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Teaching and Emphasizing Proper Landing Technique

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Abstract Teaching youths how to land properly may sometimes be overlooked. It is important to minimize the risk of injury during the developmental stages by teaching the proper way to land in order to absorb the impact from landing. This article will first highlight some techniques that are commonly observed when landing and will then provide safer alternatives for such techniques. The article will also provide options for feedback (verbal and visual) and methods for progressing students and athletes as they refine their technique.

Keywords: *landing technique, valgus, movement analysis, qualitative biomechanics*

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1. Introduction

When teaching and coaching youth physical fitness and sports programs, there is often a tendency to focus on technique proficiency associated with accelerating the body and the ability to maintain control through rapid directional changes [1,2,3,4]. However, the ability to rapidly slow the body is required any time an immediate or gradual stop or change of direction is performed. The ability to dissipate the large impact forces and transfer energy throughout the body becomes crucial as the amount of time allowed to decelerate the body decreases. If these high forces and torques generated at impact are not effectively dissipated over multiple joints, the risk for sustaining an injury is increased [5]. Therefore it is important to teach proper landing techniques during the developmental stages of physical activity and sport so the potential for injury can be minimized early.

This article will first compare several different landing techniques often observed when landing from a vertical jump or when landing from a height (i.e. drop jump). Following this comparison, recommendations including cues to promote and encourage optimal landing patterns and exercises to strengthen the primary muscle groups involved 26 will be provided (see Table 1).

1.1. Ground Contact Phase

Initial Ground Contact

The Ground Contact Phase begins when the foot first touches the ground and continues through maximum foot contact. Two common forms of initial ground contact are the flat-footed (whole foot) contact and the toe-heel (forefoot) contact (see Table 1). When the entire foot comes in contact with the landing surface at the same time, it is much more difficult to rapidly dissipate the forces incurred upon landing. When the toes are allowed to contact the surface first, the rest of the foot can be lowered down toward the surface in a more controlled manner. This technique allows the many joints of the foot and ankle to flex and extend to allow the impact force to travel up through the foot and into the ankle and lower leg. The more joints that are able to be flexed and/or extended allow for greater dissipation of the impact force [6]. A flat-footed landing can often be observed by a stiff, jolting landing and is typically accompanied by a loud noise at impact as the entire foot hits the ground at once.

It is important to note that some people may not lower their entire foot to the ground – this has potential benefits and disadvantages. A less rigid landing posture is typically observed when compared to the flat-footed landing, thereby potentially increasing the ability to dissipate the landing forces at impact. However, the increased activity required in the muscles of the lower leg to maintain the elevated heel position may lead to overuse injuries (e.g. shin splints, muscle strains, compartment syndrome, etc. [7].

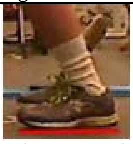
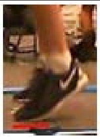
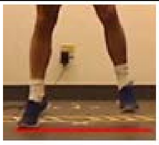
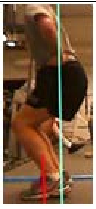
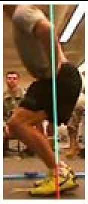
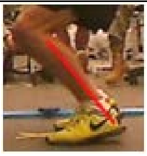
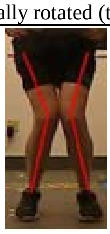
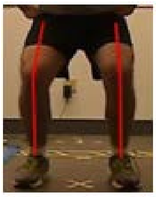
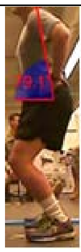
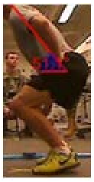
Single- and Double-Leg Landings

Whenever possible, it is optimal to have both feet contact the ground at the same time (i.e. double-leg landing). This increases the base of support (BOS) for increased stability as well as allowing both legs to dissipate the impact force [6,8,9]. When a single leg is used to absorb the landing, the BOS is decreased considerably compared to a double- leg landing. The single leg will also typically be off-center to the body's center of gravity creating additional torques across the joint. The combination of increased joint torque and decreased BOS located outside of the center of gravity are common mechanisms for injuries such as anterior cruciate ligament (ACL) strains and ruptures [10,11].

Foot placement in Relation to the Center of Gravity

Looking at the body from the side, it is ideal to perform a double-leg landing with the feet positioned parallel to each other, underneath the center of gravity [11]. When the feet contact the ground ahead of the center of gravity, the legs will be more extended at impact making it more difficult to absorb the forces (i.e., increased mechanism for ACL injury [10,11]) incurred upon landing. This will also cause a tendency to become off-balance and fall backwards. Likewise, when the feet contact the ground behind the center of gravity, there will be a tendency to fall forward with the momentum of the landing.

Table 1. Movement characteristics associated with disadvantageous and optimal landing patterns

Phase	Characteristic Observed	Disadvantageous Landing Pattern	Optimal Landing Pattern	Verbal Cueing
Ground Contact Phase	*1. Initial ground contact*	 Flat-foot/whole foot	 Toe-heel contact	Land quietly
	2. Single vs Double leg ground contact	 Single leg	 Double leg	Both feet at the same time
	3. Foot placement	  In front or behind the body's center of gravity  Staggered	 Underneath the body's center of gravity  Parallel	Feet should make a rectangle directly under you
	4. Stance width	 Less than hip-width	 Hip-width or more	Feet shoulder-width apart
Deceleration phase	*5. Foot angle*	 Externally rotated (toe out)	 Straight	Feet pointing forward
	6. Knee motion (e.g. valgus)	 Knees come together (valgus)	 Knees aligned with hip and ankle	Knees under hips
	7. Multi-joint flexion	 Limited flexion(stiff landing)	 Flex from ankle through the hip	Land softly; sink into the landing
	8. Trunk angle	 Close to 90° (erect)	 Around 45° forward	Bend forward at the waist

A staggered foot placement upon landing will also create additional loads on one leg (i.e. the forward leg) [11]. By ensuring that the feet are parallel to each other and directly under the center of gravity, the impact forces can be dissipated equally through the joints of both legs.

Stance Width

Stability is increased when the size of the BOS is increased. Therefore, when the feet are at least hip width to shoulder width apart upon landing, the BOS is sufficient in size to create a solid foundation for a balanced landing. It is important to note that a wide stance also increases the potential for valgus motion at the knees. Valgus motion is characteristic of the knees shifting inward towards each other and is commonly associated with decreased strength of the hip abductors (primarily the gluteus medius) [10,12,13]. If the hip abductors are not functioning properly, then this muscle group must first be strengthened prior to addressing the stance width.

1.2. Deceleration Phase

Foot Angle

When landing from a vertical jump, alignment of the body from the feet through the hips is essential. This allows the impact force to be transferred across multiple joints with limited amounts of torque present. Torque is a force at a joint that creates a rotational movement. This rotation is often associated with injury, especially when one or both limbs associated with that joint are fixed [10]. When the feet contact the ground during a vertical jump landing limited external rotation of the feet (i.e. toes pointing outward) should be observed. This will ensure that the impact forces can travel up through the ankles, knees and hips without excessive torques.

Knee Motion (Knee Valgus)

Alignment of the lower body is critical for the effective dissipation of forces and transference of energy throughout landing. As stated previously, there is a tendency for the knees to move closer together (i.e. valgus) during landing; however, such a movement pattern can have significant repercussions and is often associated with serious injury [10,11]. The primary function of the knee is to move through flexion and extension. While minimal rotation is allowed at the knee, the supporting structures (i.e. muscles and ligaments) are designed to provide support primarily through flexion and extension. When the knee moves into a valgus position, the muscles and ligaments located on the inside (medial) of the leg as well as within the knee joint are now required to provide medial support in addition their primary function; to assist with knee flexion and extension. The musculature of the hip is also required to help pull the knee back into alignment (abduction) [11,14]. The added stress placed on the structures of the hip and knee during a high velocity movement (landing from a jump) may exceed what the musculature and ligaments are able to withstand and the potential for injury to these structures increases.

If knee valgus is observed during any movement skills (e.g. landing from a jump, squatting, single leg squats, etc.) it is important to stop the activity and begin to correct the technique as addressed in the Conditioning section of this article.

Multi-joint Flexion

The more joints that can be used to help absorb and transfer impact forces at landing, the less traumatic the landing will be to the muscle tissue and supporting structures of the legs. A “stiff-legged” landing is characteristic of limited joint flexion at ground contact [15]. This creates a jolting or jarring motion and limits the ability of the body to dissipate the large impact force. A slight bend in the knee at ground contact is optimal and should be accompanied by “triple joint flexion” immediately following ground contact [9,16,17,18]. Triple joint flexion refers to near simultaneous flexion of the ankle, knee and hip to dissipate the energy and forces upon impact.

Torso Angle

Torso angle is the final characteristic of landing technique addressed in this article. Torso angle describes the amount of forward lean the trunk of the body has relative to the horizontal. An angle near 45-50° is optimal compared to a more erect posture where the torso angle is closer to 90° [1,2,3,19]. There are several performance 103 benefits associated with a slight forward lean. First, the body’s center of gravity will lower slightly with a forward lean; thereby increasing stability. Second, while torso angle and hip angle are not synonymous with each other, a torso angle near 45° will encourage a greater flexion of the hip compared to a more upright posture. Third, a smaller torso angle (i.e. increased forward lean) will bring the center of gravity forward slightly; thereby requiring the hips to move back to counterbalance the body. This will help to activate the large muscles located around the hips and thighs (e.g. gluteals, quadriceps and hamstrings) which will help to [15] dissipate the impact forces.

1.3. Recommendations to Encourage Optimal Landing Patterns

Once aware of the techniques that promote safe and effective landings, a coach or teacher can begin to emphasize these desired traits in their participants. Providing feedback following the activity has been shown to improve performance and may possibly lead to a decreased risk of injury if implemented consistently [20]. Such feedback may include providing specific cues to the participant in order to elicit the desired outcomes in performance (e.g., land softly and quietly with both feet at the same time; see Table 1). Reviewing video footage of the performance and providing a demonstration of the task is another way to emphasize proper technique during an activity or immediately following the performance. It is important, however, to provide consistent feedback; therefore all coaches and instructors should be using the same cues to emphasize proper landing mechanics.

Strengthening specific muscles groups essential to the performance can often benefit the individual as well. Training programs should be individualized for each participant and gradually progress to challenge the athlete or student. Exercises using resistance bands have been shown to help increase strength in the musculature surrounding the hip (i.e., gluteus medius) which is important for minimizing the tendency to move into a valgus position at the knees (knees moving towards each other) [12]. Gradually increasing the intensity by progressing towards plyometric exercises which may include small amplitude jumping exercises and working towards small jumping tasks can also help to increase the ability to control the body upon impact [12,21]. With any strength training, it is always important to let the participant's performance dictate the progression. If the techniques outlined in this article are not able to be maintained through the progression, then the participant should to be returned to a level where proper technique can be performed. Once the strength has been developed and coordination patterns have been learned, progressing to a more challenging task may be attempted.

2. Conclusions

Techniques used when landing from a jump are sometimes overlooked when working with youths. However, this is the stage when such techniques should be refined so that the proper kinematics can be learned early on during the developmental stages. Being able to efficiently absorb the large impact forces of a landing is essential to minimizing the risk of serious injury. Observing the performance, providing verbal and visual feedback, and implementing a strengthening program can all be used to help promote safe landing performances.

References

[1] Atwater, E., *Kinematic analysis of sprinting.* Track and Field Quarterly Review, 1982. 82(2): p. 12.

[2] Chu, D. and R. Korchemny, *Sprinting stride actions: analysis and evaluation.* National Strength and Conditioning Association Journal, 1993. 15(1).

[3] Hewit, J., et al., *Kinematic factors affecting fast and slow straight and change of direction acceleration times.* Journal of Strength and Conditioning Research, 2013. 27(1): p. 69-75.

[4] Sheppard, J. and W. Young, *Agility literature review: classifications, training and testing.* Journal of Sports Sciences, 2006. 24(9): p. 919-932.

[5] Hewit, J., et al., *Understanding deceleration in sport.* Strength and Conditioning Journal, 2011. 33(1): p. 47-52.

[6] Burkett, B., *Sports Mechanics for Coaches.* 3rd ed. 2010, Champaign, IL: Human Kinetics.

[7] Hamilton, W. and A. Brief, *Lower leg and ankle injuries*, in *Sports Injury*, R. Gotlin, Editor. 2008, Human Kinetics: Champaign, IL. p. 225-228.

[8] Hay, J., *The Biomechanics of Sports Techniques.* Fourth ed. 1993, Englewood Cliffs, New Jersey:Prentice Hall.

[9] Tillman, M., et al., *Jumping and landing techniques in elite women's volleball.* Journal of Sports Science and Medicine, 2004. 3(30-36).

[10] Ireland, M., *Anterior cruciate ligament injury in female athletes: epidemiology.* Journal of Athletic Training, 1999. 34(2): p. 150-154.

[11] Myer, G., et al., *Real-time assessment and neuromuscular training feedback technquies to prevent ACL injury in female athletes.* Strength and Conditioning Journal, 2011. 33(3): p. 21-35.

[12] Dai, B., et al., *A resistance band increased internal hip abduction moments and gluteus medius activation during pre-landing and early-landing.* Journal of Biomechanics, 2014. 47: p. 3674-165 3680.

[13] DeMorat, G., et al., *Aggressive quadriceps loading can induce noncontact anterior cruciate ligament injury.* American Journal of Sports Medicine, 2004. 32(2): p. 477-483.

[14] Padua, D., D. Bell, and M. Clark, *Neuromuscular characteristics of individuals displaying excessive medial knee displacement.* Journal of Athletic Training, 2012. 47(5): p. 525-536.

[15] Aerts, I., et al., *A systematic review of different jump-landing variables in relation to injuries.* Journal of Sports Medicine and Physical Fitness, 2013. 53: p. 509-519.

[16] Colby, S., et al., *Electromyographic and kinematic analysis of cutting maneuvres: implications for anterior cruciate ligament injury.* American Journal of Sports Medicine, 2000. 28: p. 234.

[17] McNitt-Gray, J., *Kinetics of the lower extremity during drop landings from three heights.* Journal of Biomechanics, 1993. 26(9): p. 1037-1046.

[18] Palmieri-Smith, R., et al., *Association of quadriceps and hanstrings co-contraction patterns with knee joint loading.* Journal of Athletic Training, 2009. 44(3): p. 256-263.

[19] Shimokochi, Y., et al., *Changing sagittal plane body position during single-leg landings influences the risk of non-contact anterior cruciate ligement injury.* Knee Surg Sports Tramatol Arthrosc, 2013. 21(888-897).

[20] Erickson, H., et al., *Immediate effects of real-time feedback on jump-landing kinematics.* Journal of Orthopaedic and Sports Physical Therapy, 2015. 45(2): p. 112-118.

[21] Hewett, T., et al., *Plyometric training in female athletes: decreased impact forces and increased hamstring torques.* American Journal of Sports Medicine, 1996. 24(6): p. 765.