

Computational Modeling of the Patellofemoral Joint with Patient Specific Alignment

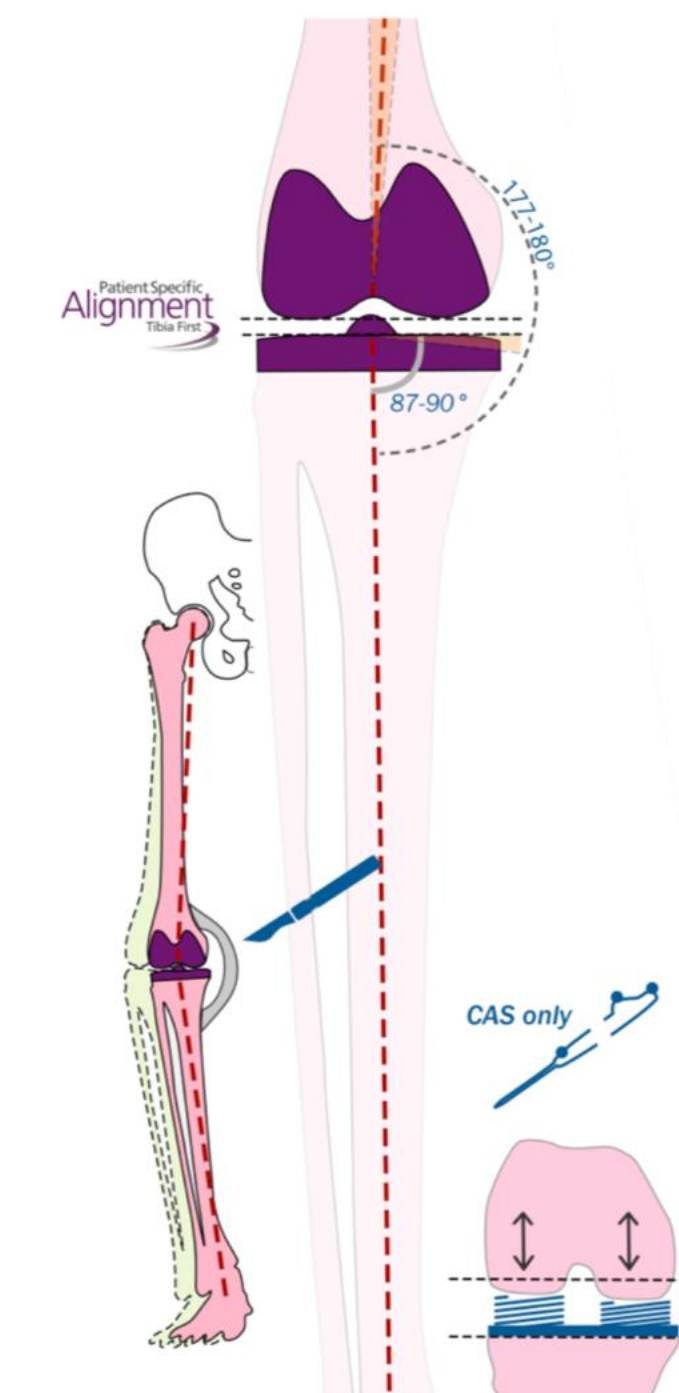
Authors: Luke Aram¹, Paul Rullkoetter²

Affiliations: ¹DePuy Synthes, ²University of Denver

1. Introduction

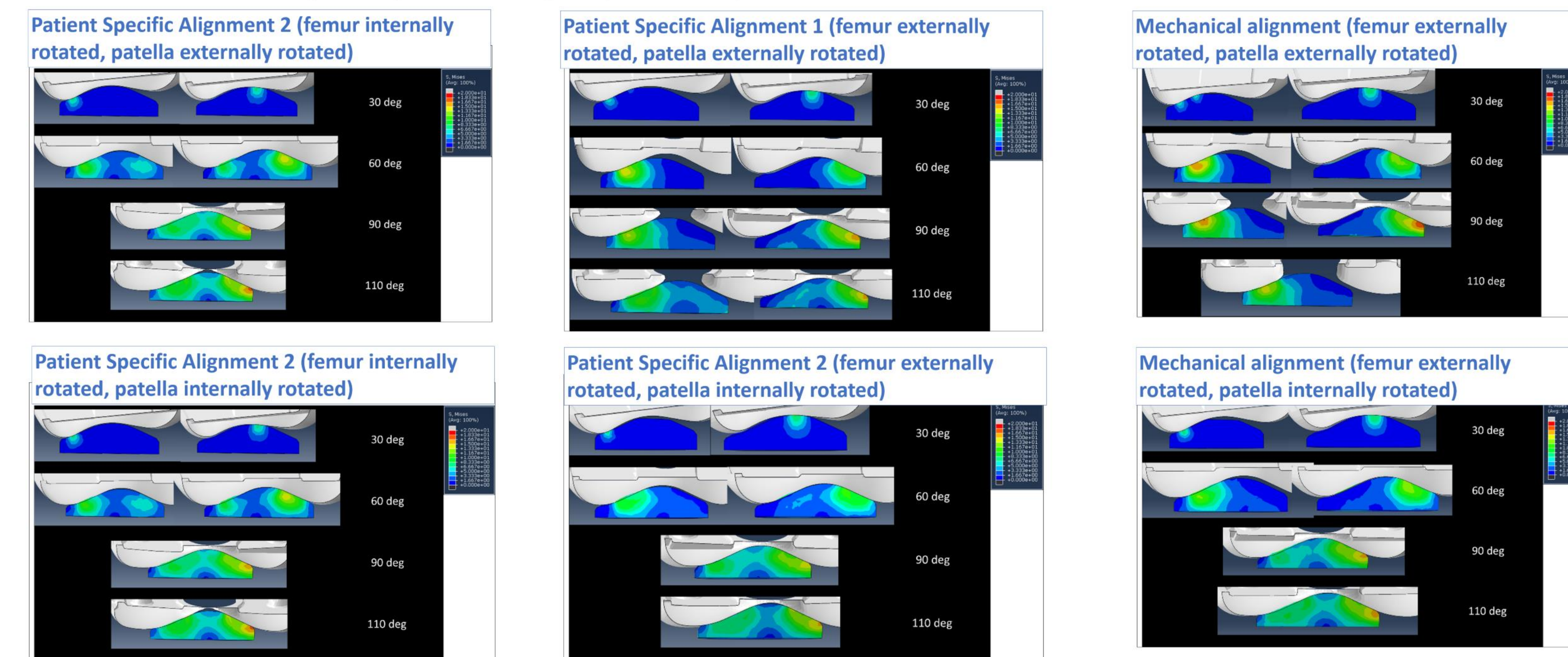
Patient Specific Alignment

- With an aim to increase patient satisfaction, there has been growing interest in patient specific alignment in total knee arthroplasty^{1,2}
- The PSA technique aims to replicate the natural joint line of the patient; typically, the tibial component is implanted in slight varus alignment while still maintaining the long leg alignment within $\pm 3^\circ$ from neutral alignment^{2,3}.
- In this study, the effect PSA has on the patella was quantified, with respect to the risk of creep of the patellar implant and the effect of the medial-lateral contact force on patellar tracking.



3. Results

Cross section of patellae implants illustrating peak von Mises stress. Bi-facet contact was maintained from 60 degrees to 110 degrees of flexion. The results of this analysis have shown that for all orientations analyzed, there is less implant volume in excess of the material yield stress for ATTUNE Knee in PSA than ATTUNE Knee in MA. Creep is localized and is unlikely to impact the longevity of the implant.



Aram L. Evaluation of the Patella: Contact Pressure and Bi-facet Contact for the Attune Implant in Anatomic Alignment. DePuy Synthes Engineering Study 103573761. 2019.

4. Discussion

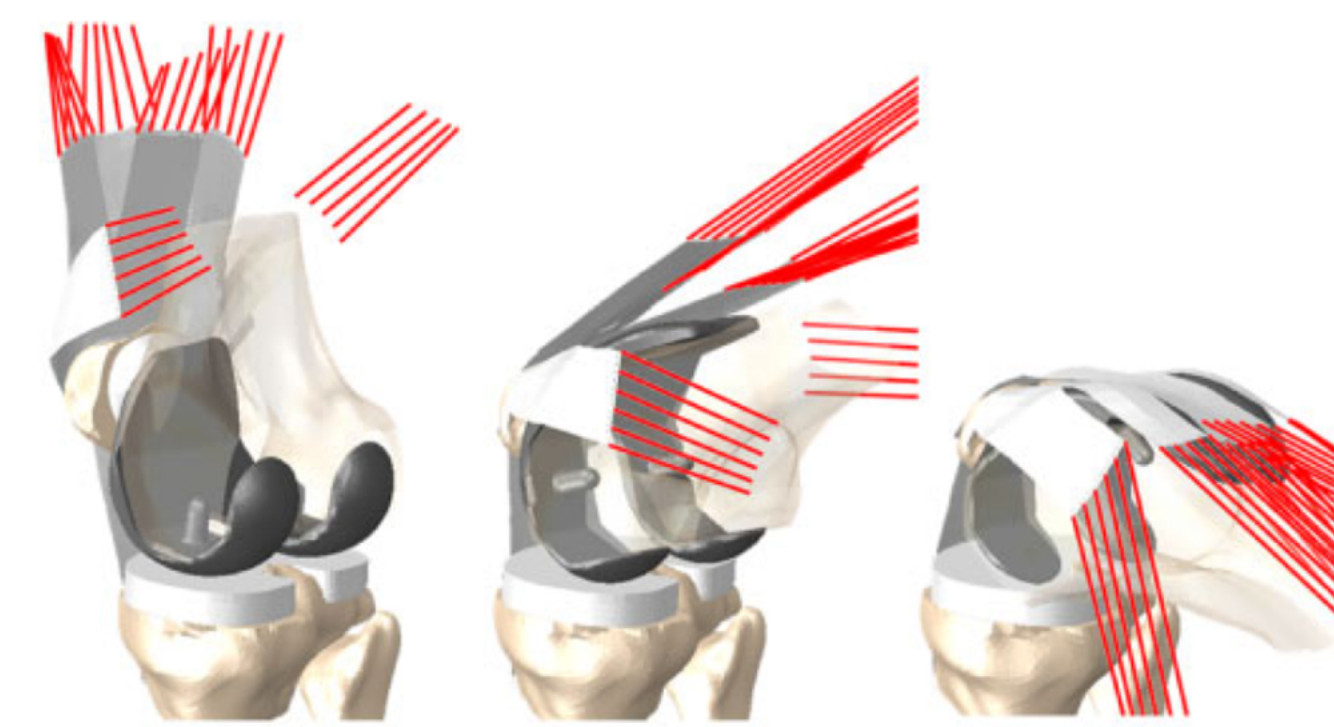
- Maximum von Mises stress in the ATTUNE Knee Patellar implants were analyzed using a computational analysis for a baseline MA and PSA orientations. Results of the contact pressure show that the patella in PSA exhibit less implant volume in excess of the material yield stress than in MA¹.
- The medial contact force was greater in PSA, however, the peak value of 140N is within the range seen in clinically successful implants¹. In a study by University of Denver, with similar computational methods and boundary conditions, the patella contact force ranged from 100N laterally to 270N medially². Thus, the 140N peak medial contact force we saw with PSA is still in the range previously measured.

1. Aram L. Evaluation of the Patella: Contact Pressure and Bi-facet Contact for the Attune Implant in Anatomic Alignment. DePuy Synthes Engineering Study 103573761. 2019.
2. Fitzpatrick CK, Baldwin MA, Clary CW, Wright A, Laz PJ, Rullkoetter PJ. Identifying alignment parameters affecting implanted patellofemoral mechanics. J Orthop Res. 2012; Jul;30(7):1167-75

2. Methods

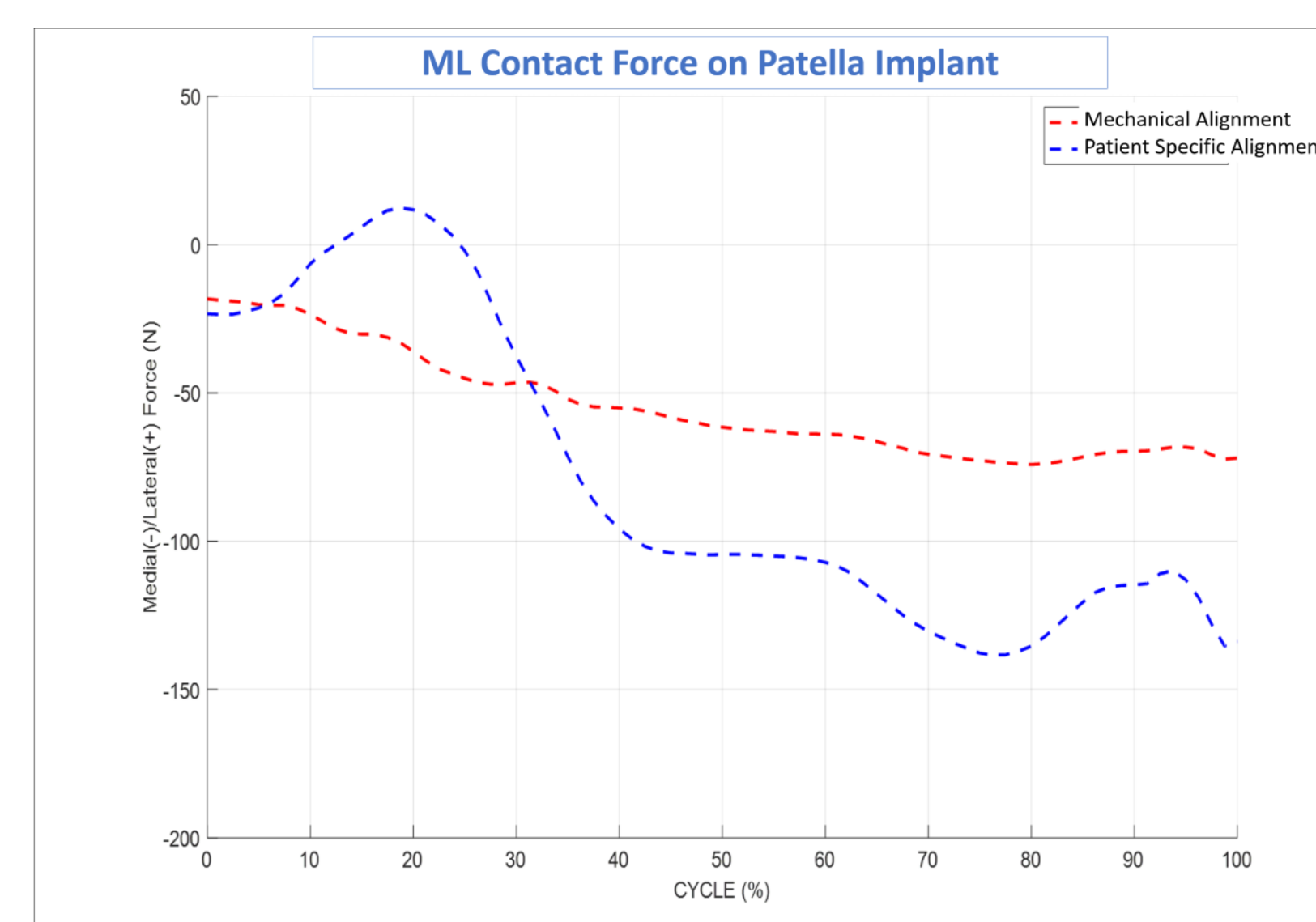
Computational Modeling

- The Attune[®] Rotating Platform Knee System implant was virtually implanted using 3 different surgical techniques:¹
 - Mechanical Alignment
 - Patient Specific Alignment Tibia First 1³: Tibial implant implanted in 5° varus and the femoral implant in 8° external rotation.
 - Patient Specific Alignment Tibia First 2³: Tibial implant implanted in 5° varus and the femoral implant in 7° internal rotation.
- The DePuy Synthes Patient Specific Alignment surgical technique limits tibial implant alignment to 3° varus. In this test we considered an additional 2° of surgical error. Additionally, testing was done at 8° of external femoral rotation and 7° of internal femoral rotation which is an extreme condition and not recommended by the surgical technique.
- Contact pressure and contact force analysis was carried out using a finite element lower limb model produced by the University of Denver.
- This model includes a representation of tibiofemoral and patellofemoral soft tissues that was calibrated using telemetric data and is driven with external boundary conditions to produce knee kinematics and kinetics.²



1. Aram L. Evaluation of the Patella: Contact Pressure and Bi-facet Contact for the Attune Implant in Anatomic Alignment. DePuy Synthes Engineering Study 103573761. 2019.
2. Fitzpatrick C, et al. Evaluating Knee Replacement Mechanics during ADL with PID-controlled Dynamic Finite Element Analysis. Computer Methods in Biomechanics and Biomedical Engineering. 17:4 (2012): 360-69.
3. DePuy Synthes - 097081-191022 Patient Specific Alignment Tibia First Surgical Technique 2019

3. Results (Cont.)



Aram L. Evaluation of the Patella: Contact Pressure and Bi-facet Contact for the Attune Implant in Anatomic Alignment. DePuy Synthes Engineering Study 103573761. 2019.

- ATTUNE Knee implants in patient specific alignment and mechanical alignment were compared during a deep knee bend to evaluate the medial-lateral contact force.
- The medial contact force generated by the femoral component onto the patella implant was slightly higher for patient specific alignment but still in a low and safe range.
- It is hypothesized that the internal rotation of the femoral component in patient specific alignment contributes to the greater medial contact force.

5. Conclusion

Computational analysis was conducted to compare of ML contact force on the patellar implant when ATTUNE Knee is placed into PSA and mechanical alignment. Although a greater medial contact force was found for PSA, additional evidence was presented that found the contact force is within the range found in previous studies.

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Please refer to the instructions for use for a complete list of indications, contraindications, warnings, and precautions.