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Kazu Matsumoto

kmatsu@skhosp.or.jp

Gifu Seiryu Hospital

Daichi Ishimaru

Gifu Seiryu Hospital

Kazuki Sohmiya

Gifu Seiryu Hospital

Nobuo Terabayashi

Gifu Seiryu Hospital

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Association Between Final Intraoperative Medial Joint Laxity and One-Year Patient Satisfaction After ROSA-Assisted Medial Unicompartmental Knee Arthroplasty

Kazu Matsumoto.1*, Daichi Ishimaru 1,

Kazuki Sohmiya 1, Nobuo Terabayashi,1

1, Department of Orthopedic Surgery, Gifu Seiryu Hospital, Gifu,

3-25, Kawabe, Gifu City, Gifu, 501-1151, Japan.

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*Correspondence should be addressed to: Kazu Matsumoto, MD, PhD
Department of Orthopaedic Surgery, Gifu Seiryu Hospital, 3-25, Kawabe, Gifu City, Gifu, 501-1151, Japan.
Tel: +81(58)239-8111, Fax: +81(58)239-8216
E-mail: kmatsu@skhosp.or.jp

Abstract

Background: Robotic-assisted unicompartmental knee arthroplasty (UKA) provides intraoperative measurements of joint laxity, but the relationship between final medial joint laxity and postoperative patient satisfaction remains unclear. This study investigated the associations of medial joint laxity measured at 0° and 90° of knee flexion with one-year patient satisfaction after ROSA-assisted medial UKA.

Methods: This retrospective, single-center study included patients who underwent ROSA-assisted medial UKA between January 2024 and May 2025. The primary outcome was the Patient Satisfaction domain of the 2011 Knee Society Score (KSS) at one year postoperatively. Multivariable linear regression was performed in patients with complete data, with medial joint laxity at 0° and 90° included simultaneously and preoperative Patient Satisfaction included as a covariate. Heteroscedasticity-consistent HC3 robust standard errors were used. The difference between the regression coefficients at the two angles was also assessed. Secondary analyses examined the Symptoms, Patient Expectations, and Functional Activities domains.

Results: Ninety-five patients were included in the primary analysis. Greater medial joint laxity at 0° was associated with lower one-year Patient Satisfaction (regression

coefficient, −1.19 points/mm; 95% confidence interval [CI], −2.09 to −0.29; P = .009). Laxity at 90° was not significantly associated with Patient Satisfaction (−0.66 points/mm; 95% CI, −2.47 to 1.14; P = .473). The difference between the regression coefficients at 90° and 0° was not statistically significant (0.53 points/mm; 95% CI, −1.70 to 2.77; P = .640). No statistically significant associations were observed between laxity at either angle and the secondary KSS domains.

Conclusions: Greater final intraoperative medial joint laxity at 0° was associated with lower one-year Patient Satisfaction after ROSA-assisted medial UKA. However, the association did not differ significantly between measurements obtained at 0° and 90°. These findings suggest a potential relationship between extension-position medial laxity and patient satisfaction, but further prospective studies using standardized measurements are needed to confirm the findings and establish their clinical significance.

Keywords: unicompartmental knee arthroplasty; robotic-assisted surgery; ROSA; medial joint laxity; patient satisfaction; Knee Society Score

Introduction

Unicompartmental knee arthroplasty (UKA) is an established surgical treatment for patients with symptomatic osteoarthritis confined to a single tibiofemoral compartment [1-5]. Compared with total knee arthroplasty, UKA preserves more native knee structures and may provide functional advantages in appropriately selected patients [5-8]. Nevertheless, postoperative outcomes vary, and achieving appropriate implant positioning and soft-tissue balance remains an important consideration.

Robotic-assisted surgical systems, including the ROSA Knee System, provide quantitative information that can support intraoperative assessment and surgical planning [9-13]. In particular, measurements of joint laxity at different knee flexion angles may help characterize the final soft-tissue balance following implant positioning. Despite these technological advances, the relationship between intraoperative laxity measurements and subsequent patient-reported outcomes remains incompletely understood.

Previous research has examined the relationship between intraoperative laxity patterns and clinical outcomes following robotic-assisted medial UKA [14-17]. Innocenti et al. [14] reported no significant differences in patient-reported outcomes among groups with different intraoperative laxity patterns following robotic-assisted medial UKA.

However, further investigation of the association between laxity measured at specific knee positions and individual patient-reported outcome domains may provide additional insight.

The purpose of this study was to investigate the association between final intraoperative medial joint laxity measured at 0° and 90° of knee flexion and one-year postoperative outcomes following ROSA-assisted medial UKA. The primary outcome was the Patient Satisfaction domain of the 2011 Knee Society Score (KSS) [18]. Secondary outcomes included Symptoms, Patient Expectations, and the Functional Activities subdomains. We hypothesized that final intraoperative medial joint laxity would be associated with one-year postoperative patient satisfaction.

Materials and Methods

Study Design and Patients

This retrospective, single-center observational study included patients who underwent ROSA-assisted medial UKA at our institution between January 2024 and May 2025.

A total of 106 patient records were available for review. Patients were included in each analysis when the relevant intraoperative laxity measurements and preoperative and postoperative KSS domain scores were available. Because data completeness varied across outcome domains, the number of patients included in each analysis differed. We showed the flowchart of patient inclusion and analysis in **Figure 1**.

The study was approved by the institutional review board of our institution (approval number: #071).

Intraoperative Medial Joint Laxity

All procedures were performed using a robotic-assisted surgical system (ROSA®, Zimmer Biomet, Warsaw, IN, USA), with two experienced surgeons involved in the procedures. A standard medial parapatellar approach was used, and medial UKA was performed in all cases as described previously [19, 20].

Intraoperative medial joint space measurements were obtained using the ROSA Knee System. The recorded variables were “Extension: Medial space [mm]” and “Flexion: Medial space [mm],” corresponding to measurements obtained at 0° and 90° of knee flexion, respectively.

Measurements were obtained during final trialing, with the planned components and insert in place. The operating surgeon manually applied varus and valgus stress while assessing the knee through a range of motion of approximately 0° to 120° of flexion. The applied stress was not quantitatively standardized. For each knee, the single value recorded at the final trialing stage was used for the corresponding analysis at 0° and 90° of flexion.

Inter-rater Reliability

Inter-rater reliability of final intraoperative medial joint laxity measurements was evaluated at 0° and 90° of knee flexion. Measurements were obtained during final trialing, with the trial components and an insert of the size intended for implantation in place. The intraclass correlation coefficient (ICC) was used to assess agreement between the two examiners. The 95% confidence intervals (CIs) were estimated using a subject-level bootstrap procedure with 20,000 resamples and the percentile method.

Outcome Measures

The primary outcome was the Patient Satisfaction domain (domain II) of the 2011 Knee Society Score (KSS) at one year after surgery.

Secondary outcomes included Symptoms (domain I), Patient Expectations (domain III), and the four Functional Activities subdomains: walking and standing (domain IV [1]), standard activities (domain IV [2]), advanced activities (domain IV [3]), and discretionary activities (domain IV [4]). Each domain and subdomain were analyzed separately, and no overall composite score was calculated.

Preoperative and postoperative Patient Satisfaction were assessed using the same set of questions and the standard 2011 KSS scoring method, with a maximum possible score of 40 points at both time points. The preoperative Patient Satisfaction score was included as a covariate in the primary regression model. The corresponding preoperative score was included as a covariate in each secondary analysis where available.

Statistical Analysis

Descriptive statistics were used to summarize the study population and study variables. The primary analysis evaluated the association between final intraoperative medial joint laxity at 0° and 90° of knee flexion and one-year postoperative Patient Satisfaction.

To compare the associations between medial joint laxity and one-year Patient Satisfaction at 0° and 90° of knee flexion, the difference between the corresponding regression coefficients (90° minus 0°) was estimated from the primary regression

model. The 95% confidence interval and P value for this contrast were calculated using the HC3 heteroscedasticity-consistent robust covariance matrix.

Multivariable linear regression was performed with the one-year postoperative Patient Satisfaction score as the dependent variable. Medial joint laxity at 0° and 90° was entered simultaneously as the primary set of explanatory variables, and the preoperative Patient Satisfaction score was included as a covariate. This model estimated the association of laxity at each angle with postoperative satisfaction while accounting for the other angle and preoperative satisfaction.

Secondary analyses used separate multivariable linear regression models to examine the associations between laxity at 0° and 90° and each secondary KSS domain or subdomain. The corresponding preoperative score was included as a covariate where available.

Heteroscedasticity-consistent HC3 robust standard errors were used to calculate 95% confidence intervals (CIs) and *P* values. Analyses were conducted using complete cases for each model. All tests were two-sided. A *P* value of less than .05 was considered statistically significant for the primary analysis. Secondary analyses were considered

exploratory, and their results were interpreted cautiously because of the number of outcomes evaluated.

Results

Patient Characteristics

A total of 106 patient records were available for analysis. The mean age was 72.8 ± 7.0 years (range, 53–90 years). Mean height, weight, and body mass index (BMI) were 158.2 ± 8.7 cm, 63.7 ± 12.3 kg, and 25.3 ± 3.5 kg/m², respectively. The affected side was equally distributed between the left and right knees, with 53 cases (50.0%) on each side. The recorded diagnoses were osteoarthritis in 88 cases (83.0%) and idiopathic osteonecrosis (ION) in 18 cases (17.0%). Among the 106 patients with available preoperative radiographic data, 61 (57.5%) had Kellgren–Lawrence grade 3 and 45 (42.5%) had grade 4. The preoperative clinical characteristics, KSS domain scores, and final intraoperative medial joint laxity measurements are summarized in **Table 1**.

Inter-rater Reliability

Inter-rater reliability analysis included 46 cases with measurements available from both examiners. The ICC was 0.727 (95% CI, 0.445–0.900) for final intraoperative medial

joint laxity measurements at 0° of knee flexion and 0.611 (95% CI, 0.240–0.818) at 90° of knee flexion.

Primary Outcome: Patient Satisfaction

The primary analysis included 95 patients with complete data. After adjustment for preoperative Patient Satisfaction and medial joint laxity at the other knee flexion angle, greater final intraoperative medial joint laxity at 0° was significantly associated with lower one-year postoperative Patient Satisfaction (B, −1.19 points/mm; 95% CI, −2.09 to −0.29; P = .009). In contrast, medial joint laxity at 90° was not significantly associated with postoperative Patient Satisfaction (B, −0.66 points/mm; 95% CI, −2.47 to 1.14; P = .473). The model had an R^2 of 0.064 (**Figure 2, Table 2**).

In an exploratory analysis using the 95 patients with complete data, the difference between the regression coefficients for medial joint laxity at 90° and 0° was 0.53 points/mm (95% CI, −1.70 to 2.77; P = .640). This difference was not statistically significant, providing insufficient evidence that the association between medial joint laxity and one-year postoperative Patient Satisfaction differed between the two knee flexion angles.

Secondary Outcomes

No statistically significant associations were observed between final intraoperative medial joint laxity at either 0° or 90° and any of the secondary KSS domains after adjustment for the corresponding preoperative score and laxity at the other angle. These outcomes included Symptoms, Patient Expectations, Walking and Standing, Standard Activities, Advanced Activities, and Discretionary Activities. All associations had P values greater than .05. The number of patients included in each analysis ranged from 72 to 95 (**Table 3**).

Discussion

The principal finding of this study was that greater final intraoperative medial joint laxity at 0° of knee flexion was associated with lower Patient Satisfaction scores one year after ROSA-assisted medial UKA, even after adjustment for preoperative Patient Satisfaction and medial joint laxity at 90°. In contrast, medial joint laxity at 90° was not significantly associated with postoperative Patient Satisfaction. Furthermore, neither measurement was significantly associated with the secondary KSS domains, including Symptoms, Patient Expectations, and the Functional Activities subdomains. These findings suggest that the association between intraoperative medial joint laxity and postoperative patient

satisfaction may vary according to the knee position at which the measurement is obtained. However, the direct comparison of the regression coefficients at 0° and 90° did not demonstrate a statistically significant difference. Therefore, the present findings do not establish that extension-position laxity has a stronger association with satisfaction than flexion-position laxity.

Previous research has investigated the relationship between intraoperative joint laxity patterns and clinical outcomes after robotic-assisted medial UKA. Innocenti et al. evaluated 326 fixed-bearing robotic-assisted medial UKA procedures and classified patients according to intraoperative joint-gap measurements under valgus stress at several knee flexion angles. They found no significant differences in preoperative or postoperative patient-reported outcome measures among the laxity-pattern groups [14]. The findings of the present study provide a complementary perspective by examining medial joint laxity at 0° and 90° as continuous variables and focusing primarily on the Patient Satisfaction domain at one year. Differences in the measurement angles, definitions of laxity, grouping strategies, follow-up periods, and outcome measures may partly explain the different findings. Nevertheless, both studies highlight the complexity of the relationship between intraoperative soft-tissue balance and postoperative patient-reported outcomes. The present findings should therefore be interpreted as an additional

observation that requires confirmation rather than as evidence that a particular intraoperative laxity pattern necessarily determines postoperative satisfaction.

One possible explanation for the observed association at 0° is that the medial compartment gap measured in full extension reflects aspects of the final soft-tissue balance that may be relevant to postoperative knee comfort and function. In contrast, the gap measured at 90° reflects a different flexion-position relationship between the femoral component and the tibial insert. These measurements may capture different aspects of the reconstructed knee. However, the present study did not directly assess postoperative kinematics, ligament tension, or the mechanisms linking the measured gaps to patient experience. Accordingly, any explanation based on differences between extension and flexion should be regarded as hypothetical. In addition, because the measurements were obtained during manual stress testing, the recorded values may reflect both the mechanical properties of the knee and the manner in which stress was applied. The precise interpretation of each measurement therefore depends on the stress condition and the gap value recorded by the robotic system.

Patient satisfaction is an important outcome after knee arthroplasty [21-23], but it is influenced by multiple factors and does not represent a purely mechanical measure of

knee function. The 2011 KSS Patient Satisfaction domain assesses patients' perceptions of pain and knee function during selected activities. Previous research in total knee arthroplasty has demonstrated correlations between this satisfaction domain and other patient-reported measures, including the Symptoms, Expectations, and Functional Activities domains of the KSS [24-26]. These findings support the clinical relevance of assessing satisfaction while also emphasizing that satisfaction reflects a broader patient experience. In the present study, the association between extension-position laxity and satisfaction was not accompanied by statistically significant associations with the secondary KSS domains. This may indicate that the relationship is not readily captured by the other domains evaluated, although the sample sizes and statistical power of the secondary analyses must also be considered.

The clinical implications of the present findings should be interpreted cautiously. The regression coefficient for medial joint laxity at 0° was −1.19 points/mm, suggesting that a 1-mm increase in the recorded measurement was associated with a 1.19-point lower Patient Satisfaction score, conditional on the other variables in the model. However, the model explained a relatively small proportion of the variation in postoperative satisfaction ($R^2 = 0.064$). The observed association may therefore represent only one component of a multifactorial postoperative outcome. The present analysis does not

identify an optimal target gap, establish a clinically meaningful threshold, or demonstrate that changing intraoperative laxity would improve patient satisfaction. It would be premature to recommend a specific extension-gap target based solely on these results.

The absence of statistically significant associations with the secondary KSS domains also warrants careful interpretation. These analyses included fewer patients than the primary analysis, particularly for Discretionary Activities, and may have had limited power to detect modest associations. Moreover, the secondary outcomes were exploratory and involved multiple comparisons. The lack of statistical significance should not be interpreted as proof that intraoperative laxity is unrelated to symptoms, expectations, or functional activities. Instead, these findings indicate that a consistent association across all measured KSS domains was not demonstrated in this cohort.

Several limitations should be acknowledged. First, the retrospective, single-center design limits generalizability and precludes causal conclusions. Second, although 106 patient records were available, only 95 patients had complete data for the primary analysis, and the sample sizes for the secondary analyses ranged from 72 to 95. Missing data may have introduced selection bias if the availability of outcome measurements

was related to patient characteristics or clinical outcomes. Third, the primary model adjusted for preoperative Patient Satisfaction and laxity at the other angle, but did not account for all potential confounders, such as patient characteristics, preoperative deformity, component positioning, or other surgical factors. Residual confounding therefore remains possible.

Fourth, medial compartment gap measurements were obtained during manually applied stress testing by the operating surgeons. If the applied force was not quantitatively standardized, variability in the applied stress may have influenced the recorded values. Although inter-rater reliability was assessed in 46 cases, the confidence intervals of the ICC estimates were relatively wide, indicating uncertainty in the reliability estimates. Further studies using standardized stress application and measurement protocols are warranted to confirm the reproducibility of intraoperative laxity measurements. Finally, outcomes were assessed at one year after surgery. Longer follow-up is needed to determine whether the observed association persists and whether it is related to subsequent functional outcomes or implant survival.

Despite these limitations, the present study provides an angle-specific assessment of the association between final intraoperative medial joint laxity and patient satisfaction after ROSA-assisted medial UKA. The use of continuous laxity measurements and adjustment

for preoperative Patient Satisfaction allowed evaluation of the association beyond postoperative satisfaction alone. Future prospective, preferably multicenter studies should use clearly defined and standardized intraoperative gap measurements, consider potential patient and surgical confounders, and assess patient-reported outcomes at multiple follow-up intervals. Larger studies are also needed to determine more precisely whether the associations between intraoperative medial joint laxity and postoperative outcomes differ between knee flexion angles. Such studies may clarify whether specific aspects of intraoperative medial compartment balance can provide clinically useful information for optimizing patient-reported outcomes after robotic-assisted medial UKA.

Conclusion

Greater final intraoperative medial joint laxity at 0° was associated with lower one-year postoperative Patient Satisfaction after ROSA-assisted medial UKA, whereas laxity at 90° was not significantly associated with satisfaction. No statistically significant associations were identified between laxity at either angle and the secondary KSS domains. These findings suggest that extension-position laxity may be relevant to postoperative patient satisfaction, although prospective studies are needed to confirm the association and determine its clinical significance.

References

1. Kyriakidis T, Asopa V, Baums M, Verdonk R, Totlis T. Unicompartmental knee arthroplasty in patients under the age of 60 years provides excellent clinical outcomes and 10-year implant survival: a systematic review: A study performed by the Early Osteoarthritis group of ESSKA-European Knee Associates section. Knee Surg Sports Traumatol Arthrosc. 2023 Mar;31(3):922-932. doi: 10.1007/s00167-022-07029-9. Epub 2022 Jun 28. PMID: 35763042

2. Plancher KD, Voigt C, Bernstein DN, Briggs KK, Petterson SC. Return to Sport in Middle-aged and Older Athletes After Unicompartmental Knee Arthroplasty at a Mean 10-Year Follow-up: Radiographic and Clinical Outcomes. Am J Sports Med. 2023 Jun;51(7):1799-1807. doi: 10.1177/03635465231163859. Epub 2023 Apr 24. PMID: 37092711.

3. Bayoumi T, Kleeblad LJ, Borus TA, Coon TM, Dounchis J, Nguyen JT, Pearle AD. Ten-Year Survivorship and Patient Satisfaction Following Robotic-Arm-Assisted Medial Unicompartmental Knee Arthroplasty: A Prospective Multicenter Study. J Bone Joint Surg Am. 2023 Jun 21;105(12):933-942. doi: 10.2106/JBJS.22.01104. Epub 2023 May 5. PMID: 37146125.

4. Di Martino A, Bordini B, Barile F, Ancarani C, Digennaro V, Faldini C.

Unicompartmental knee arthroplasty has higher revisions than total knee arthroplasty at long term follow-up: a registry study on 6453 prostheses. Knee Surg Sports Traumatol Arthrosc. 2021 Oct;29(10):3323-3329. doi: 10.1007/s00167-020-06184-1. Epub 2020 Aug 1. PMID: 32740877; PMCID: PMC8458185.

5. Burgio C, Bosco F, Cobisi C, Zepeda K, Giustra F, Capella M, Mayman D, Debbi E, Vigdorchik J. Surgical treatment of varus unicompartmental knee osteoarthritis: indications, trends, and outcomes-a narrative review. Arch Orthop Trauma Surg. 2026 Jun 18;146(1):227. doi: 10.1007/s00402-026-06388-z. PMID: 42315761; PMCID: PMC13279471.

6. Brilliant ZR, Garvey MD, Haffner R, Chiu YF, Mayman DJ, Blevins JL. Unicompartmental Knee Arthroplasty Patients Have Lower Joint Awareness and Higher Function at 5 Years Compared to Total Knee Arthroplasties: A Matched Comparison. J Arthroplasty. 2023 38(8):1464-1469. doi: 10.1016/j.arth.2023.01.063. Epub 2023 Feb 9. PMID: 36764405

7. Hariri M, Sorbi R, Moradi B, Weishorn J, Trefzer R, Reiner T, Walker T, Nees TA. Patient-reported outcomes after lateral unicompartmental and total knee arthroplasty: a propensity score-matched cohort study. Arch Orthop Trauma Surg. 2026 Aug 28;146(1):318. doi: 10.1007/s00402-026-06491-1. PMID: 42663698

8. Deng M, Hu Y, Zhang Z, Zhang H, Qu Y, Shao G. Unicondylar knee replacement versus total knee replacement for the treatment of medial knee osteoarthritis: a systematic review and meta-analysis. Arch Orthop Trauma Surg. 2021 Aug;141(8):1361-1372. doi: 10.1007/s00402-021-03790-7. Epub 2021 Jan 29. PMID: 33512583

9. Möller A, Kasabji F, Fischer M, Schoon J, Hofer A, Wassilew GI, Reichert JC. Improved surgical accuracy in total knee arthroplasty using the ROSA knee system: A randomised-controlled unblinded trial. Knee Surg Sports Traumatol Arthrosc. 2026 Aug;34(8):2897-2905. doi: 10.1002/ksa.70197. Epub 2025 Dec 1. PMID: 41324474

10. Lonner JH, Seidenstein AD, Charters MA, North WT, Cafferky NL, Durbhakula SM, Kamath AF. Improved accuracy and reproducibility of a novel CT-free robotic surgical assistant for medial unicompartmental knee arthroplasty compared to conventional instrumentation: a cadaveric study. Knee Surg Sports Traumatol Arthrosc. 2022 Aug;30(8):2759-2767. doi: 10.1007/s00167-021-06626-4. Epub 2021 Jun 13. PMID: 34120210

11. Hasegawa M, Tone S, Naito Y, Sudo A. Comparison of accuracy and early outcomes in robotic total knee arthroplasty using NAVIO and ROSA. Sci Rep. 2024 Feb 8;14(1):3192. doi: 10.1038/s41598-024-53789-4. PMID: 38326363

12. Kishi H, Nishiyama D, Fukui D, Yamanaka M, Yamada H. Interobserver Variability of Intraoperative Soft Tissue Laxity Assessment in Robotic-Assisted Total Knee Arthroplasty Using the ROSA System. J Knee Surg. 2026 Jul 16. doi: 10.1055/a-2908-1899. Epub ahead of print. PMID: 42413535.

13. St Mart JP, Goh EL, Goudie E, Crawford R, English H, Donnelly W. Clinical and radiological outcomes of robotic-assisted unicompartmental knee arthroplasty: Early lessons from the first 100 consecutive knees in 85 patients. Knee. 2022 Jan;34:195-205. doi: 10.1016/j.knee.2021.11.016. Epub 2021 Dec 29. PMID: 34973482.

14. Innocenti M, Leggieri F, Theus-Steinman C, Moya-Angeler J, Christen B, Calliess T. Different intraoperative joint laxity patterns do not impact clinical outcomes in robotic-assisted medial unicompartmental knee replacement with 1-to-1 surface reconstruction. Knee Surg Sports Traumatol Arthrosc. 2024 Dec;32(12):3299-3307. doi: 10.1002/ksa.12415. Epub 2024 Aug 8. PMID: 39113616

15. Zambianchi F, Franceschi G, Rivi E, Banchelli F, Marcovigi A, Nardacchione R, Ensini A, Catani F. Does component placement affect short-term clinical outcome in robotic-arm assisted unicompartmental knee arthroplasty? Bone Joint J. 2019 Apr;101-B(4):435-442. doi: 10.1302/0301-620X.101B4.BJJ-2018-0753.R1. PMID: 30929494

16. Li T, Kong X, Yang M, Cao Z, Li X, Li H, Nan S, Chai W. Robotic arm-assisted versus conventional jig-based unicompartmental knee arthroplasty achieves better soft-tissue balance : a unicompartmental pressure sensor study. Bone Joint J. 2026 Mar 1;108-B(3):302-309. doi: 10.1302/0301-620X.108B3.BJJ-2025-0090.R3. PMID: 41763248

17. Zambianchi F, Franceschi G, Banchelli F, Marcovigi A, Ensini A, Catani F. Robotic Arm-Assisted Lateral Unicompartmental Knee Arthroplasty: How Are Components Aligned? J Knee Surg. 2022 Sep;35(11):1214-1222. doi: 10.1055/s-0040-1722346. Epub 2021 Jan 28. PMID: 33511590.

18. Scuderi GR, Bourne RB, Noble PC, Benjamin JB, Lonner JH, Scott WN. The new Knee Society Knee Scoring System. Clin Orthop Relat Res. 2012 Jan;470(1):3-19. doi: 10.1007/s11999-011-2135-0. PMID: 22045067; PMCID: PMC3237971.

19. Matsumoto K, Ishimaru D, Sohmiya K, Terabayashi N. Impact of femoral component flexion on implant sizing in unicompartmental knee arthroplasty: A three-dimensional computed tomography-based simulation study. Journal of Joint Surgery and Research. 3(4), December 2025, Pages 233-238. https://doi.org/10.1016/j.jjoisr.2025.09.006

20. Ishimaru, Daichi et al. “Tendency of Tibial Component Placement and Short-Term

Outcomes in ROSA-Assisted Unicompartmental Knee Arthroplasty Using the Persona Partial Knee System." Arthroplasty today vol. 37 101938. 8 Jan. 2026, doi:10.1016/j.artd.2025.101938

21. DeFrance, Michael J, and Giles R Scuderi. "Are 20% of Patients Actually Dissatisfied Following Total Knee Arthroplasty? A Systematic Review of the Literature." The Journal of arthroplasty vol. 38,3 (2023): 594-599. doi:10.1016/j.arth.2022.10.011

22. Singh M, Harary J, Schilling PL, Moschetti WE. Patient Satisfaction Is Nearly 90% After Total Knee Arthroplasty; We Are Better Than We Were. J Arthroplasty. 2025 Jun;40(6):1521-1525.e1. doi: 10.1016/j.arth.2024.11.038. Epub 2024 Nov 22. PMID: 39581239.

23. Khatib Y, Badge H, Xuan W, Naylor JM, Harris IA. Patient satisfaction and perception of success after total knee arthroplasty are more strongly associated with patient factors and complications than surgical or anaesthetic factors. Knee Surg Sports Traumatol Arthrosc. 2020 Oct;28(10):3156-3163. doi: 10.1007/s00167-019-05804-9. Epub 2020 Jan 6. PMID: 31907553.

24. Tachibana S, Muratsu H, Tsubosaka M, Maruo A, Miya H, Kuroda R, Matsumoto T. Evaluation of consistency of patient-satisfaction score in the 2011 Knee Society

Score to other patient-reported outcome measures. J Orthop Sci. 2022;27(3):652–657. doi:10.1016/j.jos.2021.02.007.

25. Kuroda Y, Matsumoto T, Takayama K, Ishida K, Kuroda R, Kurosaka M. Subjective evaluation before and after total knee arthroplasty using the 2011 Knee Society Score. Knee. 2016 Dec;23(6):964-967. doi: 10.1016/j.knee.2016.06.008. Epub 2016 Oct 29. PMID: 27802922.

26. Nishitani K, Yamamoto Y, Hamada D, Ito H, Nakamura S, Kuriyama S, Matsuda S. Patient acceptable symptom state for New Knee Society Score after primary total knee arthroplasty. J Orthop Sci. 2026 May;31(3):609-613. doi: 10.1016/j.jos.2025.10.004. Epub 2025 Oct 28. PMID: 41152048.

Figure Legends

Figure 1. Flowchart of patient inclusion and analysis. The flowchart summarizes the number of patients included in the study and the number available for the primary and secondary analyses.

Figure 2. Adjusted associations between final intraoperative medial joint laxity at 0° and

90° of knee flexion and one-year postoperative Patient Satisfaction. The regression coefficients were adjusted for preoperative Patient Satisfaction and medial joint laxity at the other angle. HC3 heteroscedasticity-consistent robust standard errors were used.

Abbreviations

HC3, heteroscedasticity-consistent standard errors (HC3); KSS, Knee Society Score; ROSA, Robotic Surgical Assistant; UKA, unicompartmental knee arthroplasty.

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Gifu Seiryu Hospital (Approval No. #071). The requirement for written informed consent was waived by the ethics committee because of the retrospective nature of the study and the use of routinely collected clinical data. Instead, an opt-out approach was adopted, whereby information regarding the study was made publicly available and patients were given the opportunity to decline participation. All data were anonymized prior to analysis.

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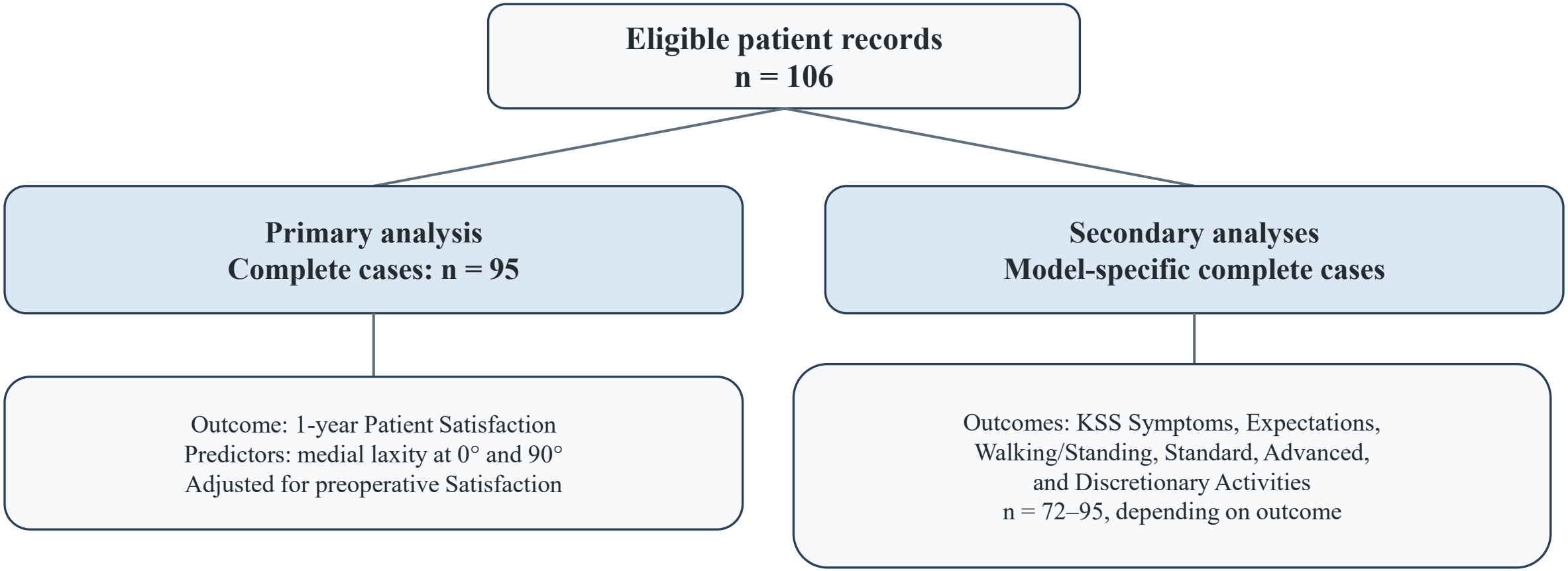
Competing interests

The authors declare that they have no competing interests.

Trial registration

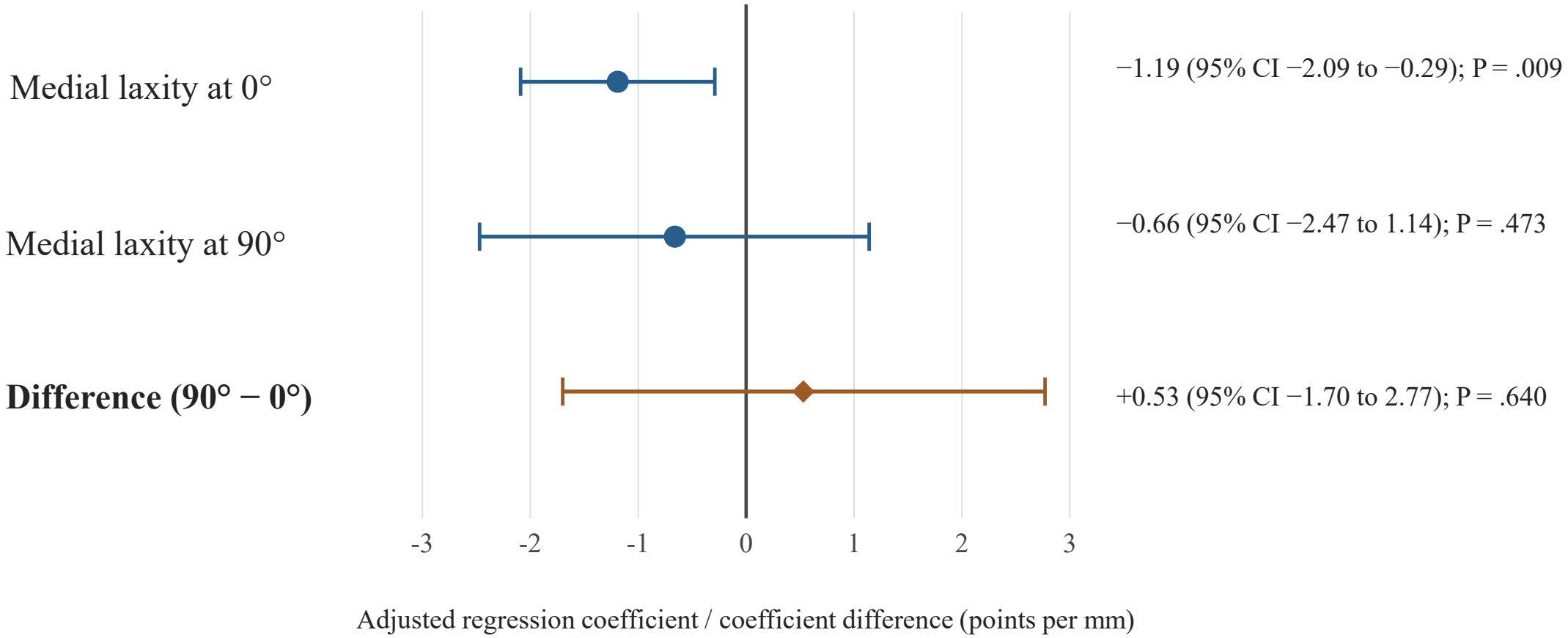
Not applicable. This study was a retrospective observational study and did not involve a clinical trial.

Figure 1. Patient flow and analysis populations



Note: Separate complete-case models were fitted because of missing data. Each secondary model was adjusted for the corresponding preoperative domain score and laxity at both angles.

Figure 2. Adjusted associations between medial laxity and 1-year Patient Satisfaction



Primary model: n = 95; R^2 = 0.064. The 0° and 90° laxity terms were entered simultaneously and adjusted for preoperative Patient Satisfaction. HC3 heteroscedasticity-consistent robust standard errors were used.

The contrast is the regression coefficient at 90° minus that at 0°. Its confidence interval includes zero; the data do not demonstrate a statistically significant difference between angles. Negative coefficients indicate lower 1-year Satisfaction scores with greater laxity.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- 261022TablesKSRR.pptx