Detection of Hamstring Force to Reduce Player Injuries with GHD Machine

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Background

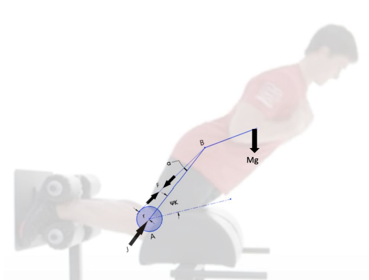
The most common injury in football is a hamstring strain and injured players often return to the field prematurely, resulting in repeated injury that causes them to miss even more playing time. In an effort to reduce the occurrence of these injuries, players often perform glute-hamstring exercises to strengthen the muscle. These exercises play a key role in strength and conditioning and are also used to evaluate when a player is ready to go back onto the field. Our work focused on providing both players and coaches a way to view the force exerted by the hamstrings during one glute ham raise. While existing products for force collection are used, such as the Nordbord, this device can only be used for the Nordic Curl exercise, which is a high strain movement that can be difficult for both athletes returning from injury and athletes of a higher mass. On the other hand, the Glute-Ham Developer machine allows for user modification of the exercise. For this reason, our work aims to integrate force collecting capabilities and motion adaptability into a new diagnostic tool.

Approach

The project was split into three phases: data collection, data analysis, and integration.

Data Collection

Different types of sensors were researched for the data collection process and various test setups were created to simulate the movement of the player. For muscle force measurement, load cells were the sensor type determined the most conducive to this application. The data was then converted into a format that could be analyzed by our biomechanical model.



Force diagram for biomechanical model

Data Analysis

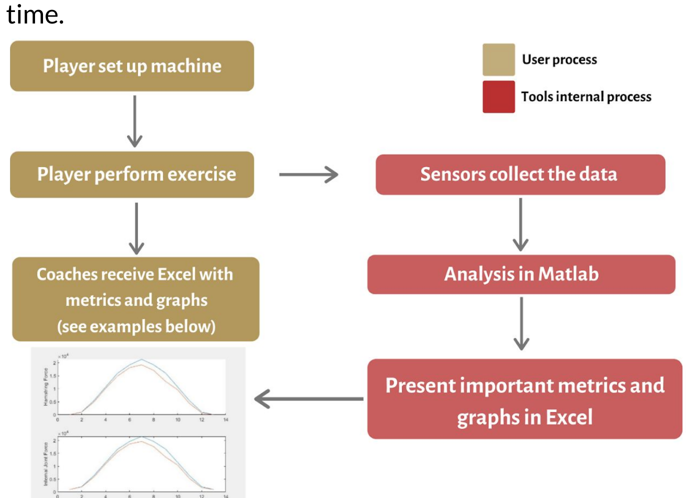
A static mechanical analysis was conducted to quantify the forces on the hamstring and the knee joint of the athlete, given the sensor data. The athlete was modelled as a collection of hinged beams with the hip angle fixed and the mass above the knees concentrated at one point. Users input athlete measurements and mass. Using these inputs as well as the force data from the sensors, an Excel code predicts the angle of the knee and subsequently outputs the force exerted by each hamstring over time.

Integration

The force data is then compiled to present the players and trainers with the most relevant information, namely the maximum force exerted by each hamstring, the imbalance of force between the hamstrings, and a graph of the force exerted over time. A wireframe was created to outline the flow of a potential app that could be used by both players and coaches when implementing this technology in the training regimen. The wireframe was made to get initial interactivity feedback for future iterations.

Conclusions and Discussion

Our process determined that with data from load cells and equations determined by our biomechanical analysis, the 49ers can have the ability to visualize hamstring force. Our vision is that the load cells could be integrated into existing GHD machines, causing minimal disruption to the current workout process. The data would then be collected from the load cell during exercise, run through our biomechanical analysis to determine hamstring force, and uploaded to an iPad app modelled after the wireframing that has been done. Coaches and players could track progress of the hamstring strength and imbalance over time, giving them a more complete view of an athlete's hamstring strength and recovery process over time.



Process flow of the final tool