Biomechanical Analysis of the Deep Squatting Position in Baseball Catchers With and Without Knee Saver™ Pads

Carr JB[1], Dooley E[2], Russell RD[2], Carson EW[1]
[1]: University of Virginia Department of Orthopaedic Surgery
[2]: University of Virginia Motion Analysis and Motor Performance Lab

Objectives: Overuse injuries continue to increase at alarming rates in youth sports. Prevention of overuse injuries is an important focus in managing young athletes. In particular, overuse upper extremity injuries are a major focus in youth baseball and softball. However, little attention has been paid to lower extremity overuse injuries. The position of catcher is a demanding position that requires prolonged time squatting with deep knee flexion. Some catchers wear posterior leg pads, called Knee Saver™ pads (Easton, Van Nuys, CA) with the goal of reducing stress across the knee joint. However, the actual ergonomic benefits of Knee Saver™ pads have never been quantified to our knowledge. This study has two main objectives: 1) to analyze the biomechanics of a catcher's deep squat with and without Knee Saver™ pads and 2) to quantify the percentage of body weight absorbed by each Knee Saver™ pad during a deep squat.

Methods: Subjects were analyzed at our institution's motion analysis lab using reflective tape marker balls and ten infrared motion sensing cameras (Figure 1a). Each catcher performed a series of two squats with and without Knee Savers™. Each squat was performed three times and held for three seconds. The first squat performed was the "sign" stance, which was the normal stance while giving a sign to the pitcher. The second squat was the "receiving" stance, which was the normal deep squat for catching a pitch without a runner on base. Lastly, each catcher performed at least three "receiving" squats while wearing our load cell Knee Saver™ pad model (Figure 1b) in order to calculate the force transmitted through a Knee Saver™ pad. Data was collected using Vicon software (Vicon Motion Systems Inc, Los Angeles, CA) and then subsequently processed for modeling in MSC.Adams (MSC Software, Newport Beach, CA) with LifeModeler plug-in. For each squat ankle, knee and hip flexion angles were calculated. Values for each leg in every stance with and without Knee Savers™ were averaged and compared using a paired student's t-test with a p-value of 0.05 set for significance. The force transmitted through each load cell model was calculated as a percentage of total body weight.

Results: A total of 4 male baseball catchers with an average age of 16.8 years (range 14-19 years) were analyzed. For both stances, Knee Saver™ pads increased the average ankle flexion angle while reducing the average knee and hip flexion angle in each leg, yet these values were not significant except for left hip flexion in the sign stance (Table 1). The greatest difference in knee flexion was observed in the right knee during the sign stance, which resulted in a 4.3 angle difference (p=0.18). On average, each catcher loaded 22.1% body weight (range 18.4%-25.6%) through the right Knee Saver™ pad and 23.0% body weight (range 18.9%-25.8%) through the left Knee Saver™ pad while squatting with the load cell model. The ankle, knee and hip flexion values from the load cell trials did not differ significantly from the values obtained from Knee Saver™ trials, suggesting that our load cell model recreated similar squatting mechanics to the Knee Saver™ pads.

Conclusions: Knee Saver™ pads did not significantly reduce the knee flexion angles in the two most commonly performed squats for a catcher. Based on our load cell model, Knee Saver™ pads received a combined 45.1% of a catcher's body weight during a normal receiving squat. Therefore, any ergonomic value is likely attributable to force redistribution as opposed to alteration of squatting mechanics. It is possible that Knee Saver™ pads may help reduce overuse injuries to the knee by reducing the force across the knee joint without altering squatting mechanics. Further studies are needed to better elucidate possible benefits of Knee Saver™ pads in overuse injury prevention.