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A Mini-Review on the Utilization of Force Plates in Athlete Rehabilitation

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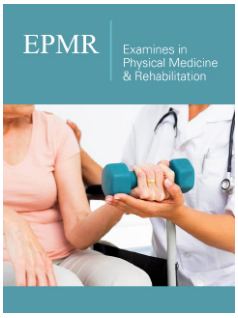

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Abstract

The force plate is an indispensable tool in athlete rehabilitation, providing objective and quantitative assessments of ground reaction forces and movement patterns. Its significance extends beyond mere evaluation, as it is essential for tracking rehabilitation progress, guiding treatment protocols, and evaluating athletic performance. One of the key advantages of the force plate lies in its ability to provide valuable insights into multi-joint exercises. By enabling the quantification of loads, strength, and power generation in the lower limbs, it offers a comprehensive understanding of an athlete's physical capabilities. This information is instrumental in tailoring rehabilitation programs to individual needs and optimizing athletic performance. Furthermore, the force plate serves as a biofeedback mechanism, enhancing training by improving balance, coordination, and movement patterns. This feature not only aids in rehabilitation but also contributes to injury prevention and overall athletic development. As technology continues to advance, the role of force plates in sports performance and rehabilitation is poised to expand further. We can anticipate the emergence of more sophisticated force plate technology applications, leading to enhanced precision and effectiveness in athlete rehabilitation and performance enhancement. In conclusion, the force plate stands as a cornerstone in the realm of athlete rehabilitation and performance evaluation. Its role in providing objective data, guiding treatment plans, and enhancing athletic training is indispensable. The continued evolution of force plate technology promises to further elevate its impact on sports performance and rehabilitation.

Keywords: Biomechanics; Ground reaction forces; Asymmetry index; Strength test

Introduction

The force plate is an important evaluation device in athlete rehabilitation. This device measures the ground reaction forces generated by a body standing on or moving across it. It provides crucial kinetic and kinematic variables for evaluating athletic performance, tracking rehabilitation progress, and guiding treatment protocols [1-3]. Given the necessity to control the body and resultant forces during maneuvers in sports exercises, multi joint exercises using body weight and additional external loads are arguably the most common and essential type of resistance training for athletes. These exercises are critical for increasing strength, power, and for rehabilitating and preventing injuries. Therefore, it is imperative to quantify and compare the loads during such exercises to establish clear criteria for appropriate loading [4, 5]. The primary advantage of using a force plate in rehabilitation is its ability to provide objective, quantitative assessments. This allows sports scientists, athletic trainers, and physical therapists to accurately evaluate an athlete's balance, stability, and gravity distribution [4,6,7]. By analyzing the data from the force plate, they can identify asymmetries or deficiencies in the athlete's movement patterns, which can then be addressed through targeted rehabilitation exercises [8,9].

Additionally, most current studies utilize the force plate to evaluate an athlete's lower limb strength and power. Such as vertical jumps, isometric maximum strength tests, and unilateral and bilateral squats performed on the force plate allow for the quantification of the

athlete's force, power generation, and rate of force development in the lower limbs [10-12]. This information is pivotal in developing personalized strength and conditioning programs aimed at enhancing athletic performance and mitigating injury risks [13-15]. Beyond its diagnostic utility, the force plate also functions as a biofeedback mechanism during rehabilitation. By providing real-time visual or data feedback based on the athlete's performance, it can enhance training by improving balance, coordination, and movement patterns [15,16]. This interactive feedback can increase the effectiveness of rehabilitation exercises and speed up the recovery process.

In summary, using the force plate to collect kinematic and kinetic parameters is a valuable tool in athlete training and rehabilitation. Its ability to provide objective measurements, evaluate lower limb strength and power, and deliver biofeedback underscores its critical role in optimizing athletic performance and ensuring a safe return to sports post-injury. As technology progresses, the significance of force plates in sports performance and rehabilitation will likely continue to grow.

Discussion

Force plates are a valuable tool in athlete rehabilitation, providing crucial data and insights into an athlete's movement patterns and biomechanics. By utilizing force plates, sports medicine professionals can better understand an athlete's physical capabilities and limitations, ultimately leading to more effective rehabilitation strategies. This discussion will explore the kinematics and kinetic variables of force plates and their application in athlete rehabilitation.

Ground Reaction Forces (GRFs)

Sports injuries often occur during jumping, running, cutting, and Change of Direction (COD) tasks. These activities require athletes to decelerate by generating significant anterior and posterior Ground Reaction Forces (GRFs). After deceleration, they must redirect their center of mass, producing greater medial or lateral ground reaction forces. During jumping, athletes generate vertical force to propel upward and must stabilize and absorb impact upon landing [17-19]. As speed and power increase, effectively modulating these multidirectional GRFs during jumping and cutting tasks is crucial for maintaining proper body support and positioning, thereby protecting against injury.

Rate of Force Development (RFD)

Rate of Force Development (RFD) determinants vary over time from force onset, with maximal strength playing a diminishing role as time decreases. Neural activation, fiber type composition, and muscle contractile properties significantly influence RFD, particularly in early rapid force development. Conventional moderate-load resistance training is often insufficient for restoring or enhancing RFD. Therefore, incorporating periodized resistance and explosive training techniques in late-stage rehabilitation is recommended before Returning to Sport (RTS)[20]. Lower limb Anterior Cruciate Ligament (ACL) injuries are common in athletes. Full recovery after ACL reconstruction is often defined by achieving 85% to 90% of the contralateral limb's maximal strength. However, since many daily and sports activities require quicker strength development than achieving maximal strength, neuromuscular functions like RFD should also be considered in the recovery criteria [1].

Asymmetry index

Analysis of GRF symmetry using force plate technology can indirectly assess knee kinetic symmetry. Understanding lower extremity asymmetry is crucial for evaluating injury risk, rehabilitation, and performance [6]. For example, individuals with anterior ACL reconstruction typically land with about 15% more force on their uninvolved limb during jump-landing tasks, and strength asymmetries greater than 15% are associated with higher injury risk [21-23]. This technology allows sports medicine professionals to objectively track patient progress throughout rehabilitation and provide athletes with feedback on their GRF symmetry during training.

Landing force

From a biomechanical perspective, landings require optimal technical performance and efficient absorption of impact forces to minimize injury risk. High-impact landing tasks are associated with various injuries, including ankle ligament sprains, patellar tendon injuries, and ACL ruptures. Previous studies have shown that measuring landing forces is crucial during an athlete's rehabilitation [24]. For example, Cohen, Clarke [25] quantified Countermovement Jump (CMJ) peak force during take-off and landing in injured and healthy soccer players, finding that landing force asymmetries were 57% greater in injured players.

Conclusion

In conclusion, the force plate stands as a cornerstone in the realm of athlete rehabilitation and performance evaluation. Its role in providing objective data, guiding treatment plans, and enhancing athletic training is indispensable. As we look to the future, the continued evolution of force plate technology promises to further elevate its impact on sports performance and rehabilitation.

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