PROPER TECHNIQUE FOR INJURY PREVENTION AND EFFICIENT PERFORMANCE

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A concise overview of fundamental movement mechanics as a prerequisite for advanced conditioning and skill learning. These underlying principles are applicable to all track and field disciplines. Klatt at the time was the director of the Human Performance Laboratory at Concordia College in River Forest, Illinois.

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The human body is a magnificent machine that was created to move. It is one of the few machines that can improve with use.

Development of the body is usually viewed systematically. The cardiovascular and respiratory systems improve as a whole. The nervous, muscular, and skeletal systems are enhanced and developed only with specificity of training. Nerve patterns and specific muscles and bones will improve or hypertrophy, depending on how they are individually trained. The most important measurable components of a physically fit individual include cardiovascular-respiratory endurance, body composition, strength and flexibility, body alignment, dynamic balance and body control, and specific sport skill development.

For this article it will be assumed that the essential components of fitness, cardiovascular-respiratory endurance and body composition, have been ideally developed. To develop maximum sport performance and prevent injuries, the coach, conditioning specialist, or biomechanist needs to design both a pre-season conditioning program and assessment analysis tool (pre and/or post-season) which includes symmetrical body alignment, strength relative to flexibility (range of movement), equal amounts of muscular strength and power (strength and speed), dynamic balance and body control, and proper technique relative to specific sport performance.

Such components of complete fitness relate to structural and functional development of the neuromuscular and skeletal systems. The pre (or post)-season assessment and conditioning program needs to be based on mechanical principles of movement.

MECHANICAL PRINCIPLES OF MOVEMENT

Concepts which need to be followed relative to maximum sport performance include:

FORCES

Production and reduction of force.

The body produces and reduces forces through its linkage system, joint by joint. Sport skill patterns can be classified into *pushing patterns* (joints moving at the same time) or *sequential patterns* (one joint following another joint).

The use of one or two joints is not sufficient to increase the production or reduction of force, since the hip, knee, and ankle, and the shoulder, elbow, and wrist work together. At least three joints are needed.

To produce a forceful throwing pattern, at least five joints are utilized—hip rotation (knee and ankle), spinal rotation, followed by shoulder, elbow, and wrist action. As an object or as the body weight is received, forces are absorbed over time and distance throughout the joint system. Landing from a run or jump potentially involves three to four times the body weight. Forces must be received by more than the ankle and/or knee joint; the hip must also be included.

Force and counter force.

The back leg in a throwing pattern initiates the production of forces, while the forward leg is the counter force which is used to change the direction of force within the body's linkage system.

MUSCLE CONTRACTION

Concentric and eccentric contraction.

The organs of the skeletal system maintain the body's structure (bone) and joint (ligaments) integrity. Forces within the body relate only to the neuromuscular systems. Muscular contractions, whether they shorten or lengthen—and not ligaments over joints—produce or reduce forces.

Athletes must be conditioned and taught how to jump up and develop their muscles concentrically (to shorten) and equally how to land, developing their muscles eccentrically (to lengthen). Since most injuries occur on the down or preparation phase of a skill, perhaps athletes need to learn first how to land, before they are taught how to project themselves upward.

PLANES OF MOVEMENT

Planes of movement.

Movement takes place anteriorly-posteriorly in the sagittal plane. Terms include flexion, and extension into hyperextension. Lateral-medial movement takes place in the coronal plane, from side to side. As a body segment moves around its long axis at the joint, rotation occurs.

"For every action there is an equal and opposite action." This quote usually is stated relative to Newton's Third Law of Motion, but it can also be applied to the body's system of arthrology, or joints. A joint complements and safeguards itself with corresponding movements; a joint that flexes will extend, a joint that abducts will adduct, and a joint that inwardly or medially rotates will outwardly or laterally rotate.

A primary consideration for efficient movement and injury prevention is the development of an equal amount of strength between opposing muscle groups. As the flexors are developed, the extensors need equal time, and vice versa. Too much inward rotation, or rotation to a particular side (i.e., left)), will cause an imbalance of strength relative to the respective joint's outward rotation. Control will be off to a particular side if one side of the trunk, or the medial muscles of the leg at the hip, are overdeveloped. Therefore, a conditioned performer develops purposeful strength and equal amounts of strength in all three directions of movement.

Range of movement (ROM).

Reciprocal innervation is a physiological phenomenon that takes place in the body and must be considered when range of movement at a joint is implemented. When a muscle contracts to perform a desired movement, its exact opposite muscle group relaxes to allow the primary movement—the agonistic movement—to take place.

Applying this phenomenon to a specific joint (i.e., hip), flexibility in the joint can be increased by contracting the flexors; as the flexors are contracted the extensor muscles will relax, allowing the joint to increase its range of movement.

ROM is a key component in enhancing sport performance and preventing joint-related injuries, keeping in mind that muscular strength goes along with flexibility, not just strength or independent joint flexibility. Strength needs to be purposeful and relative.

Performers must maintain control over their joints' range of movement for injury prevention. Good joint integrity is primary. Forces are produced by muscular contraction over specific joints. To maintain the joint integrity, the opposite muscle—the antagonist muscle—fires and keeps the joint in check.

Joints are capable of generating enough range of movement to cause dislocation components. The support ligaments of each joint have a tendency to stretch along with the fibrous joint capsule. Muscles are the only means that should be used to slow down speed of movement and keep the joint in check for good joint integrity.

SYMMETRY VERSUS ASYMMETRY

Centering, a point of focus.

The body functions bilaterally. It also prefers to remain in homeostasis or balance. Centering of the body relates to one's center of gravity. Full concentration and one's point of focus must always remain within the body. As the sagittal and coronal planes come together, a centering line is determined; the transverse plane crosses the other two planes at the body's center of gravity. A point within the pelvis becomes the performer's focal point.

Efficient movement and high levels of sport performance call for the body to be statically and dynamically balanced and under full control—in other words, in symmetry. Posture in the standing position is a dynamic phenomenon which depends largely on the efficiency of the neuromuscular system to habitually engage itself in maintaining the body's symmetry.

The core or trunk of the body constitutes the structural framework; its alignment must be conditioned to conform as closely as possible to mechanical principles of balance. The trunk consists of structural units and masses of weight; these are the head, rib-cage, and pelvis. Alignment of the spinal column plays an important part in balance and control of the head, thorax, and pelvis.

Whenever the body is balancing on one or both feet or one or both hands, the extremity is responsible for control of the body's symmetry. An example of this would be an athlete landing on one leg during a run: the hip, knee, and ankle need to maintain their own alignment. Forces need to be equalized relative to all three planes of movement and relative to the direction of forces. The core, including the head, is responsible for its own balance, and the upper extremities remain under control for independent purpose-

ful movement. As sport skills become more complex, the body's symmetry needs to be developed independently: trunk, lower extremity, and upper extremity.

PROGRESSIVE TRAINING

The body hypertrophies with use.

Progression can relate to the nervous system, the muscular system, and the skeletal system.

For injury prevention and sport skill performance, proper technique is essential as the starting point. Improper as well as efficient techniques can be progressively trained. Skills need to be performed as efficiently and economically as possible for maximum performance. This is accomplished over time, gradually and progressively.

The neuromuscular system improves and functions efficiently with use; bone hypertrophies. Cartilage at the end of bones becomes stronger with use, as do the articulating joint capsule and support ligaments. There is no substitute for progressive training of specific sport skills performed with technical correctness and under full maximum control.