Can Patient Demographic Data Be Used to Predict the Size of TKA Tibial and Femoral Components

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Introduction

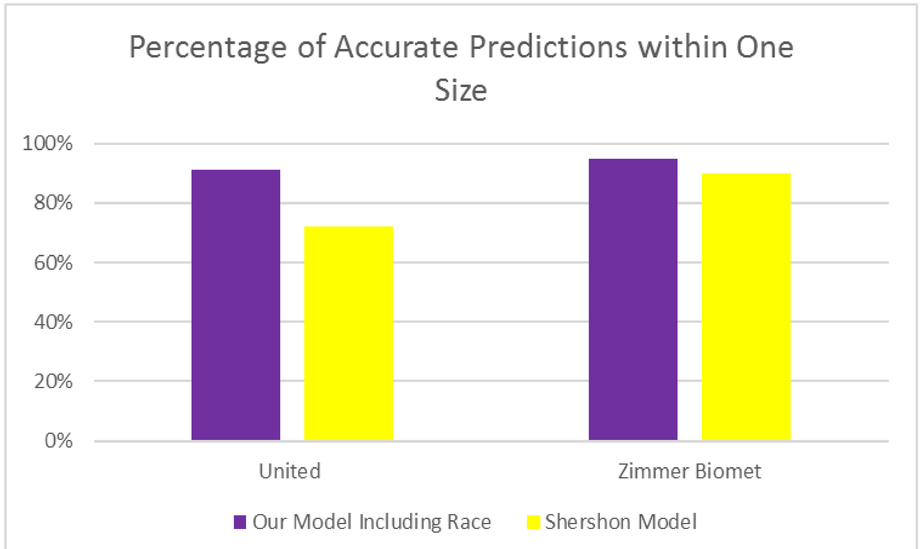
As of 2011, 600,000 people undergo Total Knee Arthroplasty (TKA) a year.[1] Given the high volume of this procedure, hospitals have sought out ways to minimize the costs associated with TKAs while still providing effective care. One of the most practical innovations to TKA surgery is the concept of accurately predicting the size of the tibial and femoral implants prior to surgery. This practice reduces operative time and streamlines distribution as it necessitates only a small number of implants be present in the operating room. Previous research by Sershon et al. showed that one could accurately predict the femoral implant size using a TKA templating model predicated on the height, weight and sex of a patient.[2] Our study was formed to test the Sershon model's accuracy on the patient population of Southeast Louisiana. In the case that the Sershon et al. model for predicting implant size is not accurate in our population we intended to develop an updated model with the addition of patient demographic information such as race.

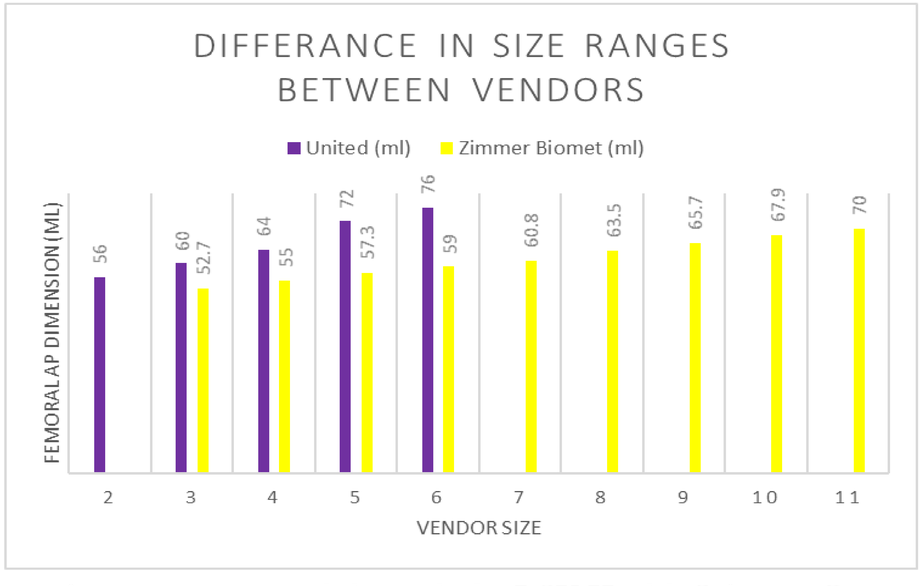
Methods

We conducted a chart review of 320 patients who underwent primary TKA performed by a single fellowship-trained surgeon from November 2015 to March 2020 at a university-based orthopaedic tertiary care safety net practice. All patients underwent navigated TKA using either Zimmer Persona, Zimmer NexGen or United U2 cemented implants. Predicted sizes using the Sershon et al. equation were compared to the reported implant sizes used. Results were categorized by vendor type and race, with an accurate predicted implant size defined as being within one size of the reported implant, just as in the Sershon et al. research. Using linear regression we formulated our own equation including race as a variable using half of our patient population and tested that equation on the other half of our population. We then compared our equation's accuracy with the Sershon equation's accuracy on the same testing half of patients.

Results

The accuracy of the final models for predicting femoral implant size within 1 size of the final implant was 91.1% (95% confidence interval [CI] 84.4-97.9%, n=68) for United and 94.8% (95% CI 89.1-100%, n=58) for Zimmer Biomet. We compared the accuracy of our final models with the Sershon model[1] using our testing dataset. Our model developed for United implants was significantly more accurate (91% vs. 72%, p=0.0008) than the Sershon model. There was no statistically significant difference in accuracy between our Zimmer Biomet model and the Sershon model (95% vs. 90%, p=0.257) although our model was highly accurate.





Equations

$$\overline{Femoral\ AP\ size}\ (mm)_{United} = 37.42 + 1.961 * Gender\ [Male = 1, Female = 0] + 0.136 * Height[cm] + 0.067 * Weight[kg] - 1.714 * Race[African\ American\ or\ Black = 1, White = 0], R^2 = 41.3$$

$$\overline{Femoral\ AP\ size}\ (mm)_{Zim/Bio} = 29.32 + 2.945 * Gender\ [Male = 1, Female = 0] + 0.188 * Height[cm] + 0.046 * Weight[kg] - 1.782 * Race[African\ American\ or\ Black = 1, White = 0], R^2 = 57.7$$

Conclusions

Our findings demonstrate that the addition of a race variable into demographic based predictive models unique to certain manufacturer's implants could improve the accuracy of said models. This was demonstrated by the significant improvement in our United knee implant's model as compared to the Shershon et al. model (72% to 91%, p = 0.0008). We believe the reason for this improvement can be attributed to the statistical significance of race as well as the fact that our United equation was modeled on, and only on, United U2 data. This allowed us to limit the confounders that arise when data from multiple vendors is used to construct these equations due to variations in size ranges between vendors.[5] These results warrant further studies into the racial differences between TKA templating and demographic based modeling. We hope that improvement in these two areas will further increase the efficiency with which surgeons and vendor representatives' function in the pre- and intra-operative stages of TKA. With continued data gathering, we envision a mobile application with equations modeled on and specific to each vendor that surgeons can access to generate reliable predictions for their respective vendors. Ultimately, this will save time and cost and allow tailored component trays in the operating room reducing waste.[6,7]

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This research project was supported through the LSU Health Sciences Center, School of Medicine