Tibial Plateau Coverage in UKA: A comparison of patient-specific and standard implants

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INTRODUCTION

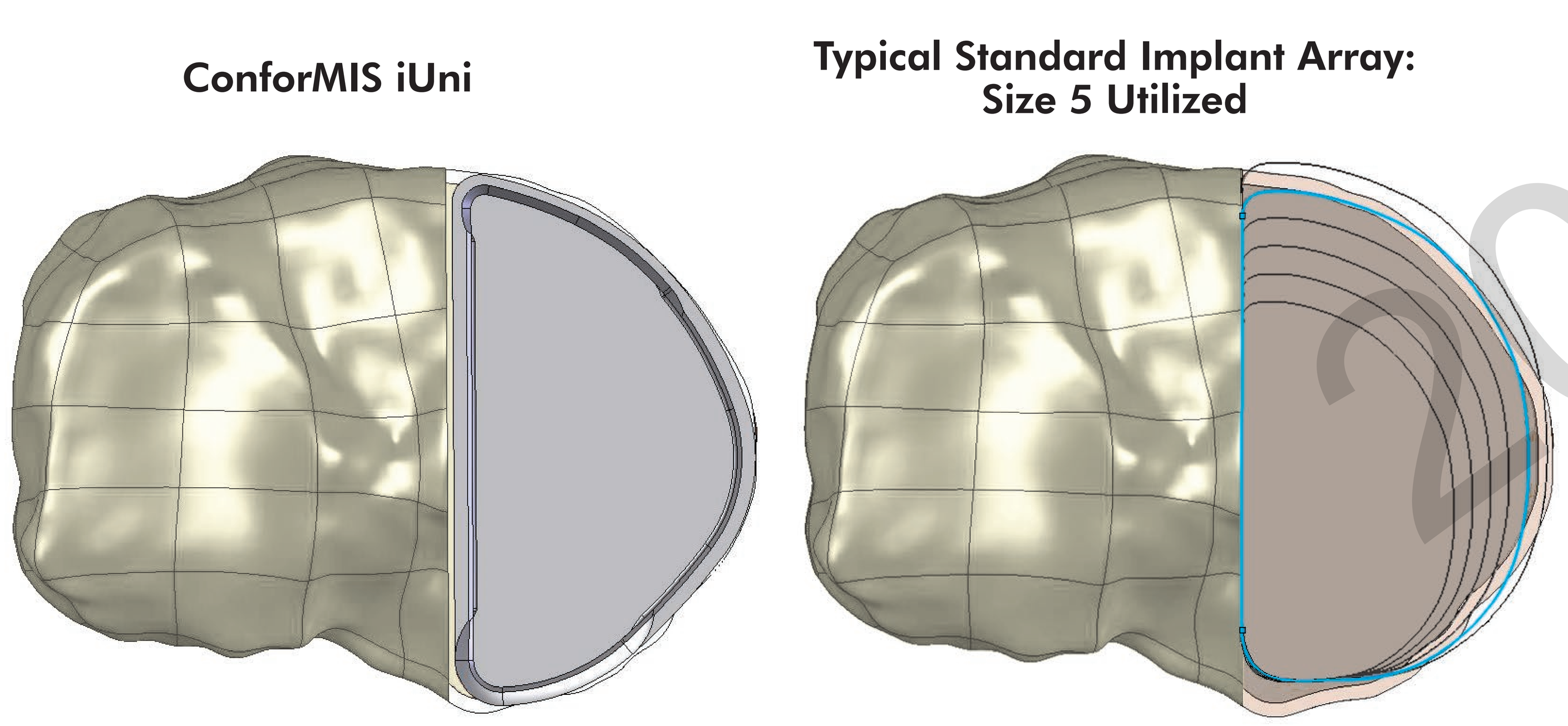
Tibial component fit has been shown to impact the success of unicompartmental knee arthroplasty (UKA) procedures. Overhang can lead to issues such as increased pain and impingment.[1,2] Undercoverage has been attributed to component loosening and subsidence.[1,3,4]

The purpose of this study was to utilize morphometric data in order to compare size match and fit between patient-specific implants and incrementally sized standard unicompartmental knee arthroplasty (UKA) implants. We hypothesized that patient-specific implants would reduce the incidence of overhang and undercoverage of the tibial surface and additionally provide significantly better fit on the cortical rim.

MATERIALS AND METHODS

CT images of 20 knees undergoing medial UKA and 10 knees undergoing lateral UKA were prospectively obtained. Standard implants, from 5 different manufacturers, and the patient-specific implants (ConforMIS, Bedford, MA) were modeled in CAD, utilizing sizing templates for the standard implants and CAD designs for the patient-specific.

Virtual surgery was then performed for each standard implant, with a surgeon selecting the best size and position in order to maximize coverage of tibial plateau while minimizing implant overhang. Placement was then confirmed by a second surgeon. Each standard implant was evaluated to examine fit on the cortical rim, defined as a continuous area 1.5mm from the edge of the resected tibial plateau[4], and the incidence of overhang/undercoverage of the tibial plateau. These results were then compared to the patient-specific implant.



References

1 Chau, R., et al.; "Tibial component overhang following unicompartmental knee replacement - does it matter?"; The Knee; 2009; V16: pp.310-313

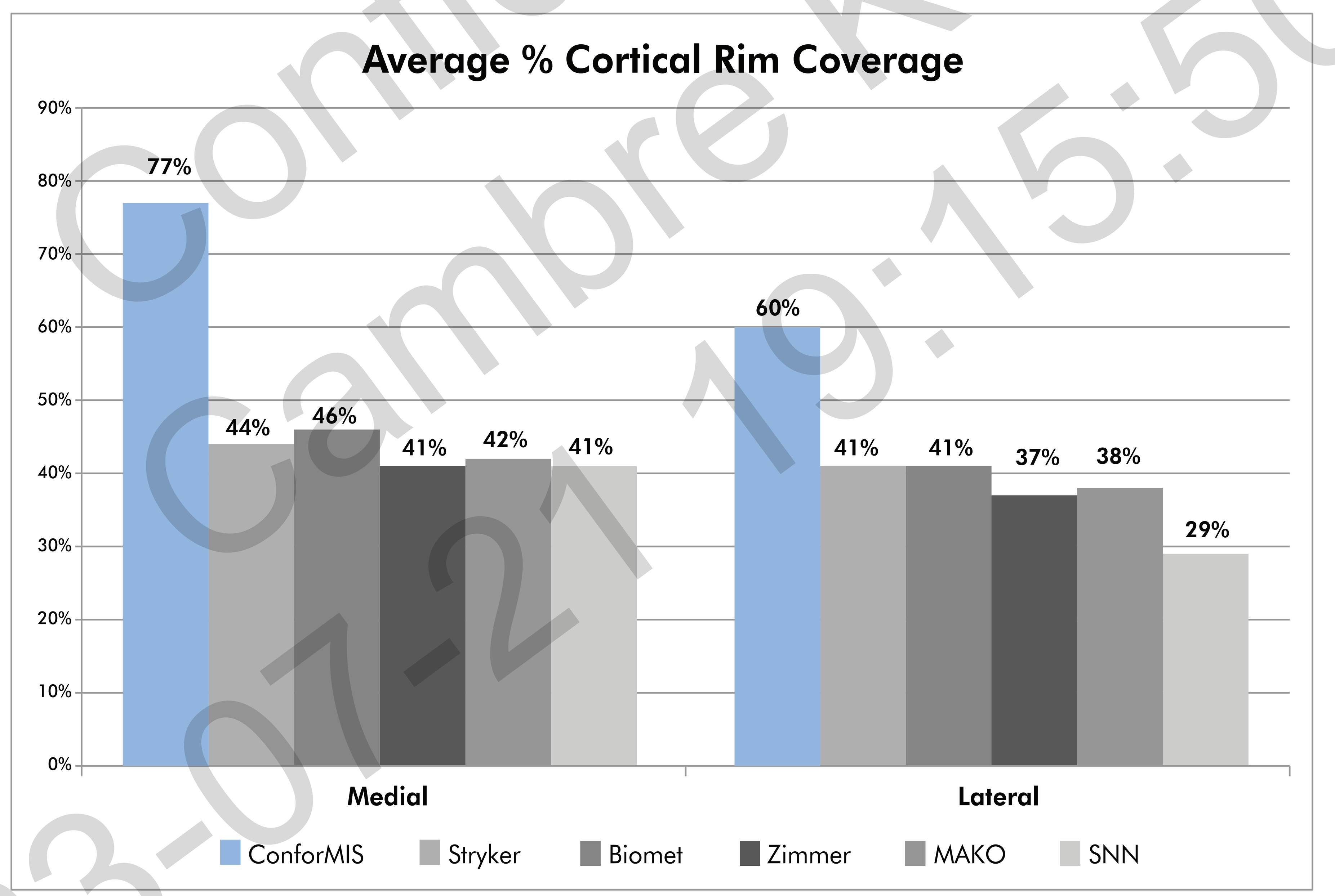
2 Gudena, et al., "A Safe Overhang Limit for Unicompartmental Knee Arthroplasties Based on Medial Collateral Ligament Strains: An In Vitro Study." Journal of Arthroplasty; 2012

3 Swienckowski, John and Pennington, Donald. "Unicompartmental Knee Arthroplasty in Patients Sixty Years of Age or Younger." JBJS. (2004)

4 Fitzpatrick,C., et al.; "Statistical design of unicompartmental tibial implants and comparison with current devices; The Knee; 2007; V14:pp. 138–144

RESULTS

Cortical Rim Coverage: Patient-specific implants provided significantly greater cortical rim surface area coverage, defined as the percentage of cortical rim covered by the tibial tray, versus incrementally sized standard implants, 77% coverage in medial knees v. 43% for standard implants (range 41-46%), ($p<0.0001$) and 60% in lateral knees v. 37% for standard implants (range 29-41%), ($p<0.0001$). The arc length of the patient-specific and standard implants was also evaluated to determine the percent of implant edge resting on cortical bone, 84% in patient-specific v. 55% in standard medial implants (range 48-59%), ($p<0.0001$) and 79% v. 57% laterally (range 53-60%), ($p<0.0001$).



Overhang & Undercoverage: A significant difference in the average amount of both overhang and undercoverage of the cortical rim area with patient-specific and standard implants was also observed: 0.24mm v. 0.46mm maximum overhang, ($p=0.043$) and 0.87mm v. 3.01mm maximum undercoverage medially ($p<0.0001$); 0.14mm v. 0.59mm maximum overhang, ($p=0.05$) and 1.19mm v. 2.26mm maximum undercoverage laterally ($p=0.017$). The presence of anterior overhang was observed in 55% (range 25-75%) of medial implants and 52% (range 30-80%) of lateral implants in the standard implant group. Anterior overhang was not observed any of the implants in the patient-specific group.

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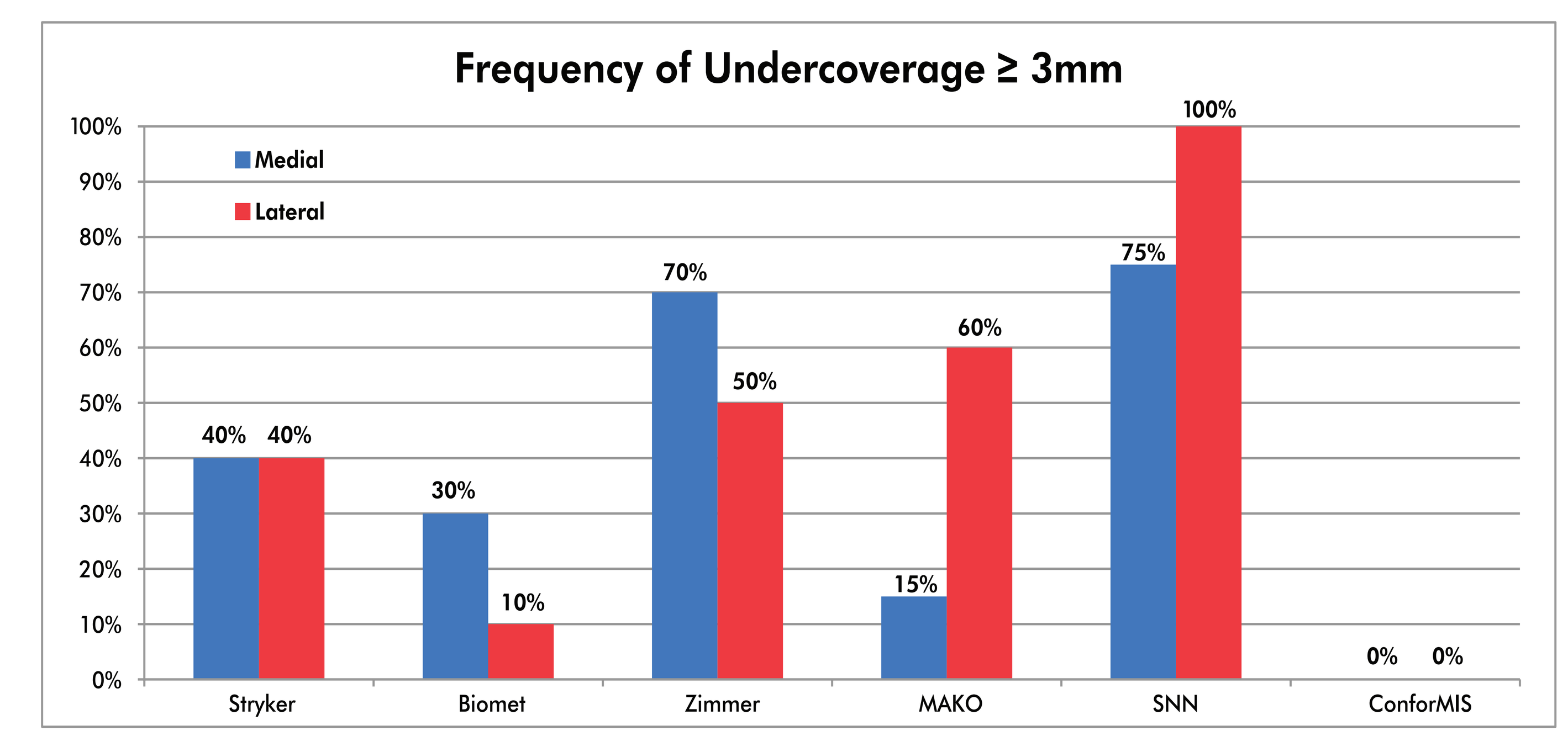
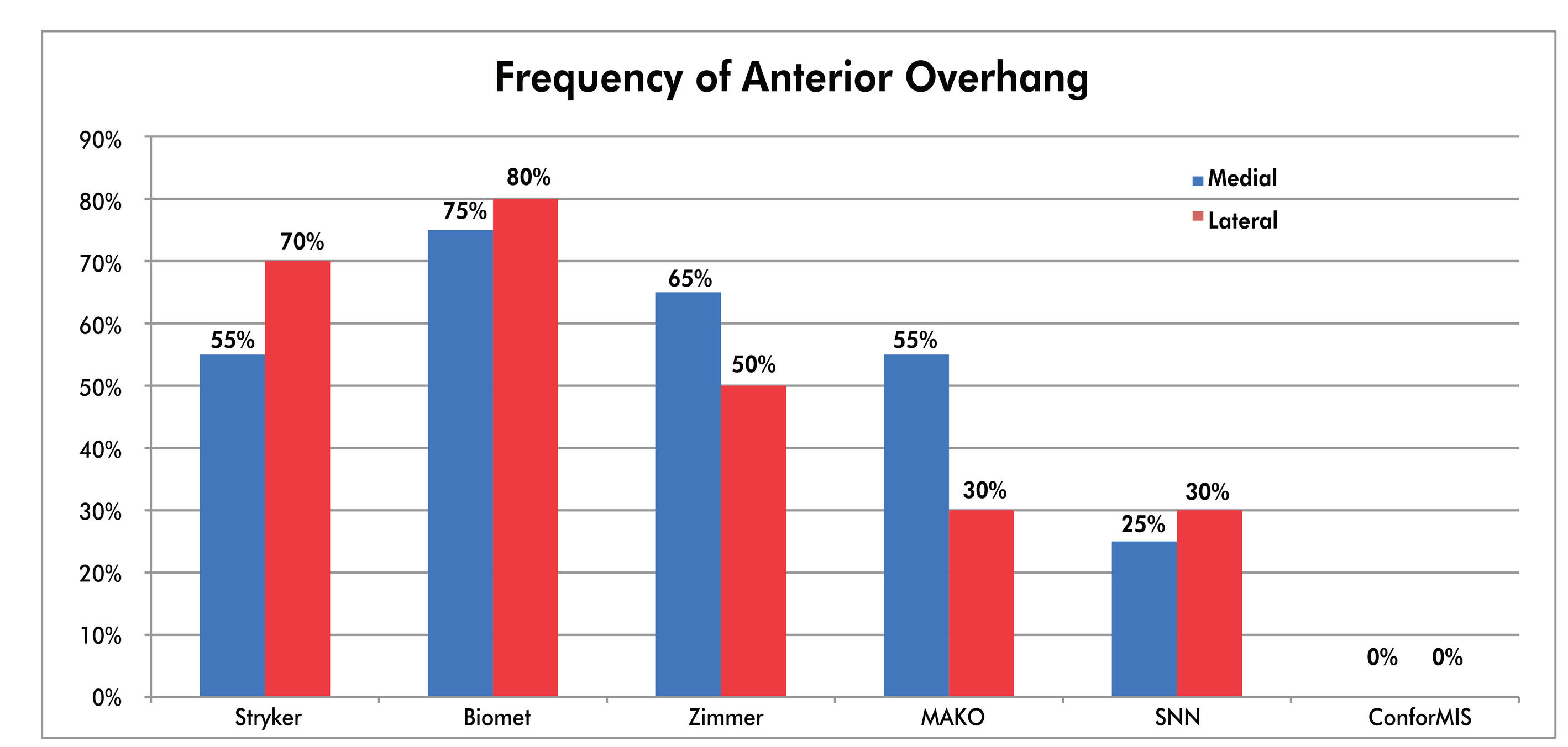
DISCUSSION

The variability of tibial plateau anatomy can result in difficulty with optimizing coverage and preventing significant implant overhang or undercoverage with standard unicompartmental implants. Previous studies have demonstrated significant clinical issues with pain, subsidence and loosening due to overhang and undercoverage in standard implants.

In this idealized scenario of virtual implantation, we undersized our standard implants in order to avoid overhang. Despite this methodology we still encountered significantly more overhang in all standard implants as compared to the patient-specific cohort. This study also removed the added surgical variability of having to match tibial tray placement to femoral implant placement in the standard group, which often leads to additional compromises with fit and tibial coverage. This is a compromise obviated by the patient-specific implants, due to the CT-based design of the implant, which aligns tibial and femoral implants pre-operatively.





CONCLUSION

In this study of virtual implantations in a CAD environment, patient-specific implants provided statistically superior cortical bone coverage and fit while minimizing the inherent issues of overhang and undercoverage seen in standard implants.

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