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ANALYSIS OF BIOMECHANICAL PERSPECTIVE OF SPORTS INJURY

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ABSTRACT

Many sportsmen today participate in highly organized sports programs that involve regimented year-round repetitive training. The excessive training has led to an increased incidence of overuse musculoskeletal injuries. Sports scientists and sport physicians have dealt with sports injuries in athletes for many years and, on the basis of their experience, they have developed guidelines to treat and to try and prevent these injuries in mechanical viewpoint. The purpose of this article is to provide a biomechanical perspective of sports injuries in athletes. Basic tissue and gross movement mechanics principles are used to identify movement factors that may influence athletes to an overuse injury. Analytical methods was used for this article by reviewing relevant publications, primarily based on the online sports medicine journals available on Internet, Wikipedia, Elsevier, PubMed and other open access journal. Biomechanics technology and approaches should be used to help enhance performance in sports and to avoid injury. Good understanding of biomechanics may be used in the sports to establish safe and effective training guidelines for sportsman.

Keywords: Biomechanics, Sport Injury and Sportsman.

INTRODUCTION:

Sports injuries are becoming more prevalent in many field sports around the world. The most affected sports are Boxing, Judo, Rugby Football, Soccer, Kabaddi, Wrestling and other contacted Sports event. *Da Vinci, (1492-1519*) All injury leaves pain in the memory except the greatest injury, that is death, which kills memory with life. *Whiting & Zernicke (1998)* sports injury is damage sustained by tissues of the body caused by physical trauma. *Van Mechelen* (1992) Sport injury is the all types of damage that occurs in relation to sporting activities. *Haddon* (1973) energy (amount, rate, transfer) exceeds material/structural capacities.

Athletes are subjected to injuries during training as well as during competition. Occurrence of injuries is an occupational hazard in sports. Stress injuries account maximum four percentages of injuries which an athlete encounters. Wrong technique, sub-standard equipment, mishap or overload are some of the factor responsible for these injuries. Injuries can be studied from many angles as from training point of view,

medical view point, physical and physiology fitness or from mechanical view point. In this paper only the mechanical aspects in prevention of injuries will be dealt with. From the mechanical view point, stress injury to a body part occurs when excessive force or pressure is exerted on it. This may be due to the fact that implied force is not absorbed properly, *i.e.* it is not distributed to other parts of the body and remains localized over a tiny area. To minimize injuries, there are two possibilities

(a) Force may be reduced so that effective implied force is less:

(b) Force is distributed to other parts and its effects are not localized.

METHODS:

Analytical methods was used for this article by reviewing relevant publications, primarily based on the online sports medicine journals available on Internet, Wikipedia, Elsevier, PubMed and other open access journal of Sport and Physical Education.

OBJECTIVE:

To describe the basic mechanical principles of sports injury control; to describe specific interventions that can be implemented in different settings to prevent sports injuries; to describe a specific sports injury problem for which the trainee can also design and implement an intervention in the trainee's own setting.

BIOMECHANICAL PERSPECTIVE:

Thus, the knowledge of mechanical factors which are responsible for dissipation of force is helpful to minimize the occurrence of injuries.

There are three aspects in the effective dissipation of force:

1. Area of Absorption.
2. Distance of Absorption.
3. Time of Absorption.

1. Area of Absorption:

As per the definition of pressure, it is the force per unit area,

$$\text{i.e. } P = \frac{F}{A}$$

Where 'P' is the pressure, 'F' is the force and 'A' is the area over which force acts.

In conditions where the force is constant pressure is inversely proportional to the area. In other words more is the area of absorption, lesser is the pressure exerted and vice versa. If the same amount of force is applied with the first and a finger on a part of the body, pressure exerted in more with the finger than with the fist as the area of absorption of force on the body part is less when force is applied with the finger. Pressure is still more if same force is applied with a needle without puncturing the skin. Thus, to reduce pressure on a body part to avoid injury, area of absorption of force should be increased.

2. Distance of Absorption:

As per the definition of energy it is the capacity to do work or in other words, when energy is absorbed, it does equivalent amount of work on the absorbing part. For example, a moving ball has kinetic energy because of its mass and velocity. When this ball is caught, it is able to do equivalent work on hands equivalent to its kinetic energy possessed. Now

$$W = F \times d$$

Where 'W' is work done, 'F' is the implied force'd' is the distance of absorption

$$F = \frac{w}{d}$$

Under given condition, kinetic energy is constant as mass of the body is constant and its velocity is constant which is determined at the time of release. Now force is inversely proportional to the distance. More is the distance of absorption of energy, less is the implied force and vice versa. For example, if the moving ball is able to do work equivalent to 250 Nm by virtue of its kinetic energy and is stopped over a

distance of 10m. Then the force imparted on the hand is 25 Newtons, but if it is stopped over a distance of 50m, then the force imparted are only 5 Newtons. Thus, to minimize the effective implied force, distance of absorption should be increased.

3. Time of Absorption

According to Newton's second law of motion, impulse is equal to the change of momentum.

Impulse = change of momentum

or $F \times t = m (V_f - V_i)$

Where F is the force, t is the time of absorption, V_f is the final velocity, And V_i is the initial velocity.

A rolling ball or a sportsman when in motion has momentum because of its mass and velocity. When the ball is stopped or the sportsman lands momentum is changed to zero or near zero, mass cannot be changed and initial velocity also cannot be changed in a given situation. This transform of momentum is equal to impulse ($F \times t$) if the time of catching or landing is increased, force implied is reduced. Thus, to decrease the force, time for which force is absorbed should be increased.

VIEWPOINT OF SPORTS:

Falling on mat, landing in pit of jumping event, catching of ball and follow through of any skill are the important actions in sports which, if not properly executed, lead to injury. These constituted the major portion of injuries which the sportsman encounters.

When landing is not properly executed becomes a fall and as a result, injury occurs. Landing or falling is of two categories: first, landing on a firmer surface like ground, floor or mat and secondly, on the non resistive surface like entry into the water, in the first category, landing can be from a high jump, long jump, pole vault, jump in basketball or volleyball, fall in judo, wrestling or in gymnastics. When falling downwards with slight or no frontward momentum, as landing after a jump in volleyball or basketball, feet should be kept under the body so that they contact the floor first. Since balance is a problem on landing a wide base (not more than shoulder width) should be formed before landing is made. When landing is done with ankles in planter flexed position, weight force can be taken first with the balls of the feet and then in rapid succession by the ankles, knees, and hips by flexing these. Thus, the downward momentum is reduced slowly by increasing the time of absorption so that impact is minimized when

forward momentum is involved as in many exercise in gymnastics, injury can be avoided of minimized by relaxing the joint to give in and muscles not remaining stiff while curling into a ball and rolling, thus increasing the time of absorption and area of absorption of force. Whether a forward roll, shoulder roll or hip roll, as in wrestling or judo, area of the force absorption is greatly increased to minimize the pressure on a body part, along with the time of absorption. Every effort should be made to avoid landing on head, knee or elbow, as these are solid areas and possible dissipation of force is negligible.

Jumping

In jumping, shoes with soles which give good cushioning effect should be used. Cushions in the shoes transmit the force, thus, increasing the area of absorption of force and reducing the pressure. During training where repeated jumps are involved, mats or other soft material should be used especially when state of conditioning is not good; otherwise there are greater chances of stress injuries. In jumps, as high jump of pole vault where great amount of force is to be absorbed, jumping pits must be used to have the cushioning effect.

Diving into water differs from landing on a firmer surface as ground or mat. In the case of firmer surface, all the dissipation is within the body while in the case of non-resistive surface, force is reduced by gradually giving of the water. The larger the area of the body with the water contacts, the greater is the water resistance and vice versa. With small area of contact, shock of impact is less because of less water resistance. This is just the reverse when fall is on the resistive surface. When falling into water, if arms are held rigid, they cut a hole for the body to move in. In opposite to fall on the resistive surface, body should be kept rigid and straight as far as possible while falling on non-resistive surface.

Catching

Catching is involved in many sport activities, viz basketball, cricket, softball, baseball handball, soccer etc. in catching, the shock of impact can be minimized by gradual loss of kinetic energy which can be achieved by using as much distance as possible, increasing the time of absorption and the area of contact. While catching, sometimes maintenance of stability is important. Thus, the area of the base should be enlarged in the direction of oncoming ball by having forward-backward stance.

The distance and time absorption can be increased by pulling the hands towards the body (flexion of elbow joints and extension of shoulder joint) position of the hands in catching is the most important factor

in avoiding injuries. Since the area of the tips of fingers is smalls, the impact of the oncoming ball will lead top injuries of the fingers. Thus, fingers should not be pointed towards the oncoming ball. Palms of the hands provide greater area and more absorbent surface. The padded gloves reduce the force of impact by increasing the area or absorption of force and providing more absorbing surface, when used.

Striking or Punching

Situations in which impact is involved are striking or punching as in boxing, hitting force of ball as batting in cricket and goalkeeping in hockey due to rebound. In these situations, protective device such as face mask, head gears, pads, padded gloves etc. should be used. These devices not only provide greater area for force absorption at sensitive area of the body, but also provide more absorbing surface.

Other types of injuries occur when an athlete slips and falls, on the surface on which he is running. Usually, the slippage occurs when the body is suddenly stopped or when the direction is suddenly changed. One of the reasons for this is insufficient friction of shoes according to the playing surface (which give firm grip) and by bringing down the C.G. of the body by widening the base at the time of stopping and change of direction.

Lifting

In lifting, stress injuries occur when excessive pressure is exerted on the weaker body parts. These injuries can be minimized by proper execution of technique. As a rule, at the time of initiation, major force should be applied by strong hip and knee muscles so that weaker muscles are not involved to break the inertia of the weights. Further more, load should be increased progressively, depending upon the conditioning state of the athlete.

Riffle shooting is another sport where shoulder joint injury occurs because of backward impact of the rifle. This injury can be prevented by reducing the backward velocity of the rifle by increasing the effective mass. This is achieved by tightly holding the rifle against the shoulder. Other type of injuries occurs when a body limb (arm or leg) is stopped suddenly after maximum acceleration because of the jerk, as in throwing or kicking. This can be minimized by the follow through action.

CONCLUSION:

An understanding of biomechanics help the sports medicine practitioner, coach, trainee and trainer provide a better guideline to reduce the risk of sports injury. Biomechanics has a major role in maximizing the sports performance by reducing the occurance of injury. Research should focus on

predictors of technique for athletes of varying physical characteristics to improve sports performance and reduce the risk of injury with the help of mechanical aspect. Biomechanics technology and approaches should be used to help enhance performance in sports and avoid injury.

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