

# Robot-Assisted Total Knee Arthroplasty

Robot-assisted total knee arthroplasty (RA-TKA) has rapidly evolved due to innovations in imaging, surgical computer planning, and robotics. These advancements in anatomical knowledge and technological novelties related to total knee arthroplasty (TKA) allow the surgeon to improve implant positioning and sizing accuracy. Perceived advantages of RA-TKA include shorter recovery time and reduced revision surgeries. Disadvantages observed with RA-TKA are implementation cost, pin site morbidity, increased blood loss, and prolonged operative time.

Three categories of robotic assisting platforms currently exist in the market: autonomous (active), hands-on (semiactive), and passive. These categories are aligned to the level of surgeon involvement and robot autonomy during the operative procedure. The autonomous system actively makes the tibial and femoral resections. The TSolution One® (THINK Surgical, Fremont, CA) is a successor of ROBODOC®, one of the earliest RA-TKA systems, and is the only active RA-TKA system cleared by the FDA (FDA 510(k) approval 2019). Compared to the autonomous platform, hands-on robotic systems have gained more popularity within the field. A significant advantage of the TSolution One® system is the use of prosthesis from several companies as opposed to proprietary total joint solutions from the respective hands-on systems.

This scientific update presents 44 relevant scientific publications related to RA-TKA between 2002 and 2021. The document is organized chronologically in the following sections: Systematic Review and Meta-Analyses, Prospective Clinical and Radiological Studies, and Retrospective Clinical and Radiological Studies.

Agarwal N,  
To K,  
McDonnell S,  
Khan W

## Systematic Review and Meta-Analysis

Clinical and radiological outcomes in robotic-assisted total knee arthroplasty: a systematic review and meta-analysis. *J Arthroplasty*. 2020;35(11):3393-3409.e2. doi:10.1016/j.arth.2020.03.005

- A meta-analysis of 22 scientific articles addressing the clinical and radiological outcomes in RA-TKA.
- 12 studies found statistically significant clinical outcomes with RA-TKA compared with conventional (manual) total knee arthroplasty (C-TKA); 9 studies found no difference.
- 14 studies reported more consistent and accurate postoperative mechanical alignment with RA-TKA; 2 studies found no difference in radiological outcomes.
- **Funding Source:** Not specified.



Sherman WF,  
Wu VJ

[Robotic surgery in total joint arthroplasty: a survey of the AAHKS membership to understand the utilization, motivations, and perceptions of total joint surgeons.](#) *J Arthroplasty*. 2020;35(12):3474-3481.e2. doi:10.1016/j.arth.2020.06.072

- Online survey distributed to AAHKS members. Survey questions were based on the use of the RA-TKA technology, perceptions regarding outcomes, and personal characteristics that influence responses.
- RA-TKA adoption is dependent on several factors.
- Increased precision (73.1%) was the primary reason to use RA-TKA.
- Nonclinical reasons, administrative pressure, and peer pressure were primary motivators for 19.7% of RA-TKA users.
- 76.5% felt RA-TKA increased operative time and 78.7% felt RA-TKA was not more cost-effective than C-TKA.
- **Funding Source:** Not specified.

Mancino F,  
Cacciola G,  
Malahias MA,  
et al

[What are the benefits of robotic-assisted total knee arthroplasty over conventional manual total knee arthroplasty? a systematic review of comparative studies.](#) *Orthop Rev (Pavia)*. 2020;12(Suppl 1):8657. doi:10.4081/or.2020.8657

- Systematic review of 9 comparative studies assessing 1199 operated knees: 614 were RA-TKA compared to 585 C-TKA.
- Improvements were observed for early functional outcomes, reduced radiographic outliers, and radiolucent lines for RA-TKA.
- RATKA displayed reduced risk of iatrogenic soft-tissue injury, including reduced blood loss and postoperative drainage.
- No significant differences observed for overall survivorship, complication rate, and operative time.
- **Funding Source:** None.

Onggo JR,  
Onggo JD,  
De Steiger R,  
Hau R

[Robotic-assisted total knee arthroplasty is comparable to conventional total knee arthroplasty: a meta-analysis and systematic review.](#) *Arch Orthop Trauma Surg*. 2020;140(10):1533-1549. doi:10.1007/s00402-020-03512-5

- Multidatabase search including 18 studies assessing 2234 RA-TKA and 4300 C-TKA.
- Authors reviewed clinical outcomes, radiographic results, complications, peri-operative parameters, and costs.
- RA-TKA resulted in significantly more precise prosthesis implantation determined by fewer outliers in the mechanical axis, femoral coronal, and tibial sagittal alignment.
- HSS score was significantly better for RA-TKA at final follow-up.
- RA-TKA resulted in reduced mean blood loss.
- RA-TKA resulted in significantly longer operative time.
- No other significant differences in other clinical outcomes, range of motion, and complications.
- **Funding Source:** Not specified.



Vermue H,  
Lambrechts J,  
Tampere T,  
Arnout N,  
Auvinet E,  
Victor J

[How should we evaluate robotics in the operating theatre?](#) *Bone Joint J.* 2020;102-B(4):407-413. doi:10.1302/0301-620X.102B4.BJJ-2019-1210.R1

- Systematic review of 11 studies evaluating the learning curve associated with RA-TKA.
- Operating time of RA-TKA is associated with a learning curve of between 6 to 20 cases.
- Surgical team stress levels show a learning curve of 7 cases.
- Experience with the RA-TKA system did not influence implant positioning, preoperative planning, and postoperative complications.
- **Funding Source:** None.

Antonios JK,  
Korber S,  
Sivasundaram L,  
et al

[Trends in computer navigation and robotic assistance for total knee arthroplasty in the United States: an analysis of patient and hospital factors.](#) *Arthroplast Today.* 2019;5(1):88-95. doi:10.1016/j.artd.2019.01.002

- Nationwide Inpatient Sample database reviewed to identify patients who underwent TKA using C-TKA, computer navigation, and RA-TKA between 2005 and 2014.
- 6,060,901 patients underwent TKA: 273,922 (4.5%) used computer navigation and 24,084 (0.4%) used RA-TKA.
- Technology assistance increased from 1.2% in 2005 to 7.0% in 2014.
- Increased hospital charges were associated with technology assistance (\$53,740.1 for RA-TKA compared to \$47,639.2 for C-TKA).
- **Funding Source:** None.

Bautista M,  
Manrique J,  
Hozack WJ

[Robotics in total knee arthroplasty.](#) *J Knee Surg.* 2019;32(7):600-606. doi:10.1055/s-0039-1681053

- Systematic review of literature addressing the current system available, outcomes, and controversies.
- Authors conclude current evidence shows “discreet to modest” advantages in knee alignment, soft-tissue balance and protection, patient satisfaction, and improved outcomes.
- **Funding Source:** Not specified.

Chin BZ,  
Tan SSH,  
Chua KCX,  
Budiono GR,  
Syn NL,  
O’Neill GK

[Robot-assisted versus conventional total and unicompartmental knee arthroplasty: a meta-analysis of radiological and functional outcomes.](#) *J Knee Surg.* 2020;10.1055/s-0040-1701440. doi:10.1055/s-0040-1701440

- Systematic review of 23 studies evaluating 2765 knees.
- RA-TKA was associated with significantly better short-term outcomes.
- RA-TKA was associated with significantly better angle alignment accuracy.
- RA-TKA was associated with significantly longer operation time.
- No significant differences were observed for short- and midterm subjective knee outcome scores.
- RA-TKA was associated with better radiological outcomes; however, no significant differences in mid- and long-term function outcomes.
- **Funding Source:** None.



Connelly TM,  
Malik Z,  
Sehgal R,  
Byrnes G,  
Coffey JC,  
Peirce C

[The 100 most influential manuscripts in robotic surgery: a bibliometric analysis.](#) *J Robot Surg.* 2020;14(1):155-165. doi:10.1007/s11701-019-00956-9

- This review encompasses robotic assisted studies in several disciplines.
- Only 2 orthopedic-related studies included.
- **Funding Source:** None.

Kayani B,  
Konan S,  
Ayuob A,  
Onochie E,  
Al-Jabri T,  
Haddad FS

[Robotic technology in total knee arthroplasty: a systematic review.](#) *EFORT Open Rev.* 2019;4(10):611-617. doi:10.1302/2058-5241.4.190022

- Commentary on RA-TKA with a focus on patient outcomes, radiological findings, and controversies.
- **Funding Source:** Industry funded. FSH COI with Stryker.

Mont MA,  
Cool C,  
Gregory D,  
Coppolecchia A,  
Sodhi N,  
Jacofsky DJ

[Health care utilization and payer cost analysis of robotic arm assisted total knee arthroplasty at 30, 60, and 90 days.](#) *J Knee Surg.* 2019;10.1055/s-0039-1695741. doi:10.1055/s-0039-1695741

- 100% Medicare standard analytical files for RA-TKA and C-TKA between January 2016 and March 2017; 519 RA-TKA and 2,595 C-TKA were included.
- RA-TKA cost was \$17,768 compared to C-TKA \$19,899 at 30 days; \$18,174 compared to \$20,492 at 60 days; and \$18,568 compared to \$20,960 at 90 days.
- At 30 days, RA-TKA patients used skilled nursing facility services and had less home health visits and costs at each time point.
- RA-TKA is associated with lower 30-, 60-, and 90-day postoperative costs and health care use.
- **Funding Source:** Not specified. MAM, AC, DG, DJS COI with Stryker. DG Stryker employee.

Urish KL,  
Conditt M,  
Roche M,  
Rubash HE

[Robotic total knee arthroplasty: surgical assistant for a customized normal kinematic knee.](#) *Orthopedics.* 2016;39(5):e822-e827. doi:10.3928/01477447-20160623-13

- Contains a thorough review of systems and history.
- **Funding Source:** Not specified. One author is an employee of Stryker Mako.



Kayani B,  
Tahmassebi J,  
Ayuob A,  
Konan S,  
Oussedik S,  
Haddad FS

## Prospective Clinical and Radiological Studies

[A prospective randomized controlled trial comparing the systemic inflammatory response in conventional jig-based total knee arthroplasty versus robotic-arm assisted total knee arthroplasty.](#) *Bone Joint J.* 2021;103-B(1):113-122. doi:10.1302/0301-620X.103B1.BJJ-2020-0602.R2

- Prospective, randomized trial of 30 patients: 15 C-TKA and 15 RA-TKA.
- Predefined serum markers of inflammation and localized knee temperature were collected pre- and postoperatively at 6 hours, day 1, day 2, day 7, and day 28.
- RA-TKA displayed significantly reduced levels of IL-6, TNF-alpha, ESR, lactate dehydrogenase, and creatine kinase at day 7 compared to C-TKA.
- RA-TKA was associated with significantly improved preservation of periarticular soft-tissue envelope and reduced femoral and tibial bone trauma.
- RA-TKA significantly improved accuracy of achieving planned limb alignment, femoral component positioning, and tibial component positioning.
- **Funding Source:** None. FSH, SO COI with Stryker; SK COI with Smith & Nephew.

Khlopas A,  
Sodhi N,  
Hozack WJ,  
et al

[Patient-reported functional and satisfaction outcomes after robotic-arm-assisted total knee arthroplasty: early results of a prospective multicenter investigation.](#) *J Knee Surg.* 2020;33(7):685-690. doi:10.1055/s-0039-1684014

- 3-month interim comparative analysis of 150 RA-TKA and 102 C-TKA patients between June 2016 and March 2018 (prospective, nonrandomized, multicenter [4 sites] comparative cohort study).
- No significance between RA-TKA and C-TKA; however, at 3 months, RA-TKA maintained larger improvements in walking and standing (6.0 points compared to 4.8 points, KSS) and advanced activities (6.2 points compared to 4.6 points).
- Overall, RA-TKA maintained equal or better improvement to C-TKA at 3 months.
- **Funding Source:** Not specified. MAM, FO, TK, OMM, AFC, WJH COI with Styker.

Kim YH,  
Yoon SH,  
Park JW

[Does robotic-assisted TKA result in better outcome scores or long-term survivorship than conventional TKA? a randomized, controlled trial.](#) *Clin Orthop Relat Res.* 2020;478(2):266-275. doi:10.1097/CORR.0000000000000916

- Prospective, randomized trial of patients receiving RA-TKA or C-TKA from January 2002 to February 2008.
- 975 RA-TKA in 850 patients compared to 990 C-TKA in 849 patients.
- In total, patients who met prespecified inclusion criteria: 750 RA-TKA in 700 patients and 766 C-TKA in 706 patients.
- Mean follow-up was 13 ± 5 years.
- No significant differences between RA-TKA and C-TKA in terms of functional outcome scores, overall survivorship, and complications.
- **Funding Source:** Not specified.



Hampp EL,  
Chughtai M,  
Scholl LY,  
et al

[Robotic-arm assisted total knee arthroplasty demonstrated greater accuracy and precision to plan compared with manual techniques.](#) *J Knee Surg.* 2019;32(3):239-250. doi:10.1055/s-0038-1641729

- Cadaveric study using 6 specimens comparing RA-TKA on right knee and C-TKA on left knee.
- Final implant component positions were significantly more precise to plan in 4 out of 5 measurements for RA-TKA compared to C-TKA.
- **Funding Source:** Stryker.

Vaidya NV,  
Deshpande AN,  
Panjwani T,  
Patil R,  
Jaysingani T,  
Patil P

[Robotic-assisted TKA leads to a better prosthesis alignment and a better joint line restoration as compared to conventional TKA: a prospective randomized controlled trial.](#) *Knee Surg Sports Traumatol Arthrosc.* 2020;10.1007/s00167-020-06353-2. doi:10.1007/s00167-020-06353-2

- Prospective study including 60 patients between April 2019 and March 2020.
- Significant difference between the RA-TKA and C-TKA groups for mechanical axis deviation, joint line deviation, and coronal alignment of femoral and tibial prosthesis.
- **Funding Source:** None.

Kayani B,  
Konan S,  
Huq SS,  
Tahmassebi J,  
Haddad FS

[Robotic-arm assisted total knee arthroplasty has a learning curve of seven cases for integration into the surgical workflow but no learning curve effect for accuracy of implant positioning.](#) *Knee Surg Sports Traumatol Arthrosc.* 2019;27(4):1132-1141. doi:10.1007/s00167-018-5138-5

- Prospective cohort study of 60 consecutive C-TKA followed by 60 consecutive RA-TKA.
- RA-TKA associated with learning curve of 7 cases for operative time and surgical team anxiety level.
- RA-TKA resulted in significantly improved implant positioning accuracy and limb alignment.
- No significant difference in cumulative robot experience for accuracy of implant positioning, limb alignment, posterior condylar offset ration, posterior tibial slope, and joint line restoration.
- **Funding Source:** None. FSH COI with Stryker.

Pietrzak JRT,  
Rowan FE,  
Kayani B,  
Donaldson MJ,  
Huq SS,  
Haddad FS

[Preoperative CT-based three-dimensional templating in robot-assisted total knee arthroplasty more accurately predicts implant sizes than two-dimensional templating.](#) *J Knee Surg.* 2019;32(7):642-648. doi:10.1055/s-0038-1666829

- 31 RA-TKA were assessed prospectively to determine accuracy of implant sizing and positioning.
- CT-based templating for RA-TKA accurately predicts size of implants compared with traditional 2D digital templating without malposition.
- **Funding Source:** Not specified. FSH COI with Stryker.



Kayani B,  
Konan S,  
Tahmassebi J,  
Pietrzak JRT,  
Haddad FS

[Robotic-arm assisted total knee arthroplasty is associated with improved early functional recovery and reduced time to hospital discharge compared with conventional jig-based total knee arthroplasty: a prospective cohort study.](#) *Bone Joint J.* 2018;100-B(7):930-937. doi:10.1302/0301-620X.100B7.BJJ-2017-1449.R1

- 40 consecutive patients with C-TKA and 40 consecutive patients with RA-TKA. All procedures performed by single surgeon.
- RA-TKA was associated with decreased pain, improved early functional recovery, and reduced time to hospital discharge compared with C-TKA.
- **Funding Source:** National Institute for Health Research University College London Hospitals Biomedical Research Centre. FSH COI with Stryker.

Kayani B,  
Konan S,  
Pietrzak JRT,  
Haddad FS

[Iatrogenic bone and soft tissue trauma in robotic-arm assisted total knee arthroplasty compared with conventional jig-based total knee arthroplasty: a prospective cohort study and validation of a new classification system.](#) *J Arthroplasty.* 2018;33(8):2496-2501. doi:10.1016/j.arth.2018.03.042

- 30 consecutive C-TKA followed by 30 RA-TKA performed by a single surgeon.
- Macroscopic Soft Tissue Injury (MASTI) classification system based on intraoperative photographs the femur, tibia, and periarticular soft tissue.
- RA-TKA resulted in significantly reduced soft-tissue injury, more pristine femoral and tibial cuts, and improved MASTI scores compared to C-TKA.
- **Funding Source:** Not specified. FSH COI with Stryker.

Kim YH,  
Park JW,  
Kim JS

[2017 Chitranjan S. Ranawat award: does computer navigation in knee arthroplasty improve functional outcomes in young patients? a randomized study.](#) *Clin Orthop Relat Res.* 2018;476(1):6-15. doi:10.1007/s11999.0000000000000000

- 15-year follow-up of patients undergoing a same day bilateral TKA between October 2000 and October 2002. One knee operated with RA-TKA and the other C-TKA.
- Of the original 282 patients, 95% were accounted for at mean 15 years.
- KSS, WOMAC, ROM, UCLA were not significantly different between RA-TKA and C-TKA at 15-year follow-up.
- No differences in radiographic parameters of alignment.
- Frequency of aseptic loosening was not different.
- **Funding Source:** Not specified.



Liow MHL,  
Goh GS,  
Wong MK,  
Chin PL,  
Tay DK,  
Yeo SJ

[Robotic-assisted total knee arthroplasty may lead to improvement in quality-of-life measures: a 2-year follow-up of a prospective randomized trial.](#) *Knee Surg Sports Traumatol Arthrosc.* 2017;25(9):2942-2951. doi:10.1007/s00167-016-4076-3

- Purpose was to determine whether there was an improvement in functional outcomes and quality of life between RA-TKA and C-TKA.
- 31 RA-TKA and 29 C-TKA were assessed, and patients were collected between May 2012 and December 2012.
- Significant differences observed in SF-36 parameters including general health, vitality, and role emotional.
- Trend toward higher functional scores in the RA-TKA group; however, not significant.
- No significant differences in OKS, KSS knee, and function scores were observed.
- **Funding Source:** Not specified.

Marchand RC,  
Sodhi N,  
Khlopas A,  
et al

[Patient satisfaction outcomes after robotic arm-assisted total knee arthroplasty: a short-term evaluation.](#) *J Knee Surg.* 2017;30(9):849-853. doi:10.1055/s-0037-1607450

- 20 consecutive RA-TKA compared with 20 C-TKA between July 2016 and August 2016.
- WOMAC was used to compare pain scores, physical function scores, and total patient satisfaction outcomes at 6-month follow-up.
- RA-TKA resulted in significantly decreased WOMAC pain score, physical function, and satisfaction score compared to C-TKA.
- **Funding Source:** Not specified. RCM COI with Stryker.

Liow MH,  
Xia Z,  
Wong MK,  
Tay KJ,  
Yeo SJ,  
Chin PL

[Robot-assisted total knee arthroplasty accurately restores the joint line and mechanical axis. A prospective randomised study.](#) *J Arthroplasty.* 2014;29(12):2373-2377. doi:10.1016/j.arth.2013.12.010

- Prospective, randomization of 60 patients: 31 RA-TKA and 29 C-TKA.
- No significant difference in mechanical axis outliers was observed between groups.
- RA-TKA displayed significantly fewer joint line outliers (3.23%) compared to C-TKA (20.6%).
- **Funding Source:** Not specified.

Yim JH,  
Song EK,  
Khan MS,  
Sun ZH,  
Seon JK

[A comparison of classical and anatomical total knee alignment methods in robotic total knee arthroplasty: classical and anatomical knee alignment methods in TKA.](#) *J Arthroplasty.* 2013;28(6):932-937. doi:10.1016/j.arth.2013.01.013

- Classical method involves making tibial and femoral cuts perpendicular to the mechanical axis of the tibia and femur, respectively.
- Anatomical method allows for the fact that the proximal tibial plateau is in a few degrees of varus.
- Patients operated on between January 2009 and June 2009.
- 117 patients included with minimum 2-year follow-up.
- No clinical differences between classical and anatomical method were observed between ROM, HSS, and WOMAC scores.
- No difference observed in mechanical alignment of the lower limb.
- **Funding Source:** Not specified.





Song EK,  
Seon JK,  
Yim JH,  
Netravali NA,  
Bargar WL

[Robotic-assisted TKA reduces postoperative alignment outliers and improves gap balance compared to conventional TKA.](#) *Clin Orthop Relat Res.* 2013;471(1):118-126. doi:10.1007/s11999-012-2407-3

- Prospectively randomized 100 patients undergoing unilateral TKA: 50 RA-TKA and 50 C-TKA.
- Minimum follow-up of 41 months, mean 65 months.
- No significant differences in postoperative ROM, WOMAC, or HSS scores. No mechanical axis outliers >3° in RA-TKA group compared to 24% in the C-TKA group.
- RA-TKA took an average of 25 minutes longer than C-TKA.
- RA-TKA displayed significantly less blood drainage compared to C-TKA.
- **Funding Source:** Not specified. WLB, JSK, NAN receive benefits from Curexo Technology Corp.

Song EK,  
Seon JK,  
Park SJ,  
Jung WB,  
Park HW,  
Lee GW

[Simultaneous bilateral total knee arthroplasty with robotic and conventional techniques: a prospective, randomized study.](#) *Knee Surg Sports Traumatol Arthrosc.* 2011;19(7):1069-1076. doi:10.1007/s00167-011-1400-9

- 30 patients underwent bilateral sequential total knee replacement. One knee was replaced by RA-TKA and the other by C-TKA.
- Surgeries were conducted between August 2004 and March 2006.
- HSS preoperative scores were 62.2 in RA-TKA and 63.8 in C-TKA. At last follow-up, a significant increase was observed in both RA-TKA (95.2) and C-TKA (94.7).
- WOMAC improved in both groups significantly.
- RA-TKA did not have significantly better postoperative knee scores and ROM.
- RA-TKA required longer operation.
- **Funding Source:** None.

Bellemans J,  
Vandenneucker H,  
Vanlauwe J

[Robot-assisted total knee arthroplasty.](#) *Clin Orthop Relat Res.* 2007;464:111-116. doi:10.1097/BLO.0b013e318126c0c0

- Prospective study with minimum 5.1-year follow-up, mean 5.5 years.
- Patients underwent surgery between September 2000 and March 2001.
- Excellent implant positioning within 1° error of neutral alignment in all 3 planes in all cases.
- Authors conclude they abandoned the active robot used (ROBODOC) and CASPAR system due to excessive operating time, technical complexity, and high operational cost.
- The authors are more interested in exploring a semi-active system.
- **Funding Source:** None.



Park SE,  
Lee CT

[Comparison of robotic-assisted and conventional manual implantation of a primary total knee arthroplasty.](#) *J Arthroplasty*. 2007;22(7):1054-1059. doi:10.1016/j.arth.2007.05.036

- Prospectively randomized 62 patients, 30 patients: C-TKA and 32 patients RA-TKA.
- RA-TKA displayed advantages in terms of preoperative planning, accuracy of the intraoperative procedure, and postoperative follow-up, especially in femoral and tibial flexion angles in the lateral x-ray and in the femoral flexion angle in the AP x-ray.
- Disadvantage of RA-TKA was the high complication rate in early adoption.
- **Funding Source:** None.

Siebert W,  
Mai S,  
Kober R,  
Heeckt PF

[Technique and first clinical results of robot-assisted total knee replacement.](#) *Knee*. 2002;9(3):173-180. doi:10.1016/s0968-0160(02)00015-7

- CASPAR system used in study.
- 70 patients included in study with first enrollment in March 2000.
- Mean difference between preoperative and postoperative tibiofemoral alignment was 0.8° for RA-TKA compared to 2.6° for C-TKA.
- **Funding Source:** Not specified.

## Retrospective Clinical and Radiological Studies

Vermue H,  
Luyckx T,  
Winnock de Grave P,  
et al

[Robot-assisted total knee arthroplasty is associated with a learning curve for surgical time but not for component alignment, limb alignment and gap balancing.](#) *Knee Surg Sports Traumatol Arthrosc*. 2020;10.1007/s00167-020-06341-6. doi:10.1007/s00167-020-06341-6

- Patients who underwent RA-TKA by 6 fellowship training surgeons between April 2018 and September 2019 were retrospectively reviewed.
- RA-TKA resulted in a learning curve of 11 to 43 cases for operative time. The learning curve was significantly affected by surgeon volume.
- No learning curve associated with implant positioning.
- Limb alignment showed a mean deviation of 1.2° toward valgus compared to intraoperative plan.
- **Funding Source:** None.



Novoa-Parra CD,  
Sanjuan-Cerveró R,  
Franco-Ferrando N,  
Larrainzar-Garijo R,  
Egea-Castro G,  
Lizaur-Utrilla A

[Complications of computer-assisted navigation in total knee replacement: retrospective cohort of eight hundred and seventy eight consecutive knees.](#) *Int Orthop.* 2020;44(12):2621-2626. doi:10.1007/s00264-020-04675-x

- Retrospective study of 878 primary TKA in 753 patients between January 2009 and November 2017.
- 20 complications were observed (20.3%) related to the navigation system that forced a switch to C-TKA: 11 complications were due to tracking pin loosening, and 9 complications were information system failures (ie, failure to recognize tracking pin, failure to calculate joint space, camera failure, and failure to recognize hip center of rotation).
- Trend for higher conversion to C-TKA with use of version 1 of the software.
- No significant difference in 2-year survival between RA-TKA and C-TKA patients.
- **Funding Source:** None.

Marchand RC,  
Sodhi N,  
Anis HK,  
et al

[One-year patient outcomes for robotic-arm-assisted versus manual total knee arthroplasty.](#) *J Knee Surg.* 2019;32(11):1063-1068. doi:10.1055/s-0039-1683977

- One-year WOMAC outcomes for 53 consecutive RA-TKA compared to 53 consecutive C-TKA.
- RA-TKA significantly improved mean total and physical function scores compared to C-TKA.
- RA-TKA mean pain score was  $2 \pm 3$  points compared to C-TKA ( $3 \pm 4$  points).
- **Funding Source:** Not specified. RCM, MSH, MAM have COI with Stryker.

Jeon SW,  
Kim KI,  
Song SJ

[Robot-assisted total knee arthroplasty does not improve long-term clinical and radiologic outcomes.](#) *J Arthroplasty.* 2019;34(8):1656-1661. doi:10.1016/j.arth.2019.04.007

- Retrospective review of 84 RA-TKA with ROBODOC compared to 79 C-TKA.
- Study evaluates clinical and radiologic follow-up between October 2006 and October 2009 with mean follow-up of 129.1 months.
- No significant difference in clinical outcomes between both groups.
- No significance in radiological outcomes, ie, alignment, although a lower rate of outliers was observed for RA-TKA, indicating a more accurate lower limb alignment and component positioning.
- 81 cc less bleeding drainage compared to C-TKA.
- **Funding Source:** Not specified.



Naziri Q,  
Cusson BC,  
Chaudhri M,  
Shah NV,  
Sastry A

[Making the transition from traditional to robotic-arm assisted TKA: what to expect? a single-surgeon comparative-analysis of the first-40 consecutive cases.](#) *J Orthop.* 2019;16(4):364-368. doi:10.1016/j.jor.2019.03.010

- Short-term outcomes and learning curves are evaluated for a single surgeon performing RA-TKA and compared 1:1 with C-TKA.
- Length of stay was longer for C-TKA (1.92 days compared to 1.27 days).
- No significant difference observed for surgical time between second 20 RA-TKA and all C-TKA (81.1 compared to 78.3 minutes).
- RA-TKA patients showed significantly improved 90-day ROM compared to C-TKA.
- No differences observed for complication rates, Knee Society Score, and patient-reported outcomes.
- **Funding Source:** Stryker.

Cho KJ,  
Seon JK,  
Jang WY,  
Park CG,  
Song EK

[Robotic versus conventional primary total knee arthroplasty: clinical and radiological long-term results with a minimum follow-up of ten years.](#) *Int Orthop.* 2019;43(6):1345-1354. doi:10.1007/s00264-018-4231-1

- Retrospective evaluation of 208 knees undergoing RA-TKA with ROBODOC compared to 370 C-TKA between January 2004 and December 2007.
- No significant difference observed for clinical patient-reported outcomes between groups.
- C-TKA showed significantly higher outliers compared to RA-TKA.
- No significant difference in survival rate between RA-TKA and C-TKA (98.8% compared to 98.5%).
- **Funding Source:** None.

Smith AF,  
Eccles CJ,  
Bhimani SJ,  
et al

[Improved patient satisfaction following robotic-assisted total knee arthroplasty.](#) *J Knee Surg.* 2019;10.1055/s-0039-1700837. doi:10.1055/s-0039-1700837

- Retrospective analysis of 120 consecutive RA-TKA compared with 103 C-TKA.
- 1-year follow-up of KSS and Likert scoring system.
- 94% satisfaction for RA-TKA compared to 82% satisfaction for C-TKA using Likert score.
- KSS function and knee scores were significantly higher for RA-TKA at 1 year.
- Authors conclude the following advantages for RA-TKA: real time information in millimeters to help obtain balanced gaps, accurate bone cuts, reduced soft-tissue injury, and achievement of target alignment.
- **Funding Source:** Not specified. ALM COI with Stryker.



Marchand RC,  
Sodhi N,  
Bhowmik-Stoker M,  
et al

[Does the robotic arm and preoperative CT planning help with 3D intraoperative total knee arthroplasty planning?](#) *J Knee Surg.* 2019;32(8):742-749. doi:10.1055/s-0038-1668122

- 335 patients undergoing RA-TKA were reviewed and differences in medial versus lateral prebone cut extension and flexion gaps were calculated.
- All patients achieved a postbone cut extension gap difference between -1 mm and 1 mm.
- 99% (332 patients) achieved a postbone cut flexion gap difference between -2 mm and 2 mm.
- RA-TKA planning software predicted within 1 implant size of the actual tibial or femoral implant size used.
- **Funding Source:** Not specified: MAM, RCM COI with Stryker; MBS, LS Stryker employees.

Sodhi N,  
Khlopas A,  
Piuizzi NS,  
et al

[The learning curve associated with robotic total knee arthroplasty.](#) *J Knee Surg.* 2018;31(1):17-21. doi:10.1055/s-0037-1608809

- Purpose was to assess RA-TKA compared to C-TKA operative times of 2 joint reconstructive surgeons and find an overall learning curve.
- Total of 240 RA-TKAs were performed. Cases were grouped into 20 cases. Compared first and last 20 to 20 randomly selected C-TKA cases.
- Surgeon 1: First RA-TKA 81 minutes. Last RA-TKA 70 minutes. First 20 RA-TKA compared to C-TKA cases were 81 and 68 minutes. Last 20 RA-TKA compared to C-TKA was 70 and 68 minutes.
- Surgeon 2: First and last RA-TKA were 117 and 98 minutes. First 20 RA-TKA compared to C-TKA was 117 and 95 minutes. Last 20 RA-TKA compared to C-TKA was 98 and 95 minutes.
- **Funding Source:** Not specified. MAM, RCM COI with Stryker.

Marchand RC,  
Khlopas A,  
Sodhi N,  
et al

[Difficult cases in robotic arm-assisted total knee arthroplasty: a case series.](#) *J Knee Surg.* 2018;31(1):27-37. doi:10.1055/s-0037-1608839

- Description of 3 cases with severe varus or valgus deformity and flexion contracture corrected with RA-TKA.
- **Funding Source:** Not specified. MAM, RCM COI with Stryker.

Parsley BS

[Robotics in orthopedics: a brave new world.](#) *J Arthroplasty.* 2018;33(8):2355-2357. doi:10.1016/j.arth.2018.02.032

- AAHKS Symposium commentary article on the future of RA-TKA.
- Tractica estimates 10,000 robotic units would be implemented by 2021.
- **Funding Source:** Not specified.



Yang HY,  
Seon JK,  
Shin YJ,  
Lim HA,  
Song EK

[Robotic total knee arthroplasty with a cruciate-retaining implant: a 10-year follow-up study.](#)

*Clin Orthop Surg.* 2017;9(2):169-176. doi:10.4055/cios.2017.9.2.169

- 10-year follow-up of 113 patients operated on between January 2004 and December 2007: 71 RA-TKA compared to 42 C-TKA.
- Clinical outcomes (VAS, HSS, WOMAC, ROM, and complications), radiological outcomes, and long-term survival were evaluated.
- Clinical outcomes were not significantly different between RA-TKA and C-TKA.
- Significantly less postoperative leg alignment outliers, including femoral coronal inclination, tibial coronal inclination, femoral sagittal inclination, tibial sagittal inclination, and mechanical axis were observed for RA-TKA.
- **Funding Source:** Research Institute of Medical Science, Chonnam National University.

Kim KI,  
Kim DK,  
Juh HS,  
Khurana S,  
Rhyu KH

[Robot-assisted total knee arthroplasty in haemophilic arthropathy.](#) *Haemophilia.*

2016;22(3):446-452. doi:10.1111/hae.12875

- The purpose of this study was to determine if RA-TKA can be carried out in hemophilic arthropathy and what precision could be obtained.
- Retrospective review of 32 RA-TKA in 29 hemophilic patients. Mean follow-up was 5 years.
- KSS improved from 27.1 to 82.8.
- ROM improved 70.7 to 84.7.
- Hip-Knee-Ankle (HKA) axis was within a range of  $\pm 3^\circ$ .
- **Funding Source:** None.