Essentials of Sports Injury Prevention & Rehabilitation

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Lecture – 4

Joints of the Lower Limb

Good morning ladies and gentlemen, and welcome to lecture 4 of week 1 of the course on Sports Injuries and Rehabilitation. I will be speaking to you today about joints of the lower limb. As we discussed in the joints of the upper limb lecture, we will be talking more about the functional biomechanics of the joint, and how they affect movement; and in case of the lower limb gait. We will be talking about the hip joint, the knee joint and the ankle joint. So, the hip joint is a ball and socket joint with articulation between the head of the femur and the acetabulum of the pelvis. It is a diarthrodial joint, and as we can see because of its position, the depth of the acetabulum, and because of the size of the head of the femur, the joint is inherently stable because of the peculiarities of the articulation of the components of the joint.

The primary function of the hip joint is to provide dynamic support to the weight of the body and the trunk, at the same time facilitating force and load transmission from the skeletal to the lower extremities; for a very simple reason, it will allow you to walk and to run. Other structures around the hip joint are the femoral neck, the acetabular labrum, like we saw in the shoulder capsule, there is an acetabular labrum in the hip; and beyond the labrum, there is a hip joint capsule. There are also muscles surrounding the hip which add to the stability. There is a cartilage on the femoral head which is present, and the thickness and the mechanical properties of the cartilage depend on the line of weight transmission. This may vary depending upon the needs of the joint and the joint forces which are acting upon the joint.

When we talk about biomechanics of the hip, we have to talk about the gait. Gait involves movement in all three planes sagittal, frontal and transverse along with rotation of the hip joint. When we walk or when we stand, there is a force three times the body weight which acts on the hip joint with the pelvis in a neutral position. When we are in the stance phase of gait, that means when the foot is on the ground during gait, the weight or the hip joint reaction force is 3 to 6 times body weight. However, when we are in the swing phase of gait, that means when the foot is off the ground, the hip joint reaction forces are equal to the body weight.

We must also know that any increase in gait velocity increases the magnitude of the hip joint reaction force in both swing and stance phases of gait. That means, if you walk or run faster, the forces on your hip joint are much higher. If we talk about the applied anatomy of the hip, dislocations of the hip are rare. The only exception is something called a dashboard injury, which happens if you are during automobile accidents, wherein there is posterior dislocation of the hip joint. Otherwise, the hip joint dislocates very very rarely because it is inherently stable and it is inherently strong.

However, arthritis of the hip joint is relatively common because of its role in weight bearing and its role during running and during gait. There are several fractures around the hip joint which affect the hip joint function. Most commonly, fractures of the head and the neck of the femur and the upper end of the femur, which definitely affect hip joint function. There is something called avascular necrosis, which may affect the head of the femur, wherein the blood supply to the head of the femur is disturbed or reduced, and the head of the femur goes into something called avascular necrosis. The head of the femur gets distorted and this leads to arthritis of the hip joint.

So, if you have fractures around the hip joint, and if you have avascular necrosis of the head of the femur, you generally go in for something called hip replacement. If the head of the femur only is replaced, it is called a partial hip replacement. If you replace the head of the femur along with the acetabular cavity, it is called total hip replacement. From the hip, we come down to the knee joint. It is a very important joint, and if you are walking, if you are running, if you are jumping, if you are doing any cutting activity, the knee joint is definitely involved.

It is a synovial joint and it connects three bones: the femur, the tibia and the patella. It is a complex hinge joint; comprised of two articulations, the tibiofemoral joint and the patellofemoral joint. Arguably, it is the most stressed joint in the body because it has a role in weight bearing, it has a role in running, it has a role in jumping, and it has a role in squatting down. It is the largest joint of the body. The arrangement of the bones in the joint provide a fulcrum that translate the activities of the flexor and the extensor muscles of the knee, that is the quadriceps and the hamstring.

The knee joint provides a fulcrum to translate the linear movement of the quadriceps and the hamstring into a hinge-like movement. It is a two joint structure, wherein the tibiofemoral joint is an articulation between the tibia and the femur, and the patellofemoral joint is an articulation between the patella and the femur. When we talk about the knee joint, we must know that all the muscles around the knee joint are not active all the time. There is something called a locking mechanism of the knee, which happens when the knee is in full extension, by which the femur is delicately balanced on the tibia due to a mechanism called locking. When the tibia or the femur has to move again, there is a mechanism called unlocking which takes place and the tibia starts to move.

So, what happens is this locking mechanism gives a passive stability to the knee joint when the joint is in full extension. Additional passive stability to the knee is given by the ligaments around the knee joint which are: the anterior cruciate ligament, the posterior cruciate ligament, the medial collateral ligament, the lateral collateral ligament, the popliteal ligament, etcetera. The dynamic stability to the knee is provided by the muscles around the knee joint. The tibiofemoral and the patellofemoral joints are subjected to high forces up to several times the body weight in both the joints. In the patellofemoral joint when the knee is flexed, there is a higher joint reaction force.

The total compressive forces on the knee are in the range of 2 to 4 times body weight with higher flexion activities having the highest forces and with the medial side carrying higher forces than the lateral. And this is the reason why the medial compartment of the knee joint is earlier affected in knee osteoarthritis. There is something called the menisci which aid in distributing the pressures and reducing the stresses on the tibial plateaus. So, these are the menisci of the knee joint.

They are classified as medial and lateral menisci. The patella helps knee extension by acting as a lever arm for the quadriceps muscle, and the quadriceps is extending the patella will act as a lever arm, and it helps to dissipate the forces and reduce the compressive stresses on the femur. So, let us talk about the applied anatomy of the knee joint. As we discussed, since it is the most stressed joint of the body, arthritis is common in the knee; and of arthritis the medial compartment arthritis is more common than the lateral. Because the knee is inherently strong and stable, dislocations of the knee joint are rare.

However, because the stability of the knee joint is provided by the ligaments, tears in the ligaments are very very common. Tears in the menisci are very very common. Any rotatory stresses on the knee joint will definitely tear the menisci and the ligaments of the knee joint. And in this context, arthroscopic reconstructions of the knee joint ligaments are very very common, and it is a very commonly used procedure to restore the knee joint to full function, if the ligaments are torn. Because arthritis in the knee joint is very common, and the knee joint arthritis progresses much faster than the rest of the joints of the body, replacements are very common in the knee joint.

So, knee replacement surgeries are very commonly performed as treatment for arthritis of the knee. Intra-articular injections are very commonly done in the knee joint, because of its ease of accessibility and the joint position. Let us talk about the ankle. The ankle joint is also called the talocrural joint, and it is a synovial joint that connects the bones of the leg, the fibula and the tibia with the talus of the foot. It is a complex hinge joint and we must talk about the articulations around it also.

So, this is the tibia, lower end of the tibia. This is the fibula and this is the talus. However, there is also something called a syndesmosis here, which connects the lower end of the fibula and the

tibia, which helps in the stability of the ankle joint. The main action of the ankle joint is to allow dorsiflexion and plantar flexion of the foot. There is also some degree of supination and pronation along with the subtalar and the midtarsal joints.

The subtalar joints help cause an action along a single axis, that is dorsiflexion and plantar friction, single axis movement. However, during weight bearing there is something called pronation at the ankle joint, which is a triplanar motion consisting of eversion, dorsiflexion and abduction. Eversion, dorsiflexion and abduction at the ankle joint. Ankle joint also can supinate with supination being a triplanar motion, triplanar ankle joints can also supinate, with supination being a triplanar motion consisting of inversion, plantar flexion and adduction. So, the ankle joint; if you talk about simple movements at the ankle joint, there are only two dorsiflexion and plantar flexion.

This is happening at the subtalar joint only. However, if you involve the other joints around the ankle, the ankle joint can also pronate, and the ankle joint can also supinate. The joint also acts as a shock absorber when the heel strikes the ground during the first phases of the gait. The ankle joint stability is determined by the joint congruency and the ligamentous integrity. That means, because the joint is a tight fitting, joint and the bones forming the joint are tightly fitting together, the ligaments around the ankle are very strong.

So, the joint is pretty stable. The fibula bears approximately one-sixth of the force exerted through the lower extremity. As we discussed, there is a distal syndesmotic joint between the distal tibia and the fibula. They also help in weight bearing through the tibia as well as the fibula. The forces acting on the ankle can rise to levels exceeding five times body weight during walking, and 13 times body weight during running.

And this is the reason why the ankle joint has to be a stable and strong joint. I repeat five times body weight during walking and 13 times body weight during running. So, let us talk about the applied anatomy of the ankle. Because the ankle is a strong and a stable joint, dislocations are rare. What happens is the syndesmosis will tear, the lower ends of the tibia or the fibula will get fractured before the ankle gets dislocated.

Ligament tears are very common in the ankle, because they add greatly to the stability around the joint and if there is any shearing force, the ligaments will get torn first. Tendon tears are common around the ankle joint, because there are a lot of tendons around the ankle joint. Fractures around the ankle are common, and these are usually seen in the active population. Arthroscopic surgeries can also be done in the ankle joint. However, incidences are rare. Replacements of the ankle joint are rarely done, but may be possibly indicated if the damage to the bones of the ankle joint are too much. Intra-articular injections of the ankle are possible, but they are also rarely done.

So, let us discuss what we have learnt in this lecture so far. The three major joints of the lower limb are the hip, the knee and the ankle. The hip joint is stable and less mobile. The hip joint is very important for gait and for weight transmission. The knee joint is stable with good mobility. The knee joint is prone to traumatic injuries due to position and function, because the knee has to bear weight in all ranges of motion and all angles. It is very prone to traumatic injuries, especially in sports like football. The ankle joint has good stability, but is injury prone.

Movements at the ankle affect gait and weight bearing. These are the references which I strongly urge you to go through, and thank you for your time and your patience. And in case you have any queries, do let us know and we will do our best to get back to you with the answers as soon as possible. So, thank you for listening ladies and gentlemen and Jai Hind.

References:

Basic Biomechanics of the Musculoskeletal System by Margareta Nordin, Victor H. Frankel; Dawn Leger - 4th ed.

Sports Injury Prevention and Rehabilitation: Integrating Medicine and Science for Performance Solutions by David Opar, Kevin Cross, and Julie Hides, 2016.