing early results of R-TKA with conventional TKA (C-TKA) and computer-navigated TKA (N-TKA). This study also aimed to highlight the differences between individual robotic systems, including Mako, Cori/Navio, and Rosa surgeries, shedding light on their respective performances. Importantly, this study provides insight into the potential of R-TKA to safely reduce length of hospital stays in an Asian setting.

Methods

Data collection

Patients' clinical data were retrospectively retrieved using the Clinical Data Analysis and Reporting System (CDARS), an electronic medical database capturing all patients within the HK public healthcare system, which represents 80% of patient care locally.[3] CDARS was created in 1995 to facilitate clinical audit and healthcare research. The system is operated by the HA, which is the exclusive public healthcare provider for primary, secondary, and tertiary care in HK. Patient data, including demographics, inpatient hospitalization records, diagnoses, operation records, and mortality numbers, are available in CDARS, with little missing data. Clinical data from all 47 local public hospitals were included. The International Classification of Diseases, Ninth Revision (ICD-9) was used as the diagnosis coding in CDARS.[4] Due to the late introduction of coding for specific operations, CDARS was only able to capture the precise enabling technology system used after 2021, hence 2021 to 2023 was chosen as the timeframe for our study. Approval from the institutional review board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster was sought before commencement of the study (UW 24-218).

Patient selection

Patients of all ages who underwent primary TKA in HA hospitals in HK between January 2021 and December 2023 were included. Individuals were considered to have TKA if they had procedure codes indicating primary TKA in data retrieved from CDARS. Exclusion criteria were: 1) complex operations with use of revision systems including stems and augments; 2) one-stage operations involving simultaneous

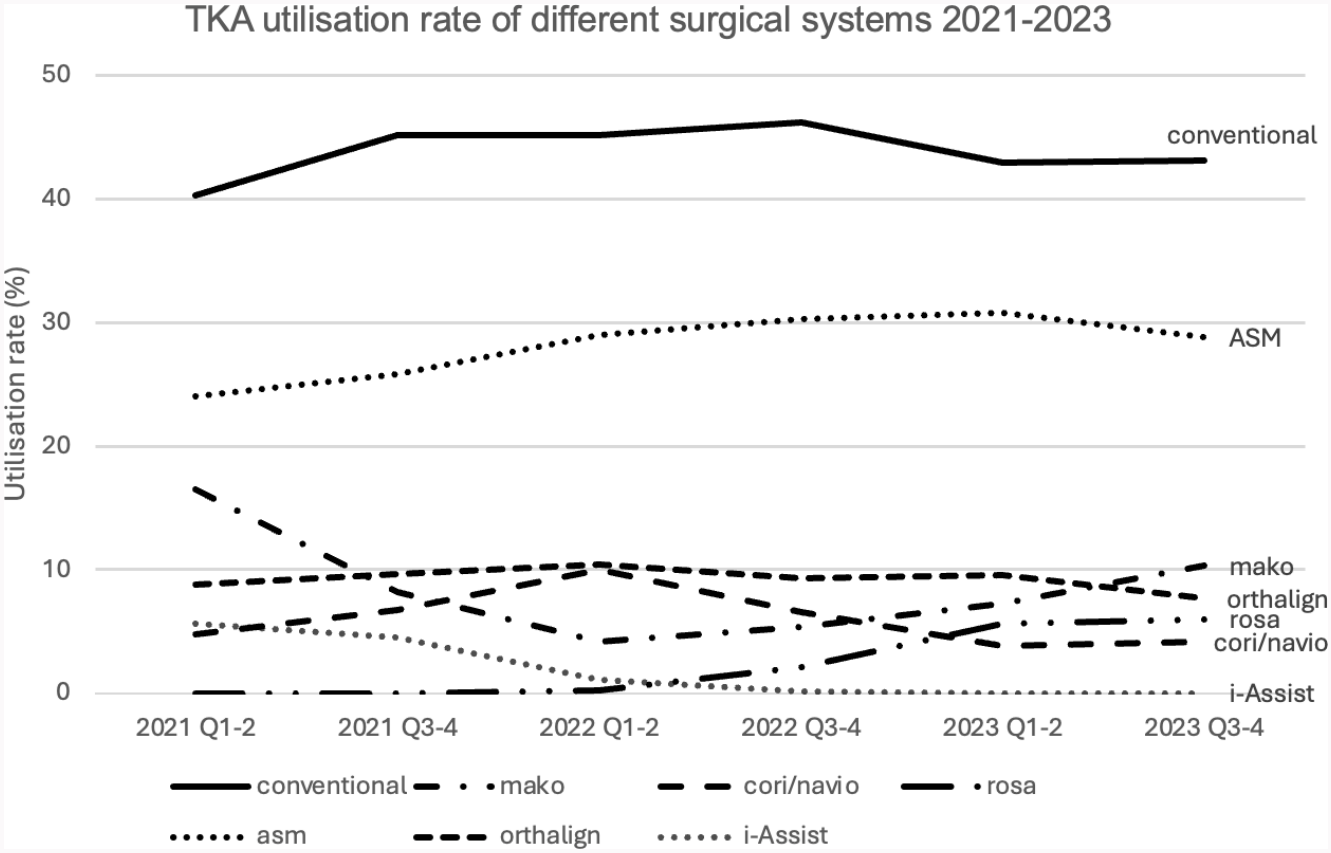

Fig. 1
Total knee arthroplasty (TKA) use of different surgical systems from 2021 to 2023. ASM, articular surface mounted.

Table II. Length of stay of different surgical systems 2021 to 2023.

Surgical system	Mean LOS, days (SD)	Difference,* days (95% CI)	p-value†
C-TKA	7.1 (5.1)	Reference	Reference
R-TKA	5.4 (3.7)	-1.6 (-1.9 to -1.30)	< 0.001
Mako	5.6 (3.1)	-1.5 (-1.9 to -1.1)	< 0.001
Rosa	5.0 (2.8)	-2.1 (-2.8 to -1.4)	< 0.001
Cori/Navio	5.5 (4.7)	-1.5 (-2.0 to -1.1)	< 0.001
N-TKA	6.3 (5.3)	-0.7 (-1.0 to -0.5)	< 0.001
ASM	6.7 (5.9)	-0.3 (-0.6 to -0.03)	0.028
Orthalign	5.3 (2.7)	-1.7 (-2.1 to -1.4)	< 0.001
i-Assist	4.8 (2.4)	-2.2 (-3.0 to -1.4)	< 0.001

*Difference between group of interest and reference.
†Calculated by comparing interest group with reference group using independent-samples *t*-test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; LOS, length of stay; N-TKA, computer-navigated total knee arthroplasty; R-TKA, robotic total knee arthroplasty.

TKA and unicompartmental knee arthroplasty (UKA); and 3) patients undergoing TKA for malignancy or post-septic arthritis. Diagnoses included were predominantly primary osteoarthritis (OA), followed by secondary OA, rheumatoid arthritis, gouty arthritis, psoriatic arthritis, and others.

Patients who underwent TKA were divided into three main groups: C-TKA, R-TKA, and N-TKA. C-TKA was defined as operations not involving the usage of robotic or navigational systems. R-TKA involved use of the Mako Robotic Arm-assisted System (Stryker), Rosa Knee Robotic System (Zimmer Biomet), or Cori/Navio Surgical System (Smith & Nephew). N-TKA involved use of an articular surface mounted (ASM) navigation system (Stryker), OrthAlign handheld accelerometer-based navigation (Orthalign, USA), or i-Assist Knee Surgical System (Zimmer Biomet).

Assessment of outcomes

Primary outcome was the percentage use of R-TKA, N-TKA, and C-TKA from January 2021 to December 2023. Study population was calculated based on patients receiving primary TKA. Patient demographic data including sex and age were retrieved. Secondary outcomes were: 1) mean LOS of patients; 2) 30-day emergency department (ED) attendance rate; 3) 90-day ED attendance rate; 4) 90-day reoperation rate; 5) 90-day mortality rate; and 6) surgical time (skin to skin). Diagnoses of patients with ED attendance were further grouped into postoperative joint inflammation, wound problems requiring minor surgical management, postoperative conditions requiring major surgical intervention including revision TKA and debridement, antibiotics and implant retention (DAIR), other orthopaedic conditions, and unrelated medical diagnoses.

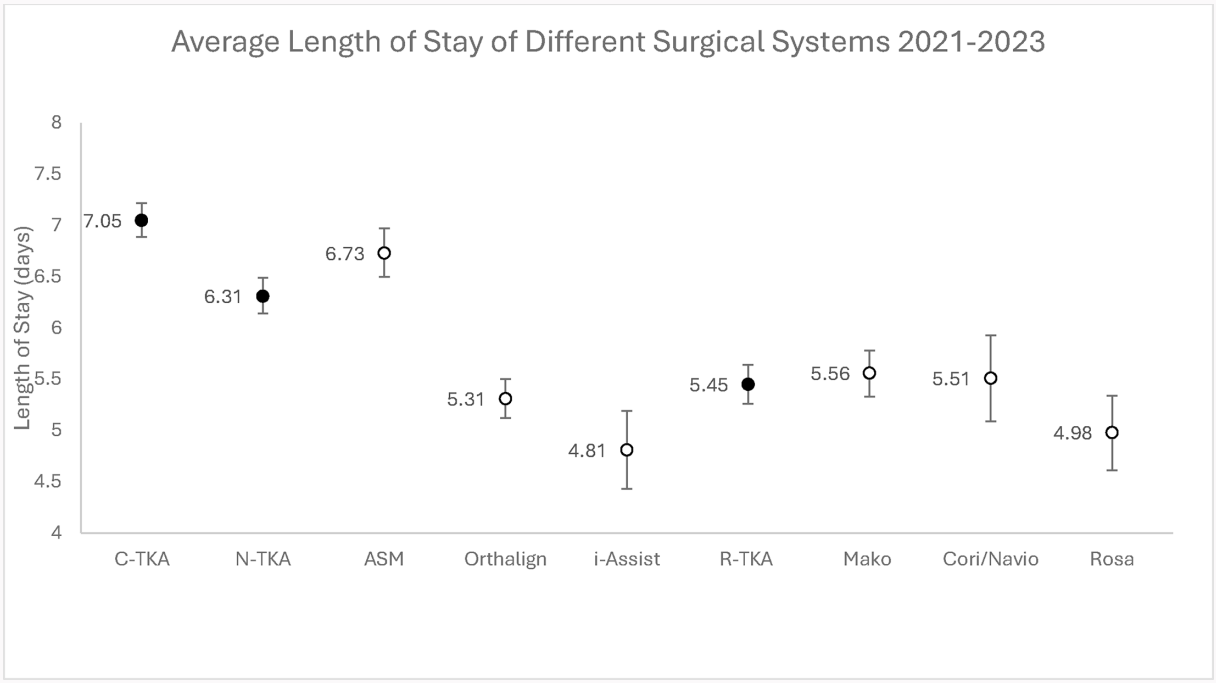

Fig. 2
Graph showing mean length of stay (LOS) of different total knee arthroplasty (TKA) systems from 2021 to 2023. Error bars show 95% CIs. ASM, articular surface mounted; C-TKA, conventional TKA; N-TKA, computer-navigated TKA; R-TKA, robotic TKA.

Statistical analysis

The independent-samples *t*-test and one-way analysis of variance (ANOVA) were used for comparison between continuous variables, and the chi-squared test for categorical variables. 95% CIs are presented for differences between variables. All analyses were undertaken using SPSS statistics v. 29.0 (IBM, USA). Two-tailed significance was set at $p < 0.05$.

Results

Use rates and patient demographics

A total of 8,492 knees from 7,746 patients were included in the study. Overall, C-TKA constituted 43.7% (3,715/8,492) of total knees over the past three years, followed by N-TKA at 39.1% (3,319/8,492) and R-TKA at 17.2% (1,458/8,492). For individual R-TKA systems, use of Mako was the highest at 8.9% (752/8,492), followed by Cori/Navio then Rosa, at 5.7% (486/8,492) and 2.6% (220/8,492) of all TKAs, respectively. Use of N-TKA systems including ASM, Orthalign, and i-Assist was at 28.1% (2,388/8,492), 9.1% (773/8,492), and 1.9% (158/8,492), respectively (Table I). From the end of 2021 to 2023, R-TKA system use showed a gradually increasing trend (14.9% to 20.4%) (Figure 1).

The majority of patients who required TKA as a result of primary OA ranged from 96.8% to 100% across different surgical groups. As for secondary OA, rheumatoid arthritis, gouty arthritis, and psoriatic arthropathy, the proportion ranged from 0% to 1.3%, 0% to 1.9%, 0% to 0.7%, and 0% to 0.3%, respectively (Table I).

Mean length of stay

The overall mean LOS was highest with C-TKA at 7.1 days (SD 5.1), followed by N-TKA at 6.3 days (SD 5.3), with R-TKA having the shortest mean LOS at 5.4 days (SD 3.7) ($p < 0.001$, one-way ANOVA). Within R-TKA groups, mean LOS for Mako, Cori/Navio, and Rosa was lower than for C-TKA at 5.6 days (SD 3.1) (difference (diff) -1.6; 95% CI -1.9 to -1.3; $p < 0.001$), 5.5 days (SD 4.7) (diff -1.5; 95% CI -2.0 to -1.1; $p < 0.001$), and 5.0 days (SD 2.8) (diff -2.1; 95% CI -2.8 to -1.4; $p < 0.001$) respectively. Rosa had a slightly shorter mean LOS than Mako (diff -0.6; 95% CI -1.0 to -0.1; $p = 0.013$). Cori/Navio had a similar ALOS when compared to Mako ($p = 0.840$, independent-samples *t*-test) and Rosa ($p = 0.117$, independent-samples *t*-test). For N-TKA, i-Assist had the shortest mean LOS at 4.8 days (SD 2.4). ALOS in all subgroups of N-TKA was also shown to be lower than for C-TKA ($p < 0.001$, independent-samples *t*-test) (Table II and Figure 2).

30-day ED attendance

The 30-day ED attendance rate was lowest for C-TKA, followed by R-TKA and N-TKA, at 5.6%, 6.8%, and 7.6%, respectively ($p = 0.002$, chi-squared test). Within R-TKA groups, the attendance rate for Mako was lowest at 4.4%, with Cori/Navio at 7.7% ($p < 0.001$, chi-squared test) and Rosa at 10.1% ($p = 0.049$, chi-squared test); Rosa had a lower rate than Cori/Navio ($p < 0.001$, chi-squared test). It was found that Cori/Navio had higher attendance than C-TKA (10.1 vs 5.6%; $p < 0.001$, chi-squared test). For N-TKA, ASM had the highest attendance rate at 8.1%, which was significantly higher than C-TKA ($p < 0.001$, chi-squared test) (Table III).

At 30 days, Cori/Navio had the highest proportion of patients with postoperative inflammatory problems at 1.4%, while ASM had the highest proportion with minor wound problems at 0.6%. Postoperative wound problems include infection requiring minor surgical management. There were no patients admitted for periprosthetic joint infections (PJIs). In addition, the proportion of patients with other orthopaedic diagnoses ranged from 0% to 0.9% across all groups. These included accident-related fractures, venous thrombosis

Table III. 30-day emergency department attendance according to different surgical systems.

Surgical system	Operations, n	Patients attending ED at 30 days, n (%)	p-value*
C-TKA	3,715	220 (5.6)	Reference
R-TKA	1,458	99 (6.8)	0.243
Mako	752	33 (4.4)	0.189
Cori/Navio	486	49 (10.1)	< 0.001
Rosa	220	17 (7.7)	0.179
N-TKA	3,319	253 (7.6)	0.004
ASM	2,388	194 (8.1)	< 0.001
Orthalign	773	52 (6.7)	0.209
i-Assist	158	7 (4.4)	0.538

*Calculated by comparing interest group with reference group using chi-squared test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; N-TKA, computer-navigated total knee arthroplasty; R-TKA, robotic total knee arthroplasty.

of the limb, gouty attacks, back pathologies, and joint pain of other locations. Percentages of patients attending ED for medical problems (cardiovascular, respiratory, neurological, and gastrointestinal) ranged from 3.8% to 8.2% (Table IV).

90-day ED attendance

N-TKA had the highest 90-day ED attendance rate at 15.5%, with C-TKA the second highest at 13.1% and R-TKA the lowest at 12.5% (chi-squared test; p = 0.004). Within R-TKA groups, Mako had lower attendance rates (9.7%) than Cori/Navio (15.4%; p = 0.005) or Rosa (16.4%; p = 0.006). Mako was found to have a significantly lower 90-day attendance rate than C-TKA (9.7 vs 13.1%; p = 0.009). ASM had the highest rate among N-TKA groups at 16.5% and was statistically higher than C-TKA (p < 0.001, all chi-squared test) (Table V).

At 90 days, ASM had the highest proportion of patients with joint inflammatory and minor wound problems at 2.3% and 0.8%, respectively. The proportion of patients with other orthopaedic diagnoses ranged from 0% to 3.2% across all groups, and the proportion with unrelated medical problems ranged from 8.3% to 12.2% across all groups (Table VI).

90-day reoperation and mortality rates

There were no statistical differences between C-TKA, R-TKA, and N-TKA groups (0.6 vs 0.4 vs 0.8%; p = 0.264, chi-squared test) (Table VII). It should also be noted that 0.1% of patients in the C-TKA group were readmitted within 90 days for PJI while there were none in the R-TKA and N-TKA groups (p = 0.525, chi-squared test). The 90-day all-cause mortality rate was similar in C-TKA, R-TKA, and N-TKA (0.002 vs 0.0007 vs 0.0003%; p = 0.065, chi-squared test).

Surgical time

The mean surgical time per knee was longest in R-TKA at 112.8 minutes (SD 32.3), followed by N-TKA at 98.4 minutes (SD 28.5) and C-TKA at 92.2 minutes (SD 37.8) (p < 0.001). Mean surgical times for Mako, Cori/Navio, and Rosa were higher than for C-TKA at 112 minutes (SD 31.5) (diff + 19.8; 95% CI 16.9 to 22.7; p < 0.001), 119 minutes (SD 33.8) (diff + 26.6; 95% CI 23.0 to 30.1; p < 0.001), and 102 minutes (SD 28.1) (diff + 9.9; 95% CI 4.7 to 14.9; p < 0.001), respectively. Differences between Mako and Cori/Navio (p < 0.001), Mako and Rosa (p < 0.001), and Cori/Navio and Rosa (p < 0.001) were all significant, with Rosa having the shortest surgical time within R-TKA subgroups (p < 0.001). For N-TKA, ASM had the longest surgical time at 103 minutes (SD 30.0). In particular, surgical times in Orthalign were found to be shorter than for C-TKA (87.4 vs 92.2 mins; p < 0.001) (Table VIII).

Discussion

Our study revealed that, despite the longer surgical time, R-TKA could reduce hospital stay without increasing reoperation or mortality rates. The importance of reducing mean LOS in the Asian population can be attributed to the unique characteristics of Asian knees, the long waiting times for TKA in the public sector, the rising age of TKA patients, and socioeconomic factors such as poor ambulatory support. Although C-TKA was the most used, Asian healthcare systems could look to increase R-TKA use to alleviate burden from prolonged hospital stays.

C-TKA remained the primary treatment approach from 2021 to 2023, followed by N-TKA. However, there has been increasing use of R-TKA systems within the public sector locally. The use trends were driven by availability and maintained by the promising early results that R-TKA demonstrated. Mako was first introduced locally in 2019; however, high upfront purchase and maintenance costs for R-TKA systems have posed potential obstacles to widespread adoption.[5] Currently, four public hospitals in HK have purchased Mako, while over ten robotic systems (Mako, Cori, and Rosa) are on loan. Wang et al[6] demonstrated the increasing popularity of R-TKA compared to C-TKA in the USA. R-TKA has been shown to significantly improve the accuracy of planned coronal plane alignments for components and optimize overall limb alignment.[7] In addition to surgical advantages, optimization of hospital stay and lower reattendance rates could potentially save public healthcare expenditure in the long term.[8] Within R-TKA systems, Mako had the highest use rate. The use trend could be explained by the unique advantages offered, including CT-based preoperative planning, the soft-tissue balancing algorithm, and haptic guidance, which have garnered favour among surgeons when compared to other imageless R-TKA systems.[9]

Our study revealed that patients undergoing R-TKA and N-TKA had shorter mean LOS. Kayani et al[10–12] noted a significantly shorter time to discharge for R-TKA patients compared with C-TKA (77 vs 105 hrs; p < 0.001) and attributed this to reduced periarticular soft-tissue trauma. Ultimately, reduced intraoperative soft-tissue trauma could lead to decreased postoperative joint inflammation and pain scores, allowing patients to have a shorter hospital stay.[10,13] The reduction in mean LOS holds particular significance in an Asian setting: compared to Caucasians, Asian subjects have significantly more varus alignments, hence OA knees are more prevalent in an Asian setting.[14] Longer waiting times for TKA in Asian cities like HK have also contributed to a rise in the mean age of TKA patients over the past ten years.[15] Locally, the low socioeconomic status of public patients, suboptimal social

Table IV. Diagnoses of patients attending emergency department at 30 days.

Surgical system	Postoperative joint inflammation, n (%)	Minor postoperative wound problem, n (%)	Postoperative condition requiring major surgical intervention, n (%)	Other orthopaedic diagnoses, n (%)	Unrelated medical diagnoses, n (%)
C-TKA (n = 3,715)	38 (1.0)	5 (0.1)	0 (0)	8 (0.2)	156 (4.2)
Mako (n = 752)	1 (0.1)	0 (0)	0 (0)	3 (0.4)	29 (3.8)
Cori/Navio (n = 486)	7 (1.4)	1 (0.2)	0 (0)	1 (0.2)	40 (8.2)
Rosa (n = 220)	0 (0)	0 (0)	0 (0)	2 (0.9)	15 (6.8)
ASM (n = 2,388)	26 (1.1)	14 (0.6)	0 (0)	9 (0.4)	145 (6.1)
Orthalign (n = 773)	3 (0.4)	2 (0.3)	0 (0)	1 (0.1)	46 (6.0)
i-Assist (n = 158)	0 (0)	0 (0)	0 (0)	0 (0)	7 (4.0)
p-value*	< 0.001	< 0.001	N/A	< 0.001	< 0.001

*Chi-squared test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; N/A, not applicable.

Table V. 90-day emergency department attendance according to different surgical systems.

Surgical system	Operations, n	Patients attending ED at 90 days, n (%)	p-value*
C-TKA	3,715	490 (13.1)	Reference
R-TKA	1,458	182 (12.5)	0.496
Mako	752	73 (9.7)	0.009
Cori/Navio	486	73 (15.4)	0.263
Rosa	220	36 (16.4)	0.248
N-TKA	3,319	514 (15.5)	0.006
ASM	2,388	395 (16.5)	< 0.001
Orthalign	773	103 (13.3)	0.915
i-Assist	158	16 (10.1)	0.263

*Calculated by comparing interest group with reference group using chi-squared test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; ED, emergency department; N-TKA, computer-navigated total knee arthroplasty; R-TKA, robotic total knee arthroplasty.

support, and unfavourable living environments are culprits of increased LOS. Given that public hospitals are funded by the government, patients have little incentive for early discharge.[16] In contrast to western countries, Klingenstein et al[17] reported that 66% of patients (1,502 out of 2,287; 2013 to 2015) were discharged on the same day post TKA. Our data demonstrated a reduction of 1.6 days of hospital stay (-23%) compared to C-TKA ($p < 0.001$). Abdelaal et al[18] reported that patients perceived R-TKA as allowing more accurate implant placement and having better results, which enables faster recovery, which means that psychologically patients may perceive a quicker recovery and are more accepting of early discharge. This could potentially help in reducing in-hospital healthcare expenses and bridging the gap between local TKA services and international standards.

Mako (4.4%) had lower 30-day attendance compared to Cori/Navio (10.1%; $p < 0.001$) and Rosa (7.7%; $p = 0.049$). However, other clinical studies did not report significant differences between the three R-TKA groups.[19,20] Overall, R-TKA and N-TKA had higher 30-day attendances when compared to C-TKA, related to early postoperative issues like tracking pin-related problems.[21] At 90 days, Mako patients had significantly lower attendance rates compared with C-TKA (9.7% vs 13.1%; $p < 0.001$). A unique advantage of Mako is a saw-based robotic system with haptic constraints, which reduces unnecessary soft-tissue dissection and knee subluxation during the procedure. Cori/Navio employs a hand-held high-speed burr system which may encounter deflection with hard bone and, combined with the absence of haptic constraints, may produce less even bone surfaces and soft-tissue trauma.[22] The Rosa robot is a jig-based system where the robot stabilizes the jig while the surgeon performs bone cuts manually, therefore the workflow is very similar to C-TKA. The surgical accuracy provided by R-TKA offers a protective effect to surrounding soft-tissues, reducing postoperative inflammation and possible complications.[10,23] However, inconsistent results have been demonstrated for whether R-TKA is superior to C-TKA in reducing postoperative complications.[24,25] It should be noted that Cori/Navio exhibited more joint inflammation over both 30 and 90 days compared to other R-TKA systems.

No statistical differences in reoperation rates were identified between all groups in 90 days, which was similar to other studies.[26,27] In general, 90-day reoperation rates were ≤ 1% across all groups. Four PJIs were recorded in our study following C-TKA, but none in other groups. Our study did not demonstrate differences in risk of PJI between groups, which was consistent with the findings of LaValva et al.[28]

No difference in 90-day all-cause mortality was found in our study (0.0003% to 0.002%). This finding aligns with Lee et al,[29] who reported a 90-day mortality rate of 0.2% in HK public hospitals in 2016. Patients with risk of mortality following TKA typically had multiple medical comorbidities.

Table VI. Diagnoses of patients attending emergency department at 90 days.

Surgical system	Postoperative joint inflammation, n (%)	Minor postoperative wound problem, n (%)	Postoperative condition requiring major surgical intervention, n (%)	Other orthopaedic diagnoses, n (%)	Unrelated medical diagnoses, n (%)
C-TKA (n = 3,715)	68 (1.8)	5 (0.1)	4 (0.1)	23 (0.6)	391 (10.5)
Mako (n = 752)	6 (0.8)	0 (0)	0 (0)	5 (0.7)	62 (8.3)
Cori/Navio (n = 486)	10 (0.9)	1 (0.2)	0 (0)	4 (0.8)	58 (11.9)
Rosa (n = 220)	2 (0.9)	0 (0)	0 (0)	7 (3.2)	27 (12.2)
ASM (n = 2,388)	54 (2.3)	20 (0.8)	0 (0)	29 (1.2)	292 (12.2)
Orthalign (n = 773)	7 (0.9)	2 (0.3)	0 (0)	5 (0.7)	89 (11.5)
i-Assist (n = 158)	0 (0)	0 (0)	0 (0)	0 (0)	16 (10.0)
p-value*	< 0.001	< 0.001	0.525	< 0.001	< 0.001

*Chi-squared test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty.

Table VII. 90-day reoperation rates of different surgical systems.

Surgical system	90-day reoperation, n (%)	p-value*
C-TKA (n = 3,715)	23 (0.6)	Reference
Mako (n = 752)	2 (0.3)	0.236
Cori/Navio (n = 486)	3 (0.4)	0.997
Rosa (n = 220)	1 (0.5)	0.761
ASM (n = 2,388)	24 (1.0)	0.092
Orthalign (n = 773)	3 (0.4)	0.442
i-Assist (n = 158)	0 (0)	0.321

*Calculated by comparing interest group with reference group using chi-squared test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty.

Table VIII. Surgical time of different surgical systems 2021 to 2023.

Surgical system	Mean surgical time, mins (SD)	Difference, mins (95% CI)*	p-value†
C-TKA	92.2 (37.8)	Reference	Reference
R-TKA	112.8 (32.3)	+ 20.4 (18.2 to 22.6)	< 0.001
Mako	112 (31.5)	+ 19.8 (16.9 to 22.7)	< 0.001
Rosa	102 (28.1)	+ 9.9 (4.7 to 14.9)	< 0.001
Cori/Navio	119 (33.8)	+ 26.6 (23.0 to 30.1)	< 0.001
N-TKA	98.4 (28.5)	+ 6.1 (4.5 to 7.7)	< 0.001
ASM	103 (30.0)	+ 10.2 (8.4 to 12.0)	< 0.001
Orthalign	87.4 (21.8)	-4.8 (-7.6 to -2.0)	< 0.001
i-Assist	91.6 (16.4)	-0.6 (-6.6 to 5.3)	0.660

*Difference between group of interest and reference.
†Calculated by comparing interest group with reference group by independent-samples *t*-test.
ASM, articular surface mounted; C-TKA, conventional total knee arthroplasty; N-TKA, computer-navigated total knee arthroplasty; R-TKA, robotic total knee arthroplasty.

Other predictive factors for postoperative mortality include age, sex, and postoperative functional scores.[30]

We found that C-TKA exhibited a significantly shorter surgical time of 20 minutes compared to R-TKA, while N-TKA surgical times were slightly longer than C-TKA by six minutes, which is consistent with the findings of Naziri et al,[31] who reported a 4.2-minute longer surgical time with R-TKA. Longer surgical times in R-TKA were due to additional time required for robot setup, pin placement and removal, intraoperative planning, and balancing. Drawbacks of prolonged surgical duration are that it may predispose patients to a higher risk of postoperative infection, but this was not demonstrated in our study.

The key strength of our study lies in its status as the first territory-wide study on the use of R-TKA in Asia, providing valuable insights into the future implementation of R-TKA in other medical systems. However, the study does have limitations. First, it did not include patient-reported outcome measures, limiting our evaluation of treatment success in patients' perceptions.[32] Second, clinical outcomes, such as hospital stay, are influenced by multiple factors like patient comorbidities, surgeon expertise, and hospital-related variables. Unfortunately, our analysis with CDARS for big-data analysis restricted access to detailed patient-specific information from other local hospitals, preventing adjustment for these confounding variables. This limitation underscored the challenges posed by utilizing large-scale big-data medical systems for research purposes. Despite this constraint, the substantial sample size of over 8,400 knees in our study is anticipated to mitigate the impact of these variables. Third, treatment outcomes like reoperation rates were assessed at a maximum of 90 days, limiting the assessment of long-term complications.

While C-TKA remains the surgical system of choice for the majority of TKAs, an increase in R-TKA use was observed in recent years. Use of R-TKA contributed to shorter hospital stays and 90-day ED attendance, despite having longer operating

times. R-TKA served as a promising and safe technology, and increasing R-TKA usage could potentially aid in cutting down global healthcare expenses, while its cost-effectiveness has to be further investigated. Discrepancies between R-TKA systems also highlighted their individual characteristics and differences in clinical outcomes.

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Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

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