**KNEE LOAD REDUCTION FROM AN ENERGY STORING MECHANICAL BRACE: A SIMULATION STUDY**

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## INTRODUCTION

Knee braces are a common conservative treatment option for reducing pain and improving function in people with osteoarthritis [1]. However, only a few studies have examined the loading effects on the knee using biomechanical models [2], and studies thus far have been focussed on varus/valgus off-loading braces. Furthermore, existing braces are not capable of returning energy to the user in the plane of motion. SpringLoaded Technology Inc. has developed a passive-mechanical brace capable of energy storage and release (ESR), that may not only benefit people with knee disorders, but could also reduce occupational injuries in otherwise healthy workers by protecting the knee and reducing energy demand.

The purpose of this study was to use a sagittal plane model of the knee to simulate brace loading effects during a deep-knee bend test, for different brace load/knee angle relationships.

## METHODS

A lower-extremity inverse dynamic model was used [3] to compute knee kinetics: peak internal knee moment, power and total work. A sagittal plane model of the knee [4] was integrated with the inverse dynamic model to compute muscle tendon forces, cruciate ligament forces and joint contact loads, as shown in Figure 1.

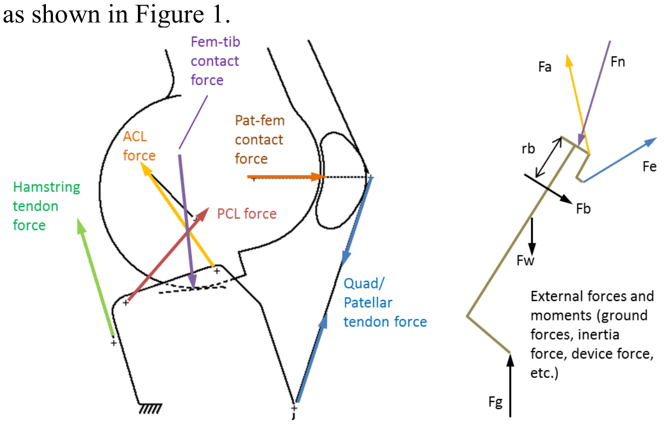


**Figure 1:** Sagittal plane model of the knee.

The brace was simulated by applying a fictitious force (Fb) perpendicular to the tibia located rb=20cm below the knee. Force applied was a function of knee angle, and three different force/angle relationships were examined: Linear (Brace #1) which applies force proportional to knee angle; Plateau (Brace #2) which applies force proportionally and then plateaus; and Walking (Brace #3) which applies load proportionally after a flexion delay. Percent change in peak joint kinetics and forces were calculated by running the simulation using five randomly selected motion data trials from a normative database.

## RESULTS

Joint forces for a representative motion data trial are shown in Figure 2. For the 5 subjects there was a 44-49% reduction in joint kinetic variables (moment, power, work) with Brace #1, and 25-35% reduction for Braces #2 and #3. Similarly, joint loads reduced by 50-64% for Brace #1, and 27-55% for Braces #2 and #3. All reductions were statistically significant ($p<.05$).

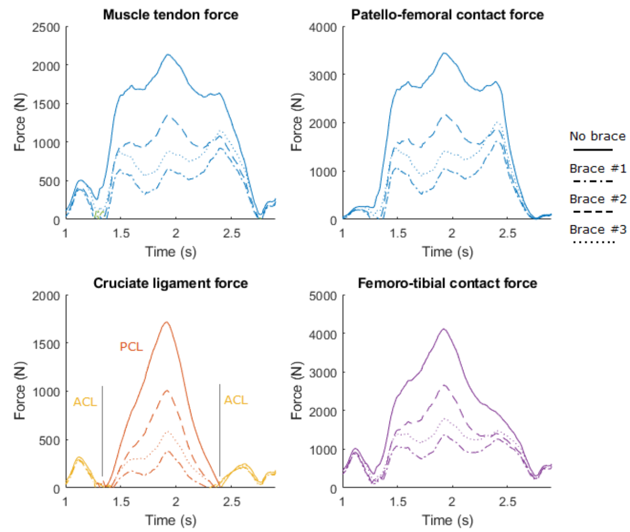


**Figure 2:** Knee joint loads during a deep-knee bend test with simulated solutions for three different brace load/angle relationships.

## DISCUSSION / CONCLUSIONS

During an activity that significantly loads the knee—the deep-knee bend test—we predicted a significant decrease in tibiofemoral and patellofemoral joint loading and mechanical energy expenditure, for all three brace designs. Although the Linear brace setting performed best for this simulation, other simulated activities (chair rise, gait, etc.) are required to evaluate which brace setting works best in which activities. We conclude that a sagittal plane knee model can be used to evaluate the biomechanics of the ESR knee brace.

## REFERENCES

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