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Common injuries in kabaddi play and their prevention with the help of biomechanics

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Abstract
The purpose of this article is to review current research on importance of biomechanics in preventing sports injuries and to present biomechanics applications related to Kabaddi technique, Kabaddi play and concepts of injury prevention. Improvement of technique with the help of biomechanics can be used by teachers and coaches to correct motions of players. Moreover, research workers in the field of biomechanics may develop a new and more effective technique for better execution of a sport motion. Some important aspects related to common injuries during Kabaddi playing and their prevention with the help of biomechanics is discussed. Conclusions are drawn based on the qualitative analysis.

Keywords: Biomechanics, Kabaddi, sports injuries, injury prevention

1. Introduction
Kabaddi is a traditional outdoor game played with minor variations in all regions of India - in fact, in most parts of Asia. It is an ancient backyard and homegrown game. Kabaddi requires tremendous physical stamina, agility, individual proficiency, neuromuscular coordination, lung capacity, quick reflexes, intelligence and presence of mind on the part of both attackers and defenders.

Modern Kabaddi is a synthesis of the game played in various forms under different names. Kabaddi received international exposure during the 1936 Berlin Olympics. The game was introduced in the Indian Olympic Games at Calcutta in 1938. In 1950 the All India Kabaddi Federation came into existence and compiled standard rules. The Amateur Kabaddi Federation of India (AKFI) was founded in 1973. After formation of the Amateur Kabaddi Federation of India, the first men's nationals were held in Madras (renamed Chennai), while the women's were in Calcutta in 1955.Kabaddi was introduced and popularized in Japan in 1979.

Kabaddi is basically an outdoor team game, played in the tropical countries of Asia. The excitement and thrill provided by the game has made it very popular and Kabaddi is rightly called the 'Game of the masses', since spectators totally involve themselves and give the players a great deal of encouragement. The game requires no equipment whatsoever, and the rules of the game are very easy to comprehend. This is the reason for the popularity of the game in rural areas, since rural youth in India can ill-afford the sophisticated equipment demanded by other sports. Today all over the world physical Educators and Coaches are facing their greatest challenge in handling problems in scientific way i.e. to give their sportsmen proper and progressive guide-lines based on scientific approach which leads to desired results. Since, both physical and physiological have been recognized as one of the best means of underlying sportsman's performance and of helping in producing better performance. The physical educators, coaches and sportsmen an understanding of physical character and the physiology of exercise to becoming increasingly important, when everyone's understanding grows the trial error methods and application of guessing becomes less than adequate in preparing high level sportsman for competition.

Biomechanics is a tool to understand human movement that can be applied to enhance player performance and prevent injury. Sports biomechanics is a diverse interdisciplinary field, with branches in Physical Anthropology, Orthopedics, Bioengineering and Human Performance. The general role of Sports Biomechanics is to understand the mechanical cause-effect relationships that determine the motions of sportsmen in particular. Sports biomechanics contributes to the description, explanation, and prediction of the mechanical aspects of human

exercise, sport and play. Sports biomechanics applies the laws of mechanics and physics to human performance, in order to gain a greater understanding of performance in Kabaddi play through modeling, simulation and measurement. The sports performance realms include the conventional areas of sports and exercise, and also field of fundamental motor skills and other highly specialized human movements. It is necessary to have a good understanding of the application of physics to sport, as physical principles such as motion, resistance, momentum and friction play a part in most sporting events. The scientific field of sports biomechanics sets out to generate and distribute knowledge to improve human performance and reduce the incidence of injury. The emphasis is on the practical implications and applications of research, it seeks to benefit practitioners, especially scientists, coaches, clinicians, teachers, and participants.

Robotics, physics, mathematical analysis, imaging, and computer simulations are the some of the latest tools in the quest to improve performance. Together they are used in the study of biomechanics-the physiological analysis of the interaction of forces and effects of forces on and within the human body. Biomechanics researchers are able to examine each aspect of a movement to enhance performance and to understand the mechanisms of injury. Applying robotic techniques can help determine whether an athlete is moving optimally by estimating muscle movement to calculate effort

A critical step in the sequence is to establish the causes. This includes obtaining information on why a particular athlete may be at risk in a given situation (risk factors), and how injuries happen (injury mechanisms). Furthermore, a complete understanding of injury causation needs to address the multifactorial nature of sports injuries.

Dey, *et al*. (2012) [2] presented Morphological and physiological studies on Indian national Kabaddi players. Jadhav (2011) [4] studied the Role of Yoga in Kabaddi Verma *et al*. (2011) [6]. Did a Descriptive Study on Developing Physical Profile of Kabaddi Players. Barfield, B (1998) [1] analyzed the biomechanics of kicking in soccer. JONES, G. (2005) [5] studied the Biomechanical consideration following injury. In the recent past it has been included in many national and international level sports competitions. In spite of the wide popularity of the game, only few articles discuss Kabaddi related sports injuries and prevention. This study lays emphasis on Some important aspects related to common injuries during Kabaddi playing and there prevention in a broad biomechanical spectrum.

2. Common Injuries

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. Kabaddi game is very fast, rough and tough. Body Injuries are very common in it. Like many other sports, Kabaddi is a vigorous body contact game. Nature of Individual defense and group offence of the sport makes Kabaddi players prone to many types of injuries and also Kabaddi being a contact game and because of its powerful nature, many body parts get prone to injuries.

Kabaddi players are subjected to injuries during training as well as during competition. Occurrence of injuries is an occupational hazard in Kabaddi game. Stress injuries account maximum four percentages of injuries which an athlete encounters. Wrong technique, 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. Knee injury is the most common type of injury sustained by both "Raiders" and "Stoppers/Defenders". Sudden turning and twisting movements are required by a Raider to free him/her from the stoppers. Thirty seconds of time limit for a raid also creates a pressure to reach the home court within allotted time in case of a raider and to keep the raider in his/her home court for a stopper. Quick reflexive actions that come into play during this time period make knees highly vulnerable to injuries. The most common part of the knee to get injured in Kabaddi is the ligaments.

When a Raider tries to evade the defender/s, sudden start and stop movements are bound to occur. These quick and reflexive movements of starting, stopping, bending, twisting and changing direction exert extreme force on the knee resulting in injuries to the ligaments. Injury to the ligament is termed as a "Torn Ligament" also commonly called a "Sprain". Ligament that is most effected by sudden movements in Kabbadi is the Anterior Cruciate Ligament (ACL). However other ligaments can also be injured. sudden stopping and changing direction to evade or catch the opponent player causes tremendous amount of stress on the knee. These movements create powerful contraction in quadriceps and hamstring muscles leading to a tear in the meniscus leading to the onset of excruciating acute knee pain. This type of injury is characterized by swelling and tenderness to the knee.

Ankle Sprain: Injury to the ligaments (tissue that connects bones to bones) is called a sprain. This type of injury is very common in Kabaddi. Sudden movements of a raider to escape or evade a stopper, a raider turning back after tagging the opponent(s) can sometimes result in twisting movements. Moreover Kabadi is a rural game. Most of the tournaments and championships are held on uneven grounds. An awkward step or landing on an uneven surface result in overstretching of the ligaments thus causing them to be partially or completely torn.

Ankle Strain: Kabadi is a contact sport and involves lot of pushing, pulling, jumping and twisting actions. These types of sporting actions are a leading cause of strains. Repetitive use of certain body parts makes them even more prone to these types of injuries. A strain is characterized by the onset of symptoms such as severe pain (in case of an acute strain), Muscles spasms, Swelling and cramping. Ankle Fracture: Due to the contact nature of the game, ankles are very prone to fractures. While playing Kabbadi, there are many instances that can lead to a fractured ankle. After tagging an opponent(s), a raider sometimes makes a sharp "U" turn towards his/her home court. This action can lead to twisting of the ankle side to side. Uneven grounds also account for many such injuries.

Secondly, in an effort to stop the raider from returning back to his/her home court, a stopper/ante tries to immobilize one or both lower limbs by performing the "ankle hold". During this the raider rolls to the sides and often does the jerking action to free him/her from the hold. Thirdly, jumping is very common in National Style Kabaddi. This is required to evade being caught by ante players. If a raider is successful in evading ante players by jumping, his/her landing can cause extreme force on the ankle joint. Body's entire weight along with the force of the fall causes trauma to the ankle and results in a fracture.

2.1 Calf Muscle Injuries

A Calf muscle injury is common in Kabadii Game. Calf injuries are sometimes known as a ‘pulled Calf'. The term 'pulled muscle' comes from the description of how the injury takes place. Usually the Calf muscle is forcibly stretched beyond its limits and the muscle tissue becomes torn. A tear in the Calf muscle is referred to as a Calf strain and depending on its severity it is classified as a first, second or third degree strain:

- A first degree strain is damage to a few muscle fibres.
- A second degree strain is damage to a more extensive number of muscle fibres.
- A third degree strain is a complete rupture of the muscle itself.

The Calf muscle group consists of the Gastrocnemius, Soleus and Plantaris muscles, situated at the back of the lower leg. The function of the Calf muscles is to pull up on the heel bone during the ‘push-off' phase of walking and running.

3. Prevention

It is important to recognize that the causes of injuries in Kabaddi game are usually multifactorial and that a single preventive action or strategy may not be successful in isolation. Rather a combined strategic approach is required to implement a successful sports safety framework that covers all possible situations. Biomechanics has been defined as the study of the movement of living things using the science of mechanics. Mechanics is a branch of physics that is concerned with the description of motion and how forces create motion. Forces acting on living things can create motion, be a healthy stimulus for growth and development, or overload tissues, causing injury. Biomechanics provides conceptual and mathematical tools that are necessary for understanding how living things move and how kinesiology professionals might improve movement or make movement safer.

Knee injuries can be prevented by changing body’s position with a blend of characteristics such as balance, coordination, speed, reflexes, and strength. It is also very beneficial to adapt certain exercise programs that incorporate exercises to stabilize knee joints. Thigh and calf muscles are large muscles that are under maximum stress during sprinting in Kabadi. Adapting exercise regimen that strengthens these muscles will provide greater control and reduce the incidence of knee injury.

Kneepads can also be used to provide additional support to the knee especially when coming back from a knee injury. However, they are meant for short term use only. Long-term use of kneepads should be avoided as they start to weaken the knee.

First few hours after the ankle sprain, strain and fracture injury are very crucial. An injured Kabaddi player with a sprained ankle must be provided first aid as soon as possible. It prevents further complications and helps in a reduced healing time. Rest the injured foot after a sprain. Avoid putting any weight in the injured foot. Crutches can be used during this initial period. Ice helps to keep swelling in check. An ice pack can be used however it should not be used for more than 20 minutes. Compression helps in minimizing swelling as well. An Elastoplast bandage can be used for this purpose. Wrap the Elastoplast in a circular motion starting from the bottom of the foot to the upper calf. Do not wrap it tight as it might cut off circulation and cause more damage. Toes getting cold or turning blue is a tell tale sign of loss of circulation. It should be snug not tight. Kabaddi players can expect up to 2 months for the bone to heal and several more months for the rehabilitation process. Recovery time can vary depending upon the severity of the injury and chances of developing arthritis in the damaged ankle down the road.

Resting may be the best approach for calf muscle treatment, but it is one that is often ignored by Kabaddi players. This is unwise, since it does not take much to turn a grade one Calf muscle strain into a grade two, or a grade two Calf strain into a grade three. As a general rule, depending on type of injury players must be rested from sporting activity for about 3 weeks to 3 months.

Biomechanics principles must be integrated with other kinesiology sciences to solve human movement problems, like in the qualitative analysis a round off and back handspring. Another way biomechanics research improves performance is advances in exercise and conditioning programs. Biomechanical studies of exercise movements and training devices serve to determine the most effective training to improve performance. Biomechanical research on exercises is often compared to research on the sport or activity that is the focus of training. Strength and conditioning professionals can better apply the principle of specificity when biomechanical research is used in the development of exercise programs. Computer-controlled exercise and testing machines are another example of how biomechanics contributes to strength and conditioning. In the next section the application of biomechanics in the medical areas of orthotics and prosthetics will be mentioned in relation to preventing injury, but many prosthetics are now being designed to improve the performance of disabled athletes.

Several basic principles should be kept in mind when evaluating the changes in the biomechanics of the lower extremities as the speed of gait increases. The transverse rotation that accrues in the lower extremity during riding and defense gait has been documented both quantitatively and qualitatively. Qualitative data obtained from high speed motives exhibit that the same basic type of rotation occurs during running, and the rotation seems to be of some what greater magnitude than that observed during walking.

In a basic biomechanical model that takes tissue properties as well as load characteristics into account, injury results from a transfer of energy to the tissue. The mechanical properties of human tissue, such as stiffness (stress–strain relation) and ultimate strength, govern how the body responds to physical loads. They differ for each tissue and are dependent on the nature and type of load, its rate, the frequency of load repetition, the magnitude of energy transfer, and intrinsic factors such as age, sex, and physical condition. In this model, it is the relation between load and load tolerance that determines the injury outcome of an event. The key point to consider with regard to biomechanical factors is that they must explain how the event either resulted in a mechanical load in excess of that tolerated under normal circumstances or reduced the tolerance levels to a point at which a normal mechanical load cannot be tolerated. McIntosh has recently described a more complex biomechanically focused model of injury causation to account for additional factors that may influence the interplay between load and load tolerance (positively or negatively), such as behaviour/attitudes, training, skills, equipment, coaching, other competitors, and the environment. One of the purposes of this model is to describe how load and load tolerance and hence injury risk can change as a result of changes in such factors through interventions. For example, a helmet will attenuate impact energy, thereby reducing the head impact force, and skills

training may enable someone to maintain their balance over the weight bearing knee, thus reducing knee loads in the frontal and transverse planes. Improved fitness may protect the tissue against injury through the effects of training on its material properties, but can also result in higher forces being applied to the tissue. If a tennis player through strength, fitness, or skill training develops a faster serve, this can result in a higher load on his/ her shoulder, as well as for the opponent.

4. Conclusion

We started this article by short introduction to Kabaddi and outlining a novel approach to sports biomechanics. The main focus in this paper would be the qualitative analysis of human movement patterns in Kabaddi sport. We defined movements in the sagittal plane and touched on those in the frontal and horizontal planes. We then considered the constraints-led approach to studying human movements, and went on to look at examples of walking, running, jumping and throwing. Finally we suggest some remedies to prevent injuries during the play.

Some of the suggestions for preventing the injuries are,

- Warm up prior to matches and training is thought to decrease muscle stretch injuries because the muscle is more extensible when the tissue temperature has been increased by one or two degrees.
- Range-of-motion exercises can help maintain normal joint function by increasing and preserving joint mobility and flexibility. In this group of exercises, gently straightening and bending the joints in a controlled manner as far as they comfortably will go can help condition the affected joints
- Maintaining good muscle strength and flexibility may help prevent muscle strains. Muscle strength allows a player to carry out match activities in a controlled manner and decreases the uncoordinated movements which can lead to injury. Tight muscles are associated with strains. Stretching is therefore practiced to maintain muscle length and prevent injury.
- Diet can have an affect on muscle injuries. If a player's diet is high in carbohydrate in the 48 hours before a match there will be an adequate supply of the energy that is necessary for muscle contractions.
- Recovery after training sessions and matches can be enhanced by performing a cool down and stretching exercises.

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