Mechanics of Human Movement
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Lecture - 43
Pathological Gait Part I

We have looked at the patterns of normal gait and now we will look at some aspects of gait which does not fit into that pattern. So, we will look at some of the causes for what we called pathological gait. And then we will also look at you know why it happens, and you know how compensations are made in order to enable a person to still locomote in this fashion.

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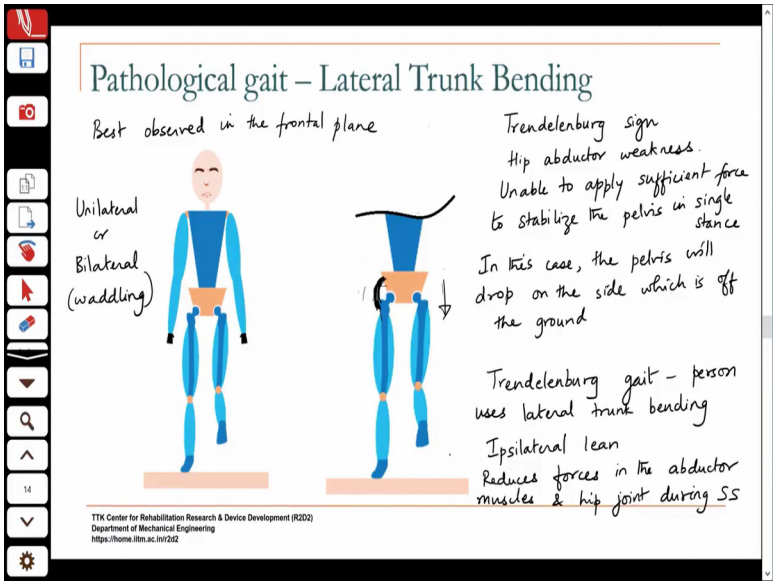

So, there are various reasons that you could have a case of pathological gait.

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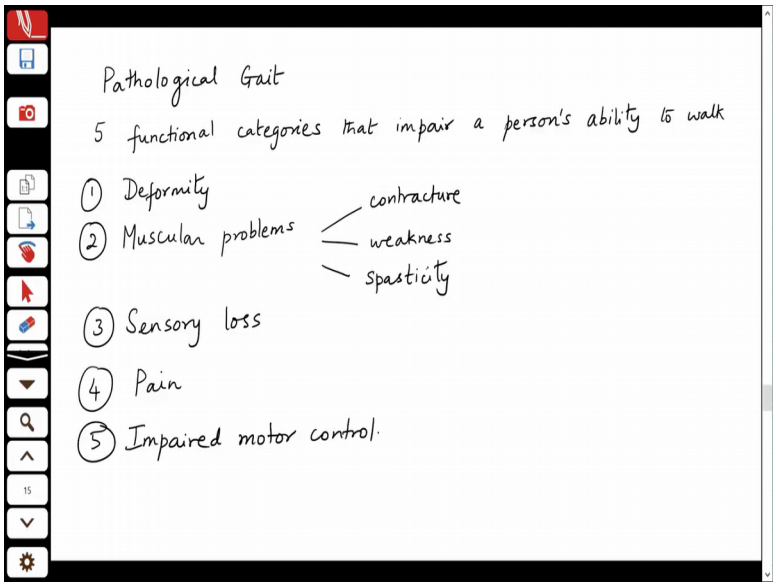

So, there are pathological gait is basically gait that does not follow the typical pattern that we have seen so far. There are some deviations from it; there are some observable deviations which could be because of various reasons.

And so, there are you can club them into like 5 functional categories that impair a person's ability to walk. One is you could have deformity you could have some form of or let us just call it muscular problems. So, this could be there are different things that could happen you could have like a what is known as a contracture and I will explain this, you could have muscle weakness or you could have what is known as ok. Then the third category is you could have sensory loss, pathological gait could be because of sensory loss, it could be because of pain, and it could be because of impaired motor control.

And we look at each of these.

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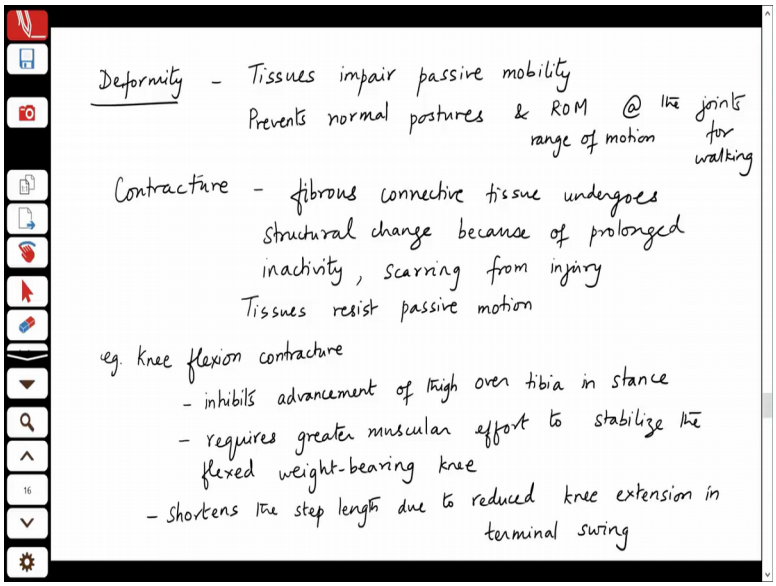

So, if you look at deformity in some ways the tissues, the soft tissues impair; impair means affect the passive mobility. So, this is not active things that were muscles are your only actuators right. But there is some problem with the tissues that could cause passive mobility. And actually I should go back this contracture comes under this. One of those could be a contracture which I will.

And so this prevents normal postures and range of motion at the various joints. This is a common term that is used ROMs range of motion at the joints required for walking ok. Because we know we know at the various joints what kind of motions are required for walking. If any of those are impaired are affected then that is going to affect your ability to walk.

Student: (Refer Time: 04:56) what is passive mobility.

Passive mobility: so a muscle is active right it provides; passive mobility is just because of the structure of the. So, your ligaments for instance right they do not exert a force, but they restrict forces that are applied. So, that is passive we are talking about passive structures affecting the mobility.

So, of these you have contractures; contractures are one kind of deformity that caused. And what essentially happens here is say a person stays in a posture for a lengthened period of time, sometimes it thinks freeze right the tissue because there is no movement

you have the connective tissue; the fibrous connective tissue actually undergoes a structural change because of prolonged inactivity its difference, right. And then the range of motion at the joint is now; the full range of motion at the joint is now not possible.

So, for some people you may see that at that hip for instance they may not be able to fully extend the hip. The hip may stay in a slightly flexed position a lot of wheelchair users because they are in the seated position all the time. They develop contractures you know it could be scar tissue also that forms there. And basically reduces the range of motion at a particular joint.

So, you could have prolonged inactivity or scarring from injury. You know when you have a scar right that on your skin that area isn't as elastic you know till the scar falls off and that skin heals you lose the elasticity in that area. So, imagine that happens across a joint, then you are not going to be able to have the full range of motion at that joint. So, that is what a contracture is.

And these tissues basically resist passive motion. So, if I apply a force trying to move about the joint its going to resist that motion. So, for instance if you had a knee flexion contracture what are possible, how could it possibly affect your ability to walk; if you had a knee flexion contracture. Remember; what are the functions of the knee. So, when you in weight acceptance, you want to have full extension and if that is not possible then that affects your ability to weight bear with an extended knee. I mean in which case it effect affects your stability.

Another thing when you are advancing the limp, right in the swing phase you have to be able to fully extend in order to attain the step length that you want. If the knee cannot extend fully, if it always stays flexed then again you are not going to achieve the so called normal step length. So, this is the way that a contracture could affect your ability to walk. You may still be able to walk, but modifications happen and the way you walk also will have to change, because now you have to maintain stability even when landing on a flex knee. So, you will make other compensations with your body in order to ensure that you still stay stable. So, those are.

So, if you have a knee flexion contracture it inhibits the advancement of the tibia also oh sorry advancement of the thigh over the tibia. Mid stance also you get into full extension, as the center of mass moves over the stationary foot. So, there if you are not able to

attain full extension again that affects your. So, it inhibits the advancement of the thigh over the tibia instance then, it requires greater muscular effort to stabilize the flexed weight bearing knee. And it shortens the step length due to reduced knee extension in the terminal swing.

This is a case this shortened step length is due to a problem in that particular leg. So, if the right leg has a flexion contracture here the shortened right step is because of the flexion contracture. I mentioned earlier that you know if you have a reduced step length with the right leg there may actually be a problem with the left leg, because you want to spend less time and stance on the left leg. This is a case where the right you know if there is a right flexion contract knee flexion contracture the right step length is reduced because of that.

So, its a case where there is a direct connection between a deformity in that leg and a educed step length with that particular leg.

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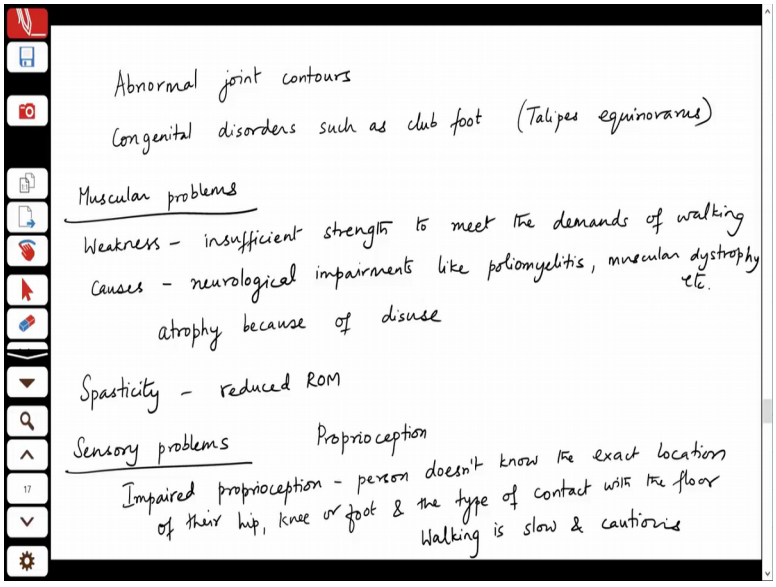

Other causes, other kinds of deformities that could affect the gait are. You could have abnormal joint contours which again affect the range of motion or you could have congenital disorders like a club foot.

So, its called talipes equinovarus its an inverted position you cannot you know; the foot instead of being in the neutral position there is some deformity in the foot that causes it

to have you know its; it will not a person with a clubfoot may not be able to put their foot flat on the ground it may be deformed in a certain way ok. The other thing that I was talking about is the drop foot where there is weakness in the dorsi flexors.

So, if the foot cannot be in the neutral position that is drop foot this is clubfoot. Clubfoot is where you have you can look up some images of this, but it happens at birth and the children cannot keep you know make their foot flat ok. So, the foot is inverted. So, that is a clubfoot. So, these again could cause these are all deformities. So, this you know there is something about the anatomical structure that has changed which causes, which reduces the ability to walk in a normal fashion.

So, the next kind of factor that could influence the gait is your muscular problems. So, you could have insufficient. So, if you have weakness; that means you have insufficient strength to meet the demands of walking. So, this could be at various, there are various muscle groups involved in walking. So, depending on which muscle group is affected you could have different set of problems. Causes could be you could have had some kind of a neurological impairment like polio, you know something because of polio after you could have muscular dystrophy. So, there are conditions like that which are neurological conditions.

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So, some of these maybe you may have more than one cause for this; polio can also cause deformity. Neurological impairments like polio, muscular dystrophy, cerebral palsy you know lots of, etcetera. The other type of cause for the other cause for muscle weakness is what is known as atrophy. Atrophy is its wasting away because of disuse.

So, say somebody is bedridden they have not used their muscles in a while, they cannot suddenly get up and walk, because those muscles have beaten. The body things if you do not if you are not using it, it things you do not need it. And so it starts wasting away. So, if you have a fracture for instance after a long time then if you suddenly once you take off the cast, you have to actually do therapy to build up your muscle strength again. You will not be able to do the same things immediately, because you have to the muscle has atrophy. Atrophy is basically wasting away because of disuse. So, that it basically becomes weaker and again you have to build up the strength and the muscle.

So, this is one cause the spasticity is actually a neurological problem because, the muscle is overactive ok. The muscles some muscle becomes; so they may not have control over when that muscle is being activated. So, children with cerebral palsy for instance many of them undergo lot of this you know this kind of this kind of cramping; and cramping is an example of spasticity you cannot control the its painful and you can see that the muscle is overexerting right, and you know how painful that can be. So, if you have spasticity then again some muscle is being too strong and that is that can be a problem, because again that will prevent full range of motion at a particular joint ok.

So, if the muscle is weak against spasticity also leads to reduced range of motion at a joint, because the other muscle the antagonist sorry the agonist muscle may not be strong enough to overcome the spasticity of this muscle in order to enable. So, for instance if you have spasticity in the hamstrings then your quadriceps have to work very hard to try to extend your knee, which may not always be possible.

So, spasticity may sometimes also lead to contractures eventually because, if its not able to its always in that slightly flexed position then over a period of time it cannot fully extend anymore. So, reduce it also leads to reduced range of motion.

Then you have sensory problems. This is when you lose sensation ok, and with walking especially its very important. See we do not pay a lot of attention when we are walking. I mean, you are not always looking at where you are placing your foot, where you are placing your you know, what posture your leg is in when you are walking; you are not really thinking about it because of what is known as proprioception. Proprioception is the body's ability to know where your segments are located in space. You have, I do not have to look at something to know where it is; you know whether its my finger or my you know I i know where that is.

So this is if you have impaired proprioception then your ability to look at your limbs in space is compromised. So, the person does not know that location of their hip knee or ankle and the type of contact with the floor. So, what happens they become extremely cautious about how they are going to, because they have to actually, see pay attention to where things are you know.

So, people would say parkinsons or something you know they have to actually be very careful about. You will you see that they have you know they will walk with very short

steps, because they are afraid they do not know exactly where their limbs are located in space and the type of contact with the floor. So, they do not know when it is safe to transfer weight.

So, they become more anxious about, because they think they will fall because they do not have that awareness of where the segments are placed and what type of contact. Again if you lose contact you know if you will have sensory loss if you are a diabetic whose lost you know you cannot feel the ground then you have to pay more attention to when your foot is in contact with the ground, ok. So, their walking becomes slow and cautious.

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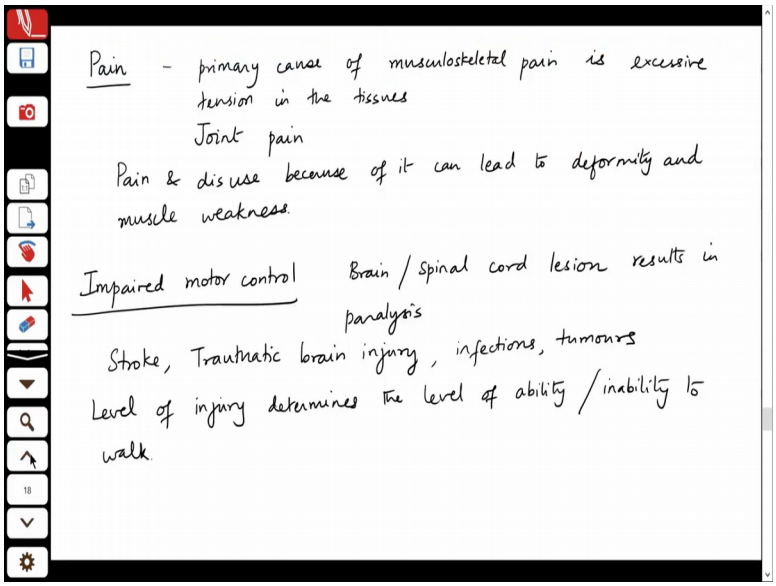

Pain is another cause for pathological gait. And typically the primary cause of musculoskeletal pain, because we are talking about pain that influences walking; primary cause of musculoskeletal pain is excessive tension in the tissues ok.

So, when you have a spring or when you have; this is or even in the case of spasticity right, the pain is because of the excessive tension in the tissues ok. And then you have to, sometimes, because of the spin so if you are trying to do something and it causes you pain the natural instinct is to stop doing that, ok. And then the disuse leads to other problems. So, it becomes a vicious cycle, that leads to muscular weakness that leads to again it reduces your ability to perform the activity.

So, pain could also be because of other things like joint pain, you know like you could have all joint pain as well say because of osteoarthritis or rheumatoid arthritis. So, tension in the tissues it could also have joint pain; joint pain could be another cause of impairing a person's ability to walk. And pain and disuse can lead to; because of it can lead to deformity like contractures. So, if I am seated all the time I do not want to walk because it is painful then, that can lead to other secondary problems it could lead to deformity and also muscle weakness.

Then impaired motor control is when the nervous system is affected; the brain or the nervous system is affected. So, a brain or a spinal cord lesion results in paralysis. So, another other causes could be: stroke, traumatic brain injury, and depending on the level at which the injury happens, it can determine; whether you are going to walk at all or whether you are going to be able to walk or whether you are going to need some other kind of a mobility device like a wheelchair.

And different levels of this can lead to. It could also be because of infections it could be because of tumors several causes could be there for impaired motor control. And the level of the injury determines the level of ability or inability to walk. So, when we look at pathological gait we will not look at it as: ok, this is the gait of a person with this particular disease or something, because usually the gait could be something that is forced on the person. So, they are walking a certain way because of a certain problem or they are compensating for something else.

They are compensating for a problem; so the problem is either causing them to walk in a particular manner or the compensation is causing them to walk in an abnormal fashion. So, those are the two reasons for a person. So, you do not say that. And how a person adapts to say an injury or to one of these conditions will vary widely. So, you cannot say that a person with this particular condition can be classified as: ok, if I cannot say this is paraplegic gait say a person is paralyzed below. I cannot say this particular gait is paraplegic gait, because each person may compensate in different ways.

So, when we look at pathological gait we will look at what is the function they are trying to accomplish and what are the different ways that they could have come. So, we actually look at what is the nature of the gait, rather than the nature of the pathology that caused

the gait. So, if I say a person is using; we look at say this anterior trunk bending first before that.

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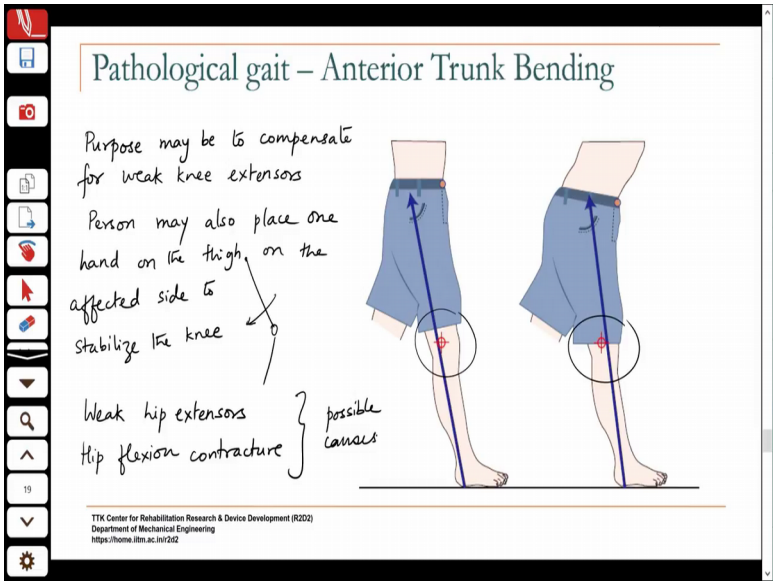

So, let us say anterior trunk bending is one type of pathological gait. People with different kinds of pathologies, different kinds of reasons could be adopting this kind of gait. So, I cannot say this is a polio person gait, I cannot call I do not want to call this gait a polio persons gait I will say this is a gait where what you observe is anterior trunk bending. And we will talk about why the person would do that ok. What functionally what are they trying to accomplish in order to do this.

So, let us look at anterior trunk bending. So, this is something that you would observe from the sagittal plane. So, if you look at the gait of the person the person tends to lean forward as they on their stance leg as they walk ok. You see that they are leaning forward. And typically the purpose may be to compensate for what do you think is happening here, what are they trying to do. When they lean forward look at what is happening to the GRF vector.

They are trying to stabilize the knee; they are trying to stabilize the knee. So, they are probably compensating for weak knee extensors. So, if their quadriceps are weak, that then this may be a way for them to compensate for that. To stabilize their knee they lean forward so that now the ground reaction force vector moves ahead of the knee, and gets the knee into extension during weight bearing.

So, the purpose of this kind of gait may be to compensate for weak knee extensors you may have also seen some people who walk like this they keep one hand on the thigh. As they are walking they lean forward they will also put one hand on the thigh. Again the purpose of that is to; so you have this thing like this right, you are trying to straighten it out. So, I am trying to straighten it out by pushing on my thigh. And that also causes my trunk to lean forward and again that also helps to move the ground reaction force vector in front of the knee.

So, person may also place one hand on the thigh on the affected side to stabilize the knee. What could be another cause for wadding?

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Hip weak hip extensors. So, the reason I am placing; you when I place my hand on my thigh I am basically trying to extend the hip. So, if my hip extensors are weak that could be another cause for anterior trunk bending. Yet another cause: flex extensors, now overly strong flexors I could have spasticity in my hip flexors or more likely I have a contracture I may have a hip flexion contracture. So, if I have.

So, weak hip extensors or a hip flexion contracture. So, say my hip cannot extend fully, then these are also other possible causes for anterior trunk bending. So, the first thing a person a clinician looks at the way the person walks they are trying to figure out what is the cause. So, they first look at what is really happening with the gait.

So, when you observe gait obviously, you can observe from you know different abnormalities may be visible better in different planes. In the case of anterior trunk bending this is best observed from the sagittal plane right. But there may be other abnormalities that may be better observed from another plane.

For instance: we saw earlier when we did back when we did the analysis of single stance ok. We saw that: you know say you are carrying a weighters; when you are in single stance you try to reduce the moment. So, suppose you had weak, hip, abductors; weak, hip, abductors right. In single stance your hip abductors have to be active in order to prevent the swing leg from just falling down like that right. You want you do not want the pelvis to tip like that. If your hip abductors are weak that is what is going to happen.

So, if you see a person with a weak hip abductors when they are in single stance the pelvis is going to tilt on the other side, because this weight will pull it down because this is not strong enough to keep it up prevent this side from dropping down, That kind of a gait is called a trendelenburg sign, where you have hip abductor weakness, and therefore you are unable to stabilize the pelvis in single leg stance single stance.

So, what happens here? Then, in this case the pelvis will drop on the side which is of the ground, on the swing side right. So, if you see a person like that walking then because they are not able to they are going to their body is going to tilt to the side which is off the ground, which again will affect their ability to clear the ground during swing.

So, it affects their ability to walk. So, in single leg stance when the other leg is swinging its actually dropping down. So, they may have to use some other compensation on that side to enable them to clear the ground. Because of the pelvis drops on that side then, the swing legs ability to clear the ground is compromised. So, this is called trendelenburg sign.

The other way a person say if they have this, weakness what they will try to do is I know that if I walk erect like that then its not going to be sufficient. So, what they will do is to compensate they will you know this is basically trying to counter the moment applied by the weight of the trunk you know above the hip; the weight of the pelvis in the trunk and the weight of the swinging leg ok. So, if I bring those closer to the side of support then I am reducing that moment ok. Then the force that is required in these hip abductors is reduced which I may be able to then apply.

So, then that is called a trendelenburg gait. This is when the person uses lateral trunk bending. So, they bend their trunk towards the side of support in order to reduce the moments about the hip joint. And so in some cases, its also called Ipsilateral lean. Remember I mentioned these words. Ipsilateral is the side of interest; Ipsilateral lean is leaning on to these in this case we are looking at single stance. So, with the stance leg is your Ipsilateral leg.

The swinging leg is the contralateral leg. So, they use Ipsilateral lean in order to compensate for the weak hip abductors. It could also be because of see the when the muscles around the joint contract, right when they contract with a certain force. It

increases the contact forces at the joint right. You have muscles around a joint when the muscles contract obviously the joints are brought together.

So, it increases the contact force. So, if you have a painful joint your hip abductors may be fine, but if you have a painful joint you would do the same thing. You would again try to do this lateral trunk bending so that the moment is reduced. And therefore the force that your hip abductors need to apply to stabilize the pelvis is reduced, and therefore your joint contact forces are reduced.

So, different causes, but what you see is a similar style of gait. So, that is why its useful to classify the gait by what you see rather than by what could be the cause of the gait. So, lateral trunk bending is. So, this reduces the forces in the abductor muscles and the hip joint during single cell stance. And this is best observed in the front ripple. This is not something you would observe in the sagittal plane right.

So, this is something this is best observed in the frontal plane. So, really it depends on; so a good clinician would look at the gait from multiple angles you would not look at only the sagittal plane and say: ok, everything seems fine. Even though most of the gait that we study is predominantly in the sagittal plane there may be compensations that occur in the other planes especially the frontal plane.

So, this trunk bending could either be unilateral or bilateral. Unilateral means only on one side; so if there is a specific problem on only one side then the person may always only when there. So, there is a problem on the right side then say right hip as painful as osteoarthritis or something, then they may just do this leaning every time they are on the right leg single stance and they may they may be fine when they are on the left plane. Or in some cases they may do it on both sides. They do it on both sides its called waddling they go like this like this. So, they are shifting their weight from one leg turn.

So, if its bilateral this is waddling; that gait pattern is waddling ok. Other causes could be an abnormal hip joint sometimes the structure of the hip joint itself may be it could be from birth or it could be because of an injury you could have. So, that could be another cause of this kind of a gait.

So, if the effective length say the structure is different and say the effective length of the gluteus medius muscle is reduced then you know that; you know when a muscle is away

from its normal length then its ability to produce force is affected. So, that could be another reason for this kind of a gait.

Yet another reason could be unequal leg length. So, a person may have their two legs the anatomical leg length may be different. And in that case when they are stepping on the on the shorter side; when they are entering singles when they go into single stance on the shorter side that is like stepping into a hole right. Its like you are walking on a pavement and you have one leg that has to walk below the pavement. So, every time you place your leg on that side you are going to lean towards that side, because that is you know its like stepping into a hole. So, that could be another cause for this kind of a gait lateral trunk bending could be this thing.

And in some cases a person may adopt a wider stance. So, we saw that if you look at the steps, if you look from the transverse plane we walk with a certain gap between the steps. So, if a person uses a wider stance for some other reason, then again the trunk has to adapt to that wider stance and you may see that they are using lateral trunk bending in that case.

So, these are possible reasons for using lateral trunk bending. We will look at some more instances of, some more types of pathological gait in the next class. So, you see now why an understanding of normal gait is necessary to, because the functional aspects of a normal gait, you know the role of the muscles in the normal gait, the joint ranges of motion in normal gait all those are important to know, because when one of those is affected one or more of those are affected that is when you start to see the different patterns in the pathological gait. And you can kind of deduce that: ok, so if this is happening then this could possibly be the cause for that.