Faculty Disclosure Information

- **Nothing to disclosure.**

- **All the authors contributed to the design, analyses and reporting for this manuscript. Both authors read and approved the final submitted manuscript.**

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INTRODUCTION

- In the United States, it is projected that by 2030, TKA surgeries will increase by 673%.

- Malalignment >3° has been identified in up to one-third of patients undergoing conventional TKA, potentially causing pain and instability.

- Inappropriate bone resection can result in suboptimal TKA component positioning, leading to component malalignment.

- Robotic assistance (RA) has proven effective in various areas, achieving precision of up to 0.05 mm.

INTRODUCTION

- Based on 3D CT scan, the robotic arm-assisted system is designed to minimize the margin of error associated with bone resection and to provide real-time guidance for intraoperative TKA component positioning

- Moreover, the system provides the ability to accurately predict implant size preoperatively, which can improve operative efficiency.

- Therefore, the aim of our study was to evaluate the predictive accuracy of the RA-TKA system in determining required bone resections and implant sizing before surgery, as well as to assess its influence on intraoperative decision-making.

METHODS

- Prospective review was conducted on a cohort of patients who underwent RA-TKA between November 2023 and May 2024.

- A patient-specific alignment philosophy was employed within a safe range. All patients received a posterior-stabilized (PS) implant.

- The following outcomes were evaluated: difference between the planned and final bone resections and coronal limb alignment of the knee; predicted and actual bone resections.

- We also compared the implant size predicted preoperatively to the actual implant size used.

RESULTS

Demographic Characteristics	N=40 (100%)
Female	28 (70%)
Age (SD)	70.6 (9.5)
BMI	29.0 (3.7)
Left Laterality	21 (52.5)

Component Size (N=40)	
Femoral implant	
Perfect estimation	36 (90.0)
Overestimation	3 (7.5)
Underestimation	1 (2.5)
Tibial implant	
Perfect estimation	30 (75.0)
Overestimation	10 (25.0)
Underestimation	0 (0)
Insert	
Perfect estimation	30 (75.0)
Overestimation	1 (2.5)
Underestimation	9 (22.5)

RESULTS

Location	Predicted (mm) mean (SD)	Actual (mm) mean (SD)	Difference (mm) mean (IC 95%)	p-value
Lateral femoral	4.5 (1.8)	3.4 (2.0)	1.1 (0.3-2.0)	0.01*
Medial femoral	8.0 (0.3)	6.8 (1.2)	1.2 (0.8-1.6)	<0.001*
Lateral posterior condyle	5.8 (1.7)	4.9 (1.6)	0.8 (0.1-1.6)	0.03*
Medial posterior condyle	8.1 (0.7)	8.0 (1.5)	0.1 (-0.4-0.7)	0.63
Lateral tibial plateau	6.6 (0.8)	5.6 (1.1)	1.0 (0.5-1.4)	<0.001*
Medial tibial plateau	4.0 (1.4)	3.6 (1.2)	0.5 (-0.1-1.01)	0.09
*denotes statistical significance (p<0.05)				

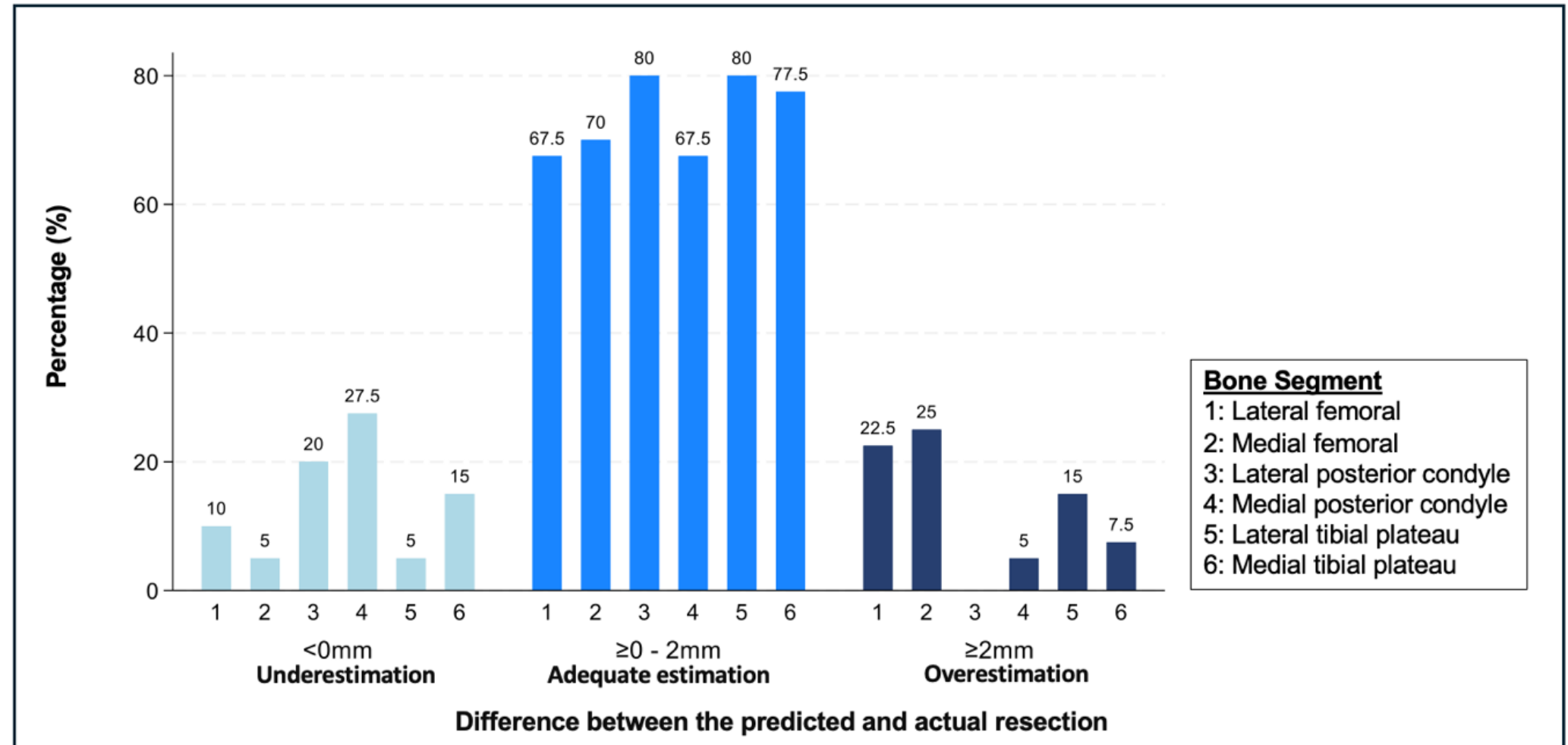Summary of the actual bone resection compared to the predicted.

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RESULTS

The distribution of absolute difference between the preoperative prediction and the actual bone resection.

DISCUSSION

- The main finding of this study supports the use of the RA-TKA system for precise preoperative planning, particularly in predicting bone resection, implant size, and ensuring optimal postoperative alignment.

- The difference between the predicted and actual femoral and tibial bone resections was < 2 mm in 210 (87.5%) of our cases.

- Our findings reported high accuracy in both femoral and tibial bone resections, with 94% of actual cuts deviating less than 1 mm from the predicted cuts.

CONCLUSION

- The RA-TKA system, which uses three-dimensional (3D) CT reconstructions for manipulation, visualization, and surgical planning, provides highly accurate guidance for total knee arthroplasty (TKA). By enabling precise and reproducible bone resections, optimal component positioning, and accurate postoperative alignment, RA-TKA improves surgical outcomes and consistency.

- Furthermore, it reflects a growing trend toward intelligent systems in orthopedic procedures, enhancing both procedural precision and surgeon confidence.

REFERENCES

1. Ben-Shlomo Y, Blom A, Boulton C, et al. The National Joint Registry 17th Annual Report 2020 [Internet]. London: National Joint Registry; 2020 Sep. Available from: https://www.ncbi.nlm.nih.gov/books/NBK566660/

2. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am. 2007 Apr;89(4):780-5. doi: 10.2106/JBJS.F.00222. PMID: 17403800.

3. Gunaratne R, Pratt DN, Banda J, Fick DP, Khan RJK, Robertson BW. Patient Dissatisfaction Following Total Knee Arthroplasty: A Systematic Review of the Literature. J Arthroplasty. 2017 Dec;32(12):3854-3860. doi: 10.1016/j.arth.2017.07.021. Epub 2017 Jul 21. PMID: 28844632.

4. Mason JB, Fehring TK, Estok R, Banel D, Fahrbach K. Meta-analysis of alignment outcomes in computer-assisted total knee arthroplasty surgery. J Arthroplasty. 2007 Dec;22(8):1097-106. doi: 10.1016/j.arth.2007.08.001. PMID: 18078876.

5. Liu HX, Shang P, Ying XZ, Zhang Y. Shorter survival rate in varus-aligned knees after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2016 Aug;24(8):2663-71. doi: 10.1007/s00167-015-3781-7. Epub 2015 Sep 16. PMID: 26377095.

6. Domb BG, Redmond JM, Louis SS, Alden KJ, Daley RJ, LaReau JM, Petrakos AE, Gui C, Suarez-Ahedo C. Accuracy of Component Positioning in 1980 Total Hip Arthroplasties: A Comparative Analysis by Surgical Technique and Mode of Guidance. J Arthroplasty. 2015 Dec;30(12):2208-18. doi: 10.1016/j.arth.2015.06.059. Epub 2015 Jul 2. PMID: 26282499.

7. 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 Jul;32(7):642-648. doi: 10.1055/s-0038-1666829. Epub 2018 Aug 1. PMID: 30068010.

8. Rossi SMP, Ivone A, Ghiara M, Jannelli E, Sangaletti R, Perticarini L, Benazzo F. A ligament tensor-guided extramedullary alignment technique for distal femoral cut in total knee replacement: results at a minimum 3 years follow-up. Arch Orthop Trauma Surg. 2021 Dec;141(12):2295-2302. doi: 10.1007/s00402-021-04115-4. Epub 2021 Aug 12. PMID: 34386837.

9. Ritter MA, Davis KE, Meding JB, Pierson JL, Berend ME, Malinzak RA. The effect of alignment and BMI on failure of total knee replacement. J Bone Joint Surg Am. 2011 Sep 7;93(17):1588-96. doi: 10.2106/JBJS.J.00772. PMID: 21915573.

10. Hadi M, Barlow T, Ahmed I, Dunbar M, McCulloch P, Griffin D. Does malalignment affect revision rate in total knee replacements: a systematic review of the literature. Springerplus. 2015 Dec 30;4:835. doi: 10.1186/s40064-015-1604-4. PMID: 26753122; PMCID: PMC4695472.

11. Hockstein NG, Gourin CG, Faust RA, Terris DJ. A history of robots: from science fiction to surgical robotics. J Robot Surg. 2007;1(2):113-8. doi: 10.1007/s11701-007-0021-2. Epub 2007 Mar 17. PMID: 25484946; PMCID: PMC4247417.

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