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Supplementary Material

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Table i. Studies included in the systematic review.

Authors	Year	Design	Patients, n	Mean age, yrs	Mean follow-up, mths	Implant	Key findings	NIH Quality Assessment Score
Banger et al(35)	2021	RCT	55 RAUKA vs 49 mUKA	N/R	5 years	RAUKA: RESTORIS MCK mUKA: Phase-3 Oxford mobile-bearing unicompartmental knee replacement	Functional outcomes: At 5 years, no difference between RAUKA and mUKA groups in OKS, UCLA, AKSS scores or FJS scores. Survivorship: Lower reintervention rate in RAUKA when compared to mUKA (0% vs 9%)	Good
Bell et al(41)	2016	RCT	62 RAUKA vs 58 mUKA	62.5 vs 61.7	N/A	RAUKA: RESTORIS MCK mUKA: Phase-3 Oxford mobile-bearing unicompartmental knee replacement	Alignment: The RMS errors were lower in all six component alignment parameters in the robotic-assisted arthroplasty group.	Good
Blyth et al(33)	2017	RCT	70 RAUKA vs 69 mUKA	Supplementary material	1 year	RAUKA: RESTORIS MCK mUKA: Phase-3 Oxford mobile-bearing unicompartmental knee replacement	Functional outcomes: At one year, the observed differences with the AKSS had narrowed from a median of 21 points to a median of seven points (p = 0.106) (RAUKA median 171, IQR 153 to 179; mUKA median 164, IQR 144 to 182). No difference was observed with the OKS, and almost half of each group reached the ceiling limit of the score (OKS > 43). Complications: No significant differences in complications between RAUKA and mUKA noted. A number of minor wound complications were more common in the manual surgery group	Good

							(supplementary material), but there were no deep infections in either group. <u>Survivorship:</u> No revision surgery was performed on any patient within the first 12 months after surgery.	
Clement et al(32)	2019	Markov decision analysis	100 RAUKA	65	N/A	RAUKA vs mTKA vUKA (Markov decision model)	<u>Cost:</u> RAUKA gain 1.39 more QALYs compared with manual UKA. Cost per QALY was influenced by case volume: low-volume centre (ten cases per year) would achieve a cost per QALY of £7,171 and £8,604, whereas for a large-volume centre (200 cases per year) the cost per QALY decreased to £1,074 and £757 relative to TKA and mUKA, respectively.	Good
Cool et al(39)	2019	Retrospective	246 RAUKA vs 492 mUKA	N/R	2 years	Fixed bearing RAUKA vs Mobile Bearing mUKA	<u>Survivorship:</u> Revisions at 24 months (mUKA 5.28% (26/492) vs RAUKA 0.81% (2/246, p = 0.002); <u>Cost:</u> No significant differences between RAUKA and mUKA in terms of the cost of index surgery and stay, although LOS index surgery was significantly shorter for the RAUKA group (mUKA 2.02 vs RAUKA 1.77, p = 0.047). Mean cost of index surgery and stay (mUKA USD 26,307 vs RAUKA USD 25,786)	Good
Gilmour et al(42)	2018	RCT	58 RAUKA vs 54 mUKA	61.8 vs 62.6	2 years	RAUKA: RESTORIS MCK mUKA: Phase-3 Oxford mobile-bearing unicompartmental knee replacement	<u>Functional outcomes:</u> No significant difference between RAUKA vs mUKA: AKSS (mUKA 173.0 (SD 17.19) vs RAUKA 168 (SD 37.04)); OKS (mUKA 40 (SD 23.4) vs RAUKA 39 (SD 9.04)); FJS (mUKA 54.1 (SD 31.26) vs RAUKA 55.2 (SD 43.33)). <u>Complications:</u> There was a slightly higher rate of minor complications in the mUKA group. 2 patients required further surgery and exchange of polyethylene. 9.3% of patients in the manual group had a radiographic lucency visible at follow-up, although no treatment was required. <u>Survivorship:</u> 100% in RAUKA group and 96.3% in the mUKA group.	Good
Hansen et al(4)	2014	Retrospective	30 RAUKA vs 32 mUKA	57.1 vs 60.7	2 years	RAUKA: RESTORIS MCK mUKA: Zimmer High-Flex UKA, Zimmer, USA).	Alignment: Postoperatively, there was no statistically significant difference in coronal tibial axis or alignment (p = 0.184). Complications: Both techniques had equal EBL, tourniquet time and intraoperative complication rates. One patient (mUKA group) presented with a deep postop infection requiring early debridement and revision to TKA at 6 months postop. Two patients (one RAUKA, one mUKA) had postoperative cellulitis requiring antibiotic treatment only. Continued medial-sided knee pain was reported more commonly in	Fair

							the RAUKA group compared to mUKA group (6 patients, 20% vs 1 patient, 3.3%. p = 0.041).	
Kayani et al(37)	2018	Prospective	60 RAUKA vs 60 mUKA	64.1 vs 65.5	1 month	RAUKA: RESTORIS MCK mUKA: Oxford Phase 3 mobile-bearing UKA (Zimmer Biomet, UK)	Learning curve: RAUKA has a learning curve of six cases for operating time and surgical team confidence levels. However, there was no learning curve for precision of components, joint line restoration and postoperative limb alignment. Alignment: Improvement afforded by the RAUKA in achieving the planned femoral coronal and sagittal implant positioning, tibial coronal and sagittal implant positioning, posterior tibial slope, and joint line height compared with conventional jig-based UKA ($p < 0.001$). There was no difference relating to PCOR ($p = 0.54$). Complications: Two patients in the conventional mUKA group developed increasing pain and swelling in the operated leg at day 2 following surgery. Resolved with conservative management. No other complications in either treatment groups.	Good
Kayani et al(40)	2019	Prospective	73 RAUKA vs 73 mUKA	64.5 vs 62.8	3 months	RAUKA: RESTORIS MCK mUKA: Oxford Phase 3 mobile-bearing UKA (Zimmer Biomet)	Functional outcomes: RAUKA reduced postoperative pain ($p < 0.001$), decreased opiate analgesia requirements ($p < 0.001$), shortened time to straight leg raise ($p < 0.001$), decreased physiotherapy sessions ($p < 0.001$), increased maximum knee flexion at discharge ($p < 0.001$), and mean time to discharge ($p < 0.001$). Complications: Two patients in the conventional mUKA group developed increasing pain and swelling in the operated leg at day 2 following surgery. Resolved with conservative management. No other complications in either treatment groups.	Good
Lonner et al(36)	2010	Prospective with Retrospective element	31 RAUKA vs 27 mUKA	64 vs 57	N/R	RAUKA: RESTORIS MCK mUKA: Cemented Metal Backed onlay tibia components	Alignment: RMS error when using manual techniques compared with robotic arm assistance for bone preparation is higher for posterior slope, with greater variance (2.6 times). In the coronal plane, relative to the mechanical axis of the tibia, the varus/valgus root mean square error was 3.4° manually compared with 1.8° robotically.	Fair
Moschetti et al(34)	2015	Markov decision analysis	100	65	N/A	N/R	Cost: RAUKA was more costly than mUKA, but offered a slightly better outcome, adding 0.06 QALYs at an incremental cost of $47,180 per QALY, given a case volume of 100 cases annually. The system was cost-effective when case volume	Good

							exceeded 94 cases per year, 2-year failure rates were below 1.2%, and total system costs were < $1.426 million.	
Park et al(1)	2019	Retrospective	55 RAUKA vs 57 mUKA	64.8 vs 68.4	2 years	RAUKA: RESTORIS MCK mUKA: the medial Zimmer Unicompartmental High Flex Knee System (Zimmer, USA)	Alignment: No significant differences for mFTA, coronal alignment of tibial and femoral components between RAUKA and mUKA. However, there was significantly less outliers (3˚ away from the optimum angle). [mFTA, p = 0.022; coronal alignment of tibial, p = 0.003; femoral components, p = 0.037). Functional outcomes: No significant difference between the two groups regarding postoperative ROM (p = 0.470), AKS (p = 0.381), WOMAC (p = 0.533) and PF score (p = 0.642).	Fair
St Mart et al(43)	2020	Prospective	2,851 RAUKA vs 3093 ZUK mUKA vs 6468 other mUKA	65.7 vs 65.4 vs 65.1	1.4 vs 1.8 vs 1.9 years	RAUKA: RESTORIS MCK mUKA: Zimmer Unicompartmental High Flex Knee System (Zimmer) and other non-robotic group	Survivorship: At 2 years: mUKA (ZUK) 2.7% (SD 15.2) vs mUKA (others) 3.9% (SD 16.98) vs RAUKA 2.3% (SD 14.32)) At 3 years: mUKA (ZUK) 3.7% (SD 20.6) vs mUKA (others) 5.0% (SD20.06) vs RAUKA 2.6% (SD 17.39)); mUKA (others) vs RAUKA (HR 0.58 (95% CI 0.42 to 0.79); p < 0.001) at three years. no difference in the rate of revision when the RAUKA was compared to the ZUK mUKA (zero to nine months: HR 1.14 (95% CI 0.71 to 1.83; p = 0.596) vs nine months and over: HR 0.66 (95% CI 0.42 to 1.02; p = 0.058));	Good
Wong et al(38)	2019	Retrospective	58 RAUKA vs 118 mUKA	70.4 vs 67.9	2.8 vs 3.8 years	RAUKA: RESTORIS MCK mUKA: Miller–Galante Unicompartmental Knee, Zimmer Unicompartmental Knee (Zimmer) or Smith and Nephew Journey Unicompartmental Knee (Smith & Nephew, USA)	Functional outcomes: No significant differences between the RAUKA and mUKA cohorts in SF-12, WOMAC and KSS scores. (SF 12: mUKA 45.7 (SD 11.2) vs RAUKA 43.9 (SD 9.5); WOMAC: mUKA 79.9 (SD 23.0) vs RAUKA 83.6 (SD 16.0); KSS: mUKA 77.7 (SD21.3) vs RAUKA 83.4 (SD 14.7)) Survivorship: Revision rate RAUKA 7/58 (12%) vs mUKA 7/118 (6.8%) (p < 0.05).	Fair

CI, confidence interval; EBL, estimated blood loss; KSS, Knee Society Score; OS, length-of-stay; mUKA, manual unicompartmental knee arthroplasty; N/A, not applicable; NIH, National Institutes of Health; N/R, not reported; OKS, Oxford Knee Score; PCOR, posterior-condylar offset ratio; QALY, quality-adjusted-life-years; RAUKA, robotic arm-assisted unicompartmental knee arthroplasty; RCT, randomized controlled trial; RMS, root mean square.

References

1. **Banger M, Doonan J, Rowe P, Jones B, MacLean A, Blyth MJB.** Robotic arm-assisted versus conventional medial unicompartmental knee arthroplasty: five-year clinical outcomes of a randomized controlled trial. *Bone Joint J*. 2021 Jun;103-B(6):1088-1095.
2. **Bell SW, Anthony I, Jones B, MacLean A, Rowe P, Blyth M.** Improved Accuracy of Component Positioning with Robotic-Assisted Unicompartmental Knee Arthroplasty: Data from a Prospective, Randomized Controlled Study. *J Bone Joint Surg Am*. 2016 Apr 20;98(8):627-35.
3. **Blyth MJG, Anthony I, Rowe P, Banger MS, MacLean A, Jones B.** Robotic arm-assisted versus conventional unicompartmental knee arthroplasty: Exploratory secondary analysis of a randomised controlled trial. *Bone Joint Res*. 2017 Nov;6(11):631-639.
4. **Clement ND, Deehan DJ, Patton JT.** Robot-assisted unicompartmental knee arthroplasty for patients with isolated medial compartment osteoarthritis is cost-effective: a markov decision analysis. *Bone Joint J*. 2019 Sep;101-B(9):1063-1070.
5. **Cool CL, Needham KA, Khlopas A, Mont MA.** Revision Analysis of Robotic Arm-Assisted and Manual Unicompartmental Knee Arthroplasty. *J Arthroplasty*. 2019 May;34(5):926-931.
6. **Gilmour A, MacLean AD, Rowe PJ, Banger MS, Donnelly I, Jones BG, Blyth MJG.** Robotic-Arm-Assisted vs Conventional Unicompartmental Knee Arthroplasty. The 2-Year Clinical Outcomes of a Randomized Controlled Trial. *J Arthroplasty*. 2018 Jul;33(7S):S109-S115.
7. **Hansen DC, Kusuma SK, Palmer RM, Harris KB.** Robotic guidance does not improve component position or short-term outcome in medial unicompartmental knee arthroplasty. *J Arthroplasty*. 2014 Sep;29(9):1784-9.
8. **Kayani B, Konan S, Pietrzak JRT, Huq SS, Tahmassebi J, Haddad FS.** The learning curve associated with robotic-arm assisted unicompartmental knee arthroplasty: a prospective cohort study. *Bone Joint J*. 2018 Aug;100-B(8):1033-1042.
9. **Kayani B, Konan S, Tahmassebi J, Rowan FE, Haddad FS.** An assessment of early functional rehabilitation and hospital discharge in conventional versus robotic-arm assisted unicompartmental knee arthroplasty: a prospective cohort study. *Bone Joint J*. 2019 Jan;101-B(1):24-33.
10. **Lonner JH, John TK, Conditt MA.** Robotic arm-assisted UKA improves tibial component alignment: a pilot study. *Clin Orthop Relat Res*. 2010 Jan;468(1):141-6.
11. **Moschetti WE, Konopka JF, Rubash HE, Genuario JW.** Can Robot-Assisted Unicompartmental Knee Arthroplasty Be Cost-Effective? A Markov Decision Analysis. *J Arthroplasty*. 2016 Apr;31(4):759-65.
12. **Park KK, Han CD, Yang IH, Lee WS, Han JH, Kwon HM.** Robot-assisted unicompartmental knee arthroplasty can reduce radiologic outliers compared to conventional techniques. *PLoS One*. 2019 Dec 3;14(12):e0225941.

13. **St Mart JP, de Steiger RN, Cuthbert A, Donnelly W.** The three-year survivorship of robotically assisted versus non-robotically assisted unicompartmental knee arthroplasty. *Bone Joint J*. 2020 Mar;102-B(3):319-328.
14. **Wong J, Murtaugh T, Lakra A, Cooper HJ, Shah RP, Geller JA.** Robotic-assisted unicompartmental knee replacement offers no early advantage over conventional unicompartmental knee replacement. *Knee Surg Sports Traumatol Arthrosc*. 2019 Jul;27(7):2303-2308.