



CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

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Project Title Tension on Knee Joint and Quadriceps Muscle	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of my project was to find how the amount of force put on the human knee and quadriceps muscle is affected by the knee's angle. The results of this experiment can be used to prevent knee injuries by not putting it at angles that put immense force on it. The knee is the most complex hinge-joint that enables the leg to flex and extend. My hypothesis was that at a 180 degree angle, the knee and quadriceps will not feel tension since the quadriceps muscle and tendon will not expand. As the knees bend further down, the force will increase because the muscle will continue to expand. When the knees are bent completely, the quadriceps muscle will stretch the most, putting more force on the knee.</p> <p>Methods/Materials To do this experiment, I built a knee model where a spring represented the quadriceps muscle, and a string represented the quadriceps tendon. Different sizes of wood were used for the shin bone, femur, hip, and foot. To find the force for each angle I used Hooke's Law ($F = -kx$). Hooke's Law shows that the force on the spring is related to the change in length of the spring. By multiplying "k", the stiffness of the spring, with "x", the change in length of the spring, I was able to find force four times for seven different angles, and calculated the average of the four trials.</p> <p>Results The hypothesis was partly supported. At 180 degrees there was no force since the spring (quadriceps) stayed the same length, and as the knee bent more, the force increased because the spring stretched further. I was incorrect because I did not predict that at a 45 degree angle there would be less force due to gravity. At this point the gravity was pulling the spring in the opposite direction that the tension in the string (quadriceps tendon) was pulling the spring. Because of this, the spring did not expand as much, leading to less force. At 30 degrees, even though the gravity and tension forces were opposing each other, the tension force was greater than the force of gravity and was able to expand the spring.</p> <p>Conclusions/Discussion The results indicate that gravity also plays a role in the amount of force that is exerted on our knees and quadriceps. To maintain healthy knees my research indicates that one must not bend the knees while sitting, he or she should stretch muscles and exercise often, and when lifting heavy objects from the ground, going to a 45 degree angle rather than a 30 degree angle is best.</p>	
Summary Statement Using Hooke's Law, I discovered how the amount of force put on the human knee and quadriceps muscle varies based on the different angles of the knee.	
Help Received My father bought all the materials required for this experiment. My brother helped me understand Hooke's Law thoroughly and taught me how to safely use a drill.	