Utilizing Depth Drop Training to Reduce ACL Rupture Risk Factors In Division I Collegiate Women's Volleyball Players

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Introduction

- The purpose of this study was to determine if increased use of depth drop in strength and conditioning programs decreases ACL rupture risk factors.
- Injury rates for volleyball players are 4.21 injuries per 100 hours. The knee is the second most common injury site behind the ankle. The most common knee injury for female volleyball players are ACL injuries. (Migliorini et al., 2019)
- Female athletes are 2-10 times more likely to sustain ACL injuries than males. (Silvers & Mandelbaum, 2007)
- Jump landings are the most common non-contact ACL rupture mechanism.
- Collegiate women's volleyball players, on average, jump between 40-220 times in a 5-set match. (Vlantes and Readdy, 2017)
- A 2D video analysis found participants ACL injuries showed increased knee valgus at ground contact when compared to uninjured groups. (Numata et al., 2017)
- Frontal view of knee valgus collapse can be seen by the decrease in knee distance. During knee flexion, tibial abduction and femur internal rotation occurs. (Quatmann & Hewett, 2014)
- Stiff landings, landing with minimal hip and knee flexion, increase shear force at the quadricep. This increases ACL loading, increasing injury risk. This can be seen through increased ground reaction forces. (Silvers & Mandelbaum, 2007)
- 400 N of quadriceps force can increase ACL strain by 3-5%. (Ueno et al., 2021)
- Increased Ground reaction forces can increase ACL strain by 33%. (Ueno et al., 2021)

Soft landing (Sagittal View)

Proper Landing (Frontal View)

Stiff Landing (Sagittal View)

Knee Valgus Collapse (Frontal View)

Figures 1-4 (Rabin et al., 2018)

Methods

Participants

- Thirty division I college volleyball players participated in this study.
- Average age was 20, with a range of 18-22 years old.
- All participants had at least five years of volleyball experience, and two years of strength training experience.
- Exclusions included those with a history of ACL injury, cardiovascular disease, and respiratory disease.
- All participants were free of lower extremity and lumbar injury at the time of this study.

Instrumentation

- Collection of the kinematic variable, knee valgus collapse, was captured using two high speed cameras. These were placed in front of and to the side of the landing area.
- This collected frontal and sagittal 2D motion analysis information. Determining changes in knee valgus was done through the change in knee distance from initial contact to minimum knee distance. This was analyzed for each attempt.
- Collection of the kinetic variable, vertical ground reaction force, utilized force plates.
- Maximum vertical ground reaction force was recorded for each attempt.

Procedure

Testing

- All participants completed a five-minute dynamic warm-up prior to testing.
- Testing included a 30-inch box, with force plates directly in front. These plates served as the landing area.
- For video analysis, reflective markers were placed at the top of the paella and tibial tuberosity.
- Participants were instructed to stand on the box, step off, and land with both feet on the force plates. They were told to land with as little forward momentum as possible.
- No other feedback regarding kinematic or kinetic variables were provided during testing.
- Participants were provided three practice attempts to familiarize them with the exercise.
- A five-minute rest period was provided between practice and recorded attempts to prevent fatigue.
- Each participant completed five depth drops, with 30 second rest periods between each set.
- All recorded kinematic and kinetic variables were averaged in both pre and post testing.
- The change in knee distance was calculated by the following equation:
  (Change in knee distance = knee distance at initial contact – minimum knee distance)

Procedure

Training

- Working in conjunction with university strength and conditioning coaches, participants continued their strength training programs. However, programming of depth drop exercises were dependent on groups.
- 8-week training period between pre and post testing
- Participants were divided into three groups:
  - Control – no depth drops programmed
  - Experimental 1 – 1 training day per week included depth drop
  - Experimental 2 – 2 training days per week included depth drop
- During training, feedback regarding kinematic and kinetic factors were provided by strength professionals.
  - Kinematic feedback included cues such as "Keep your knees apart"
  - Kinetic feedback included cues such as "softer landing" or "quiet landing"
- Participants were told to continue their current diet plan, and to reframe from additional training outside university scheduled training.

Limitations

- Participants may engage in additional landing skill training outside of training protocol.
- Minimal forward movement when landing may not be representative of conditions of volleyball play. This is because most jumping includes some form of run up prior to jumping.
- This may not represent single leg landing, which occurs occasionally during match play.

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