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Lecture – 23 Static Analysis of Hip-Part II

So, last class we looked at the effect of using a cane, when you have weak hip abductors and how using the cane reduces the load on the opposite side ok. So, you use a cane to compensate for either pain or weak hip abductors on the other side ok.

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So, we saw the analysis that led to that. I just wanted to mention in the problem that we had last time, there was one the answers that I gave you, they would be for so, they assumed that this distance is very small. So, basically you know the joint, where the joint forces at the moment of Fm cos theta was negligible, because that because there was one quantity that was missing. So, it basically assumes that it almost passes through the joint that this head you know it so, it is like this almost ok. So, instead of having this extreme inclination it is almost as if Fm.

Student: (Refer Time: 01:46).

Fm cos theta does not cause a moment about the joint so, the values that I gave the answers that I gave you would be valid for this moment of Fm negligible about the hip.

If you can assume some, you know distance for that and computed, you will just get answers that are slightly different from what I gave you ok.



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So, that was the so, we looked at the 2 cases, 1, you can see that this is this was the one with the cane and basically, we saw that it is too extreme. Say, if this is the cane on the other side and this is just single stance, where you do not have a supporting cane on the other side. So, these are the two things that, we compared last time and we found that the loads on the hip reduced considerably, when you use a cane even though, the cane takes only a small portion of the overall body weight ok. Here, I think we assume the entire body weight is acting on this leg here, we had 5 by 6 w and w by 6 ok, but here this is along the direction of the net w, here the body weight at somewhere in the middle the foot is displaced ok. So, the overall body weight at somewhere here and the foot is displaced ok.

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So, you see that just as you know using the cane as a support reduces that. So, let us look at the case, where you are carrying a load ok. If you are carrying a load on one side now, this is going to be the reverse of supporting using a cane ok. So here, if you have let us call this, W dash where W dash equal to so, if I take the free body diagram in single stance of this side the leg that is suspended and the whole body, then this W dash is basically, the whole body weight minus the weight of the supporting leg. This is the supporting leg this leg, I am removing that from the I am removing that for the free body diagram. And then, I have the muscle force, which is acting here, the what muscle am I talking about here? The hip abductors, hip abductors acting to Fm for hip abductors, the primary hip abductor is your gluteus medius.

So again, this becomes a say if this is my joint at which then, it becomes a 3. So, if I look at I have WL ok. So, WL and W dash together, I can find. If I did not have a WL let us say, if WL is equal to 0 then, I have this is a three fourth system and essentially, this joint force also has to pass through that point ok. So, if WL is 0, I have this so, let us say, this makes some angle phi, the joint force makes some angle phi with the horizontal from this geometry, I have WL, I have Fm and then this also I know, where J is the location. So, this would be J, making some angle phi and then I can just use sigma Fx equal to 0, because this is basically using sigma m equal to 0. Now, if I carry a load.

Student: (Refer Time: 06:46).

So J, J and Fm are not parallel, they are not parallel. So here, I have this angle theta so, I can find out in this case. So, if Fm is angle acting at an angle. Let us say, theta to the horizontal ok so, I have I can draw this as theta then I have W dash and then I have that is an angle phi. So, Fm cos theta equal to J cos phi and Fm sin theta plus W dash equal to J sin phi, Fm equal to W dash cos phi by cos theta sin phi minus sin theta cos phi, if I solve for Fm from there.

Now, if I carry a load WL then essentially that is going to shift. So, instead of W dash here, it is going to shift slightly away from the midline ok. So, if W if there is a if WL is not equal to 0 then you know, I can sum these two parallel forces and I can say that the new CG lies somewhere between these two right, which would be away from still more away from the midline, where I have the load only on one side.

So, if I have that then essentially, what is going to happen? The moment about the hip is going to increase. So now, what is my phi going to be, is it going to be less or more then what I have now? From this can you tell? Now, instead of W dash, this has shifted slightly if WL is not equal to 0, I have this equal to W, let us call it W double dash equal to W minus WL, sorry leg plus WL and it would act slightly to it would act somewhere here ok. It will be larger and slightly shifted from the midline.

So now, if I intersect these two Fm and this, now my J is still here. So, that will be my new the direction of the new J J dash Fm also the magnitude will change, it is not going to be the same so, I will have, but it will act along the same line I have Fm. So now, J dash is going to be more and this angle phi will also be smaller than what you had. So, you can see here if I take this as W dash cos phi by sin of phi minus theta ok. In the second case, my phi dash will actually be smaller than phi ok. So, that makes this the denominator smaller, which increases the muscle force the overall effect will be because, W dash has also increased. Now the numerator has increased so, that any offset in the cos phi will not compensate for the increase in the W dash ok.

So, overall so, when you carry a load, this is the reverse effect of using a cane, the load on the opposite side on the side opposite to where, you are carrying it. You are going to see more loads on the hip to balance this. So, what do we normally do, when we carry a weight on one side when? So, if I during my right leg single stance, I will tend to lean over to the side opposite to the side where I am carrying the load right. So, what am I trying to do? I am trying to move the net you know; I am trying to move the CG closer to the midline so that, I can reduce the loading on my hip ok.



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Let me just Fm dash will be W double dash cos phi dash by phi dash W double dash cos phi dash by sin of theta dash minus phi dash minus theta ok. So, this so, it increases the loads on the single stance side carrying a load on one side, single stance.

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Now, if I distribute the loads on either side then my net. So, if I say I am carrying WL on either side let us just say now the same WL. So, let me call it WL by 2 instead of

carrying it on one side I distribute it equally, this is W dash, which is equal to W of the body minus weight of the leg ok. So, the net is higher, I have W double dash equal to W dash plus WL ok.

But, this time because, it is equally distributed, it will be closer to the midline than in the previous case here you will have the. So, during single stance, it will reduce the it will still be higher because, you are you are carrying a load ok, but when it is equally distributed, then this is closer to the midline than when carrying on one side. And therefore, you will even though, the hip loads are higher, it will be lower than this previous case.

So, the better way of carrying a load is to distribute it equally on both sides ok so, not loading one side. So, anytime you bring loads closer to the midline of the body, it helps to reduce the musculoskeletal forces. We saw that with the arm any anytime, you reduce the momentum, body weight is usually, your external load body weight or the loads that you carry anytime, you bring it closer, you reduce the momentum about the joint, you are going to have less damage done to reduce the musculoskeletal loads.

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When carrying a load on one side, we lean towards the other side A A X This brings the CF of the upper body and loads being carried closer to the midline of the body and reduces the length of the moment and from the farther hip joint People with weak abductor muscles and/or painful hip joints lean towards the loading side - "abductor gait - lean towards right during right single Weak left side Stance and vice-versa

So, when carrying in order to do that, what you do is when you carry a load on one side, we lean towards the other side. This brings the CG of the upper body and loads being carried of the body and reduces the from the distal hip joint., I should say farther, hip joint since distal has a specific meaning. So, people with weak abductor muscles, sorry

hip abducted muscles and or painful hip joints, how do they walk? They lean towards the weaker side.

So, as they were walking, you can if you observe them, you will see that they have like a swaying gait like that each time, when they are getting on single support, they are going to lean more towards that side ok so, they have this, it is called abductor gait. So, this helps them to reduce the loading on the hip joint on the weaker side ok. So, let me let us say, they have they lean towards the loading side, that is probably a better way of saying it. So, if I am if I have heap, say left side weak hip abductors.

Student: I lean towards the right.

I lean towards the right so then, loading sign towards the because single stance on the right side. So, weak left side lean towards right, during right single stance and vice versa ok. So, if I have weak on both sides then, I lean to the right then when I am loading the left, I lean towards the left.

Student: (Refer Time: 20:43).

Wait a minute, did I no no, wait weak sorry, they leaned towards the opposite side right from the loading side hold on just a minute, I have, they lean towards.

Student: the opposite side, but the loading side (Refer Time: 21:23) weaker joint (Refer Time: 21:25).

See when you are standing, it is equal on both sides, we are talking about the single stance case ok, where you are putting all the loading on one side ok. So, you are loading one side here, in this case, it is the right leg for instance ok. Now, when I am, when all the loading is on this side ok, I need to bring this line closer to that side to reduce because, this is the stabilization that is happening this is where my abductor muscles have to stabilize the joint. Because, I have, I am supporting say I have this body weight, which is creating a moment about this joint I need to reduce that moment arm.

So, I am leaning more towards the loading side, this is the muscle know, I am this is the muscle I am trying to use ok. So, it is towards the loading side and we are talking about in single stance, where all the body weight is on one side and vice versa. So, if I have a weak right side then when I am on left side single stance, I try to lean more towards that

is it. So, as to reduce the moment and to correct the abductor gait, you would hold the cane in the hand, opposite the weak side of course, if you have one both sides then it becomes a problem ok, but typically if you have an injury on one side then holding a cane helps because otherwise, you might have to use something like a walker, to do that ok.

So, if it is a problem on one side a cane on the side opposite to the effective side can help you, but if not if the problem is on both sides then because, the other side will keep getting loaded anyway so, the cane alone will not help ok.