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Machine Learning Algorithms Identify Optimal Sagittal Component Position in Total Knee Arthroplasty

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Introduction: Advanced technologies, like robotics, provide enhanced accuracy and precision implanting total knee arthroplasty (TKA); however, the optimal target for implant position specifically in the sagittal plane does not exist. This study identified implant position in the sagittal plane which may correlate with improved outcomes using advanced modeling techniques.

Methods: A retrospective review of 1,091 consecutive TKAs was performed. All TKAs were PCL retaining or sacrificing with anterior lipped (49.4%) or conforming bearings (50.6%) performed with modern perioperative protocols. Preoperative and postoperative tibial slope and postoperative femoral component flexion were measured with standardized radiographic protocols. Patients were grouped by satisfaction at latest follow-up, and asked the question: "How often does your knee feel normal?" Support vector machine (SVM) learning algorithms were used to identify optimal sagittal alignment zones correlated with satisfaction and knees always feeling normal.

Results: Mean age and BMI were 66 years and 34 kg/m2 with 67% being female. PCL status and bearing type did not affect outcomes ($p \geq 0.249$) with numbers available. Patients whose tibial component slope more closely approximated native slope demonstrated higher satisfaction and greater numbers whose knee always felt normal ($p=0.046$). Femoral flexion alone did not impact these metrics with numbers available ($p=0.268$). However, change in tibial slope closer to native (±10°) in combination with femoral flexion up to 15° correlated with improved satisfaction and knees always feeling normal. Worst outcomes were associated with excessive femoral flexion >15° or any femoral component extension and/or adding or removing >10° of native tibial slope.

Conclusions: Superior patient-reported outcomes correlated with approximating native tibial slope and incorporating some femoral flexion. Deviation from native tibial slope and excessive femoral flexion or any femoral component extension correlated with worse outcomes. Further study is warranted to externally validate and elucidate the effects of sagittal alignment on other outcomes.

Notes