CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
J0217

Project Title
Plies to Perfection: The Force on Your Patellar Tendon

Abstract

Objectives/Goals
The objective of my science fair project is to test my hypothesis that if a person does a grande plie, then there will be more tension on the patellar tendon than if a person does a demi plie.

Methods/Materials
To test this hypothesis, my dad and I built a model knee that contained a spring to measure tension. To collect my data, I first held the knee in the desired position, which was determined by measuring the inside angle of the knee. I then tightened the string, or tendon, using a guitar tuner. I adjusted the tension until the knee stayed in position. Once the knee was in position, I measured how much the spring, or quadriceps, had extended. To convert the extension into tension, I used the equation:

Tension = Spring Extension x Spring Constant + Pretension

The pretension is the minimum amount of force it takes for the spring to begin extending.
Once I collected my data, I graphed it using Microsoft Excel. My graph showed that the tension on the patellar tendon goes up at a faster than linear rate as the plie gets deeper. Putting in a trend line, I obtained the equation:

$y = 0.0007x^2 + 0.0176x + 0.8411$

to describe the relationship between the angle of the plie (x) and the tension on the patellar tendon (y).
I then formed the equation:

Tension = 8.35[(Sin(90-[½ inside angle])) x 2]

to model the theoretical tension on the patellar tendon on my knee model.

Results
There was 100% more tension on the patellar tendon in a grande plie than a demi plie. The tension predicted by the theoretical equation above was reasonably close to the measured force, but not precisely the same.

Conclusions/Discussion
In conclusion, my data support my hypothesis. There is approximately 100% more tension in a grande plie than there is in a demi plie. I think the reason that the theoretical force did not entirely agree with the model, is because of the many complications of my model that were hard to measure, and include in my theoretical equation. For example, the string is not perpendicular to the upper leg all of the time, as my theoretical equation assumes, the heel rises, and there are varous frictions around the ankle and hip. All of these things make it difficult to have a perfectly accurate theoretical equation.

Summary Statement
The objective of my project is to see whether there was more tension on the patellar tendon in a grande plie or a demi plie, two moves in ballet.

Help Received
My dad helped build the model; James Neilson, a PhD student at UCSB help with equations; My teacher Mrs. Miller helped with the theoretical tension.