

Supplementary data

Supplementary Table S1. RSA double examination measurements for the 5 different implant types

Axis	Translations (mm)				Rotations (°)				MTPM (mm)
	x	y	z	TT ^a	x	y	z	TR ^b	
Cemented Vanguard TKA, n = 12									
Mean difference	0.00	0.01	−0.02	−0.01	0.01	−0.01	0.03	−0.10	−0.08
SD difference	0.06	0.04	0.10	0.07	0.14	0.30	0.10	0.18	0.16
CR (1.96 * SD difference)	0.11	0.09	0.19	0.14	0.28	0.58	0.19	0.34	0.32
Cementless NexGen Monoblock TKA, n = 51									
Mean difference	0.01	0.01	0.02	−0.01	−0.02	−0.05	−0.02	−0.02	−0.01
SD difference	0.07	0.07	0.25	0.16	0.51	0.31	0.13	0.36	0.20
CR (1.96 * SD difference)	0.14	0.14	0.48	0.31	0.99	0.61	0.26	0.70	0.38
Cemented NexGen Stemmed Precoat TKA, n = 71									
Mean difference	0.00	0.00	0.00	0.00	−0.05	−0.10	−0.00	−0.05	−0.05
SD difference	0.07	0.09	0.19	0.12	0.31	0.38	0.10	0.34	0.24
CR (1.96 * SD difference)	0.15	0.18	0.37	0.24	0.60	0.75	0.19	0.67	0.47
Cemented Oxford UKA, n = 101									
Mean difference	−0.01	−0.01	0.00	−0.01	0.03	0.01	0.02	−0.01	−0.01
SD difference	0.05	0.03	0.11	0.07	0.20	0.18	0.15	0.16	0.09
CR (1.96 * SD difference)	0.10	0.06	0.21	0.14	0.39	0.35	0.29	0.30	0.18
Cementless Oxford UKA, n = 130									
Mean difference	0.00	0.00	0.00	0.00	−0.02	0.00	0.02	0.01	0.00
SD difference	0.03	0.03	0.10	0.08	0.20	0.12	0.15	0.16	0.09
CR (1.96 * SD difference)	0.06	0.07	0.20	0.15	0.38	0.24	0.29	0.31	0.17

The mean difference represents the systematic measurement error. The SD difference represents the random variation (precision). Coefficient of repeatability (CR) ($\pm 1.96 * \text{SD difference}$) represents the expected clinical precision.

^a Total translation (TT) was calculated using the Pythagorean theorem ($\text{TT} = \sqrt{x^2 + y^2 + z^2}$).

^b Total rotation (TR) was calculated using the Pythagorean theorem ($\text{TR} = \sqrt{x^2 + y^2 + z^2}$).

RSA: radiostereometric analysis, MTPM: maximum total point motion, TKA: total knee arthroplasty, UKA: unicompartmental knee arthroplasty, SD: standard deviation.

Supplementary Table S2. Mean translation (Tx, Ty, Tz, Total) (mm) and rotation (Rx, Ry, Rz, Total) (°) with CI in T-score groups for cementless TKA adjusted for BMI and age

Axis and follow-up	Low T-score ^a n = 28 mean (CI)	Normal T-score n = 50 mean (CI)	Difference mean (CI)
X-axis translation (Tx) mm			
1 year	0.01 (−0.15 to 0.16)	0.00 (−0.11 to 0.12)	0.00 (−0.19 to 0.20)
2 years	−0.03 (−0.17 to 0.12)	−0.02 (−0.12 to 0.09)	−0.01 (−0.19 to 0.17)
5 years	−0.06 (−0.16 to 0.11)	−0.04 (−0.16 to 0.08)	−0.01 (−0.22 to 0.19)
Y-axis translation (Ty), mm			
1 year	−0.06 (−0.19 to 0.07)	−0.01 (−0.11 to 0.08)	−0.05 (−0.21 to 0.11)
2 years	−0.01 (−0.14 to 0.11)	0.00 (−0.10 to 0.09)	−0.01 (−0.17 to 0.15)
5 years	0.03 (−0.09 to 0.16)	0.01 (−0.08 to 0.11)	0.02 (−0.14 to 0.18)
Z-axis translation (Tz,) mm			
1 year	−0.17 (−0.35 to 0.00)	−0.06 (−0.19 to 0.07)	−0.12 (−0.34 to 0.11)
2 years	−0.28 (−0.45 to −0.11)	−0.07 (−0.20 to 0.06)	−0.21 (−0.43 to 0.00)
5 years	−0.31 (−0.52 to −0.10)	−0.10 (−0.26 to 0.06)	−0.21 (−0.48 to 0.06)
Total translation (TT) ^b , mm			
1 year	0.59 (0.41 to 0.76)	0.53 (0.39 to 0.66)	0.06 (−0.16 to 0.28)
2 years	0.62 (0.46 to 0.79)	0.51 (0.39 to 0.63)	0.12 (−0.09 to 0.32)
5 years	0.67 (0.47 to 0.88)	0.58 (0.43 to 0.73)	0.10 (−0.16 to 0.35)
X-axis rotation (Rx), °			
1 year	−0.17 (−0.62 to 0.28)	−0.28 (−0.62 to 0.05)	0.12 (−0.45 to 0.68)
2 years	−0.38 (−0.87 to 0.11)	−0.16 (−0.52 to 0.19)	−0.21 (−0.83 to 0.40)
5 years	−0.40 (−0.86 to 0.07)	−0.35 (−0.69 to 0.00)	−0.05 (−0.63 to 0.53)
Y-axis rotation (Ry), °			
1 year	0.22 (−0.06 to 0.50)	0.05 (−0.16 to 0.25)	0.17 (−0.18 to 0.52)
2 years	0.21 (−0.09 to 0.49)	0.02 (−0.19 to 0.23)	0.19 (−0.17 to 0.54)
5 years	0.16 (−0.21 to 0.52)	0.03 (−0.24 to 0.29)	0.13 (−0.32 to 0.58)
Z-axis rotation (Rz), °			
1 year	−0.23 (−0.61 to 0.14)	0.02 (−0.26 to 0.30)	−0.25 (−0.73 to 0.22)
2 years	−0.14 (−0.50 to 0.22)	0.06 (−0.21 to 0.32)	−0.20 (−0.65 to 0.25)
5 years	−0.12 (−0.46 to 0.23)	0.11 (−0.14 to 0.36)	−0.23 (−0.66 to 0.20)
Total rotation (TR) ^c , °			
1 year	1.49 (1.09 to 1.90)	1.29 (0.99 to 1.60)	0.20 (−0.30 to 0.71)
2 years	1.49 (1.11 to 1.86)	1.36 (1.09 to 1.64)	0.12 (−0.34 to 0.59)
5 years	0.69 (0.49 to 0.89)	0.60 (0.45 to 0.75)	0.09 (−0.16 to 0.34)

^a The low T-score group includes patients with T-score ≤ −1.0.

^b Total translation (TT) was calculated using the Pythagorean theorem ($TT = \sqrt{(x^2 + y^2 + z^2)}$).

^c Total rotation (TR) was calculated using the Pythagorean theorem ($TR = \sqrt{(x^2 + y^2 + z^2)}$).

BMI: body mass index, CI: 95% confidence interval, TKA: total knee arthroplasty.

Supplementary Table S3. Mean translation (Tx, Ty, Tz, Total) (mm) and rotation (Rx, Ry, Rz, Total) (°) with CI in T-score groups for cementless UKA adjusted for BMI and age

Axis and follow-up	Low T-score ^a n = 54 mean (CI)	Normal T-score n = 78 mean (CI)	Difference mean (CI)
X-axis translation (Tx) mm			
1 year	0.10 (0.04 to 0.16)	0.07 (0.02 to 0.12)	0.03 (−0.05 to 0.10)
2 years	0.14 (0.08 to 0.20)	0.13 (0.08 to 0.18)	0.00 (−0.08 to 0.08)
5 years	0.24 (0.17 to 0.30)	0.22 (0.16 to 0.27)	0.02 (−0.07 to 0.11)
Y-axis translation (Ty), mm			
1 year	−0.12 (−0.22 to −0.02)	−0.31 (−0.39 to −0.22)	0.19 (0.05 to 0.32)
2 years	−0.09 (−0.20 to 0.01)	−0.30 (−0.39 to −0.21)	0.20 (0.06 to 0.34)
5 years	−0.06 (−0.18 to 0.05)	−0.28 (−0.37 to −0.19)	0.22 (0.07 to 0.36)
Z-axis translation (Tz,) mm			
1 year	−0.08 (−0.16 to 0.00)	−0.12 (−0.18 to −0.06)	0.03 (−0.07 to 0.14)
2 years	−0.04 (−0.14 to 0.05)	−0.12 (−0.19 to −0.05)	0.08 (−0.04 to 0.19)
5 years	−0.12 (−0.21 to −0.02)	−0.13 (−0.20 to −0.06)	0.01 (−0.11 to 0.13)
Total translation (TT) ^b , mm			
1 year	0.44 (0.33 to 0.54)	0.48 (0.40 to 0.55)	−0.04 (−0.17 to 0.09)
2 years	0.47 (0.37 to 0.57)	0.50 (0.42 to 0.58)	−0.03 (−0.16 to 0.10)
5 years	0.55 (0.45 to 0.65)	0.55 (0.48 to 0.63)	0.00 (−0.13 to 0.13)
X-axis rotation (Rx), °			
1 year	−0.58 (−0.95 to −0.21)	−0.91 (−1.18 to −0.63)	0.32 (−0.15 to 0.80)
2 years	−0.65 (−1.03 to −0.27)	−0.90 (−1.18 to −0.62)	0.25 (−0.23 to 0.73)
5 years	−0.69 (−1.09 to −0.29)	−0.92 (−1.21 to −0.62)	0.22 (−0.28 to 0.72)
Y-axis rotation (Ry), °			
1 year	−0.23 (−0.43 to −0.02)	−0.07 (−0.23 to 0.08)	−0.15 (−0.41 to 0.11)
2 years	−0.20 (−0.41 to 0.01)	−0.06 (−0.21 to 0.10)	−0.14 (−0.41 to 0.13)
5 years	−0.21 (−0.43 to 0.00)	−0.09 (−0.25 to 0.07)	−0.12 (−0.40 to 0.15)
Z-axis rotation (Rz), °			
1 year	0.46 (0.12 to 0.80)	0.38 (0.13 to 0.63)	0.08 (−0.36 to 0.51)
2 years	0.31 (−0.03 to 0.65)	0.15 (−0.10 to 0.41)	0.16 (−0.27 to 0.59)
5 years	0.15 (−0.22 to 0.51)	0.06 (−0.21 to 0.32)	0.09 (−0.37 to 0.55)
Total rotation (TR) ^c , °			
1 year	1.36 (0.97 to 1.75)	1.58 (1.29 to 1.88)	−0.23 (−0.71 to 0.26)
2 years	1.37 (0.99 to 1.76)	1.59 (1.30 to 1.88)	−0.22 (−0.70 to 0.26)
5 years	0.53 (0.42 to 0.64)	0.52 (0.45 to 0.60)	0.00 (−0.13 to 0.14)

^{a–c} See Supplementary Table 2.

BMI: body mass index, CI: 95% confidence interval, UKA: unicompartmental knee arthroplasty.

Supplementary Table S4. Mean translation (Tx, Ty, Tz, Total) (mm) and rotation (Rx, Ry, Rz, Total) (°) with CI in T-score groups for cemented TKA adjusted for BMI and age

Axis and follow-up	Low T-score ^a mean (CI)	Normal T-score mean (CI)	Difference mean (CI)
X-axis translation (Tx) mm			
1 year	0.02 (−0.06 to 0.09)	−0.14 (−0.26 to −0.03)	0.16 (0.02 to 0.30)
2 years	0.00 (−0.08 to 0.08)	−0.15 (−0.28 to −0.02)	0.15 (−0.01 to 0.30)
5 years	−0.02 (−0.11 to 0.07)	−0.13 (−0.27 to 0.00)	0.11 (−0.05 to 0.27)
Y-axis translation (Ty), mm			
1 year	0.12 (0.07 to 0.16)	0.16 (0.09 to 0.23)	−0.04 (−0.13 to 0.04)
2 years	0.15 (0.10 to 0.20)	0.18 (0.11 to 0.26)	−0.03 (−0.12 to 0.05)
5 years	0.18 (0.13 to 0.23)	0.21 (0.13 to 0.28)	−0.03 (−0.12 to 0.06)
Z-axis translation (Tz), mm			
1 year	−0.04 (−0.15 to 0.08)	−0.26 (−0.44 to −0.08)	0.22 (0.00 to 0.45)
2 years	0.00 (−0.12 to 0.13)	−0.30 (−0.49 to −0.10)	0.30 (0.06 to 0.54)
5 years	0.02 (−0.12 to 0.16)	−0.25 (−0.46 to −0.04)	0.28 (0.02 to 0.53)
Total translation (TT) ^b , mm			
1 year	0.46 (0.37 to 0.56)	0.49 (0.34 to 0.64)	−0.03 (−0.21 to 0.15)
2 years	0.49 (0.39 to 0.60)	0.56 (0.40 to 0.72)	−0.07 (−0.26 to 0.13)
5 years	0.52 (0.40 to 0.63)	0.53 (0.36 to 0.71)	−0.02 (−0.23 to 0.19)
X-axis rotation (Rx), °			
1 year	−0.01 (−0.19 to 0.16)	−0.36 (−0.63 to −0.10)	0.35 (0.03 to 0.68)
2 years	0.07 (−0.11 to 0.26)	−0.31 (−0.59 to −0.03)	0.38 (0.04 to 0.72)
5 years	−0.11 (−0.30 to 0.08)	−0.35 (−0.64 to −0.06)	0.24 (−0.12 to 0.59)
Y-axis rotation (Ry), °			
1 year	−0.29 (−0.54 to −0.04)	0.07 (−0.31 to 0.46)	−0.36 (−0.83 to 0.11)
2 years	−0.30 (−0.50 to −0.10)	−0.04 (−0.35 to 0.27)	−0.26 (−0.64 to 0.12)
5 years	−0.25 (−0.50 to −0.01)	0.25 (−0.11 to 0.61)	−0.50 (−0.94 to −0.06)
Z-axis rotation (Rz), °			
1 year	−0.07 (−0.19 to 0.04)	0.21 (0.03 to 0.38)	−0.28 (−0.49 to −0.06)
2 years	−0.08 (−0.20 to 0.05)	0.22 (0.04 to 0.41)	−0.30 (−0.52 to −0.07)
5 years	−0.09 (−0.23 to 0.04)	0.18 (−0.03 to 0.38)	−0.27 (−0.52 to −0.02)
Total rotation (TR) ^c , °			
1 year	0.99 (0.76 to 1.21)	0.87 (0.52 to 1.22)	0.11 (−0.31 to 0.53)
2 years	0.98 (0.80 to 1.16)	0.88 (0.61 to 1.15)	0.10 (−0.23 to 0.43)
5 years	0.56 (0.42 to 0.69)	0.55 (0.35 to 0.75)	0.00 (−0.24 to 0.25)

^{a-c} See Supplementary Table 2.

BMI: body mass index, CI: 95% confidence interval, TKA: total knee arthroplasty.

Supplementary Table S5. Mean translation (Tx, Ty, Tz, Total) (mm) and rotation (Rx, Ry, Rz, Total) (°) with CI in T-score groups for cemented UKA adjusted for BMI and age

Axis and follow-up	Low T-score ^a mean (CI)	Normal T-score mean (CI)	Difference mean (CI)
X-axis translation (Tx), mm			
1 year	0.12 (0.06 to 0.19)	0.09 (0.03 to 0.14)	0.04 (−0.05 to 0.12)
2 years	0.15 (0.08 to 0.22)	0.11 (0.04 to 0.17)	0.04 (−0.05 to 0.14)
5 years	0.21 (0.12 to 0.31)	0.11 (0.03 to 0.20)	0.10 (−0.02 to 0.23)
Y-axis translation (Ty), mm			
1 year	0.10 (0.02 to 0.18)	0.06 (−0.01 to 0.13)	0.04 (−0.06 to 0.15)
2 years	0.13 (0.03 to 0.21)	0.08 (0.00 to 0.16)	0.05 (−0.08 to 0.17)
5 years	0.13 (0.04 to 0.23)	0.11 (0.02 to 0.19)	0.03 (−0.10 to 0.16)
Z-axis translation (Tz), mm			
1 year	−0.04 (−0.11 to 0.04)	−0.03 (−0.09 to 0.04)	−0.01 (−0.11 to 0.09)
2 years	−0.05 (−0.12 to 0.02)	−0.04 (−0.10 to 0.02)	−0.01 (−0.11 to 0.08)
5 years	−0.04 (−0.14 to 0.06)	0.00 (−0.09 to 0.09)	−0.04 (−0.17 to 0.10)
Total translation (TT) ^b , mm			
1 year	0.29 (0.20 to 0.38)	0.35 (0.27 to 0.43)	−0.06 (−0.18 to 0.06)
2 years	0.32 (0.22 to 0.41)	0.38 (0.29 to 0.47)	−0.07 (−0.20 to 0.07)
5 years	0.36 (0.24 to 0.49)	0.48 (0.36 to 0.59)	−0.11 (−0.28 to 0.05)
X-axis rotation (Rx), °			
1 year	−0.17 (−0.31 to −0.03)	−0.23 (−0.36 to −0.11)	0.06 (−0.13 to 0.25)
2 years	−0.22 (−0.40 to −0.05)	−0.31 (−0.47 to −0.16)	0.09 (−0.14 to 0.32)
5 years	−0.28 (−0.47 to −0.10)	−0.27 (−0.43 to −0.10)	−0.02 (−0.27 to 0.23)
Y-axis rotation (Ry), °			
1 year	0.02 (−0.11 to 0.14)	0.06 (−0.05 to 0.18)	−0.05 (−0.22 to 0.13)
2 years	−0.01 (−0.14 to 0.11)	0.06 (−0.05 to 0.17)	−0.07 (−0.24 to 0.10)
5 years	−0.04 (−0.19 to 0.12)	−0.01 (−0.15 to 0.12)	−0.02 (−0.23 to 0.19)
Z-axis rotation (Rz), °			
1 year	−0.26 (−0.43 to −0.10)	−0.19 (−0.34 to −0.04)	−0.08 (−0.30 to 0.15)
2 years	−0.28 (−0.46 to −0.09)	−0.26 (−0.43 to −0.09)	−0.02 (−0.27 to 0.24)
5 years	−0.40 (−0.63 to −0.17)	−0.30 (−0.51 to −0.09)	−0.10 (−0.41 to 0.21)
Total rotation (TR) ^c , °			
1 year	0.67 (0.51 to 0.82)	0.80 (0.66 to 0.94)	−0.14 (−0.35 to 0.08)
2 years	0.67 (0.49 to 0.85)	0.94 (0.77 to 1.11)	−0.27 (−0.52 to −0.02)
5 years	0.35 (0.22 to 0.49)	0.49 (0.37 to 0.62)	−0.14 (−0.33 to 0.04)

^{a-c} See Supplementary Table 2.

BMI: body mass index, CI: 95% confidence interval, UKA: unicompartmental knee arthroplasty.

Supplementary Table S6. Number of patients with continuous migration.
Values are count

Factor	Continuous migration between 1 and 2 years (> 0.2 mm)	Continuous migration between 2 and 5 years (> 0.1 mm /year)
Cementless TKA (yes/no)	17 / 54	27 / 51
Cementless UKA (yes/no)	15 / 107	45 / 87
Cemented TKA (yes/no)	21 / 51	46 / 37
Cemented UKA (yes/no)	13 / 85	28 / 76

TKA: total knee arthroplasty, UKA: unicompartmental knee arthroplasty.