Applied Ergonomics
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Module – 04
Lecture – 20

Hello and welcome to this Applied Ergonomics lecture 20. So, we will be covering a new domain today which is about biomechanics is a very important area in terms of ergonomics as well as treatment of injuries which happen because of heavy work or work athletic work among various human subjects.

So, let us look at this new area on biomechanics which is increasingly gained lot of prominence among the research community as of now is become one of the very fundamental areas of research contributions. So, what is biomechanics?

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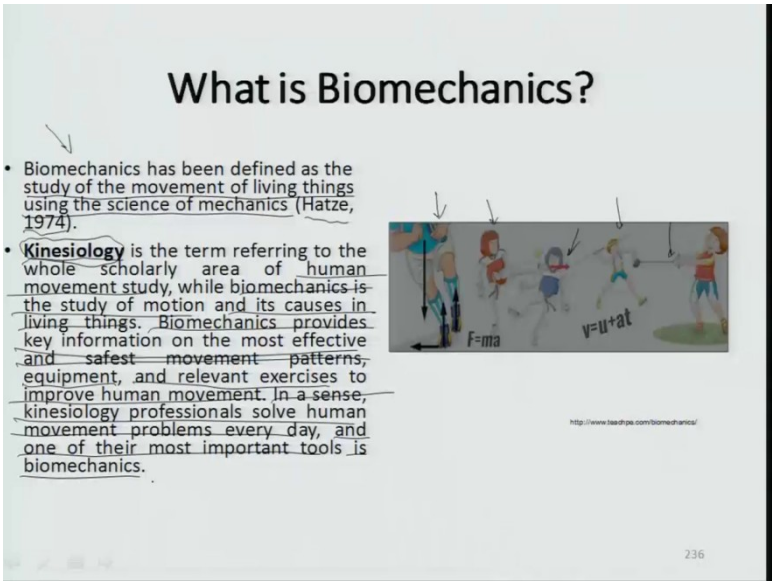

So, if we really look at definition which came up way back in 1974 from has at all it talks about biomechanics as the study of the movement of living things using the science of mechanics. So, basically the way that a human being balances himself in all different positions applies forces or you know throws projectiles at a certain velocity they all are in a way related to the simultaneous movement of the musculoskeletal structure within a human

body and if we can organise the study of such structure they can all lay to this domain of so called bio mechanics.

So obviously, the broader term that people would use is kinesiology which is term referring to the whole scholarly area of human movement study biomechanics is only the study of motion and its causes in living things, but the kinesiology is basically giving a plot domain of all kind of human movements which would exist.

So, biomechanics provides key information on the most effective and safest movement patterns with reference to equipments which are being utilized also while doing relevant exercises and some these exercises can improve for example, human movement, so how to even conduct motion in a particular guided manner is also within domain of biomechanics. So, in a sense kinesiology professionals solve human movement problems every day and one of their most important tools is motion study which is coming from this area of biomechanics. So, it becomes a sub domain of kinesiology. That is how we would like to explain biomechanics.

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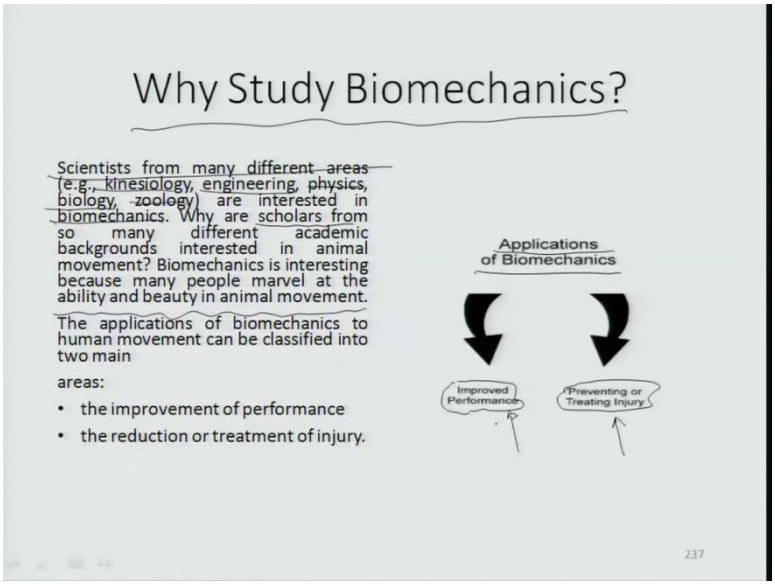

So, the obvious question that one would ask here is that why to really study this whole new area of movement of limes and other body parts and if you really looked into what are the basic applications of such biomechanics related studies. So, one of course, is to improve performance, performance of work performance and any sport or athletic motion for example, or even performance and overall performance and movement which going to improve the

quality of life in general of people and the other broad application area is to prevent or treat injurious from happening. So, define work in a manner in a certain motion cycles so that the body does not get affected too much and again in case one has got an affected we would also help to treat by again incorporating small motions within different parts of the body for proper alignment of the muscles skeletal structure which is a subject of attention here.

So obviously, scientists from many different areas is you know kinesiology for example, engineering in physics, biology, zoology these all different areas they are interested in this area biomechanics the thing to be noted is that there are a team number of reason why scholars from so many different academic backgrounds are interested and one of the main reason is that biomechanics is interesting due to the natural urge of human beings to marvel act the ability and beauty of movements. Movements could be related to animals movements related to any bio inspired system and then apply such movements as and when necessary to broadly improve one's day to day performance in terms of motions executed by the human body or in terms of prevention in treating injuries.

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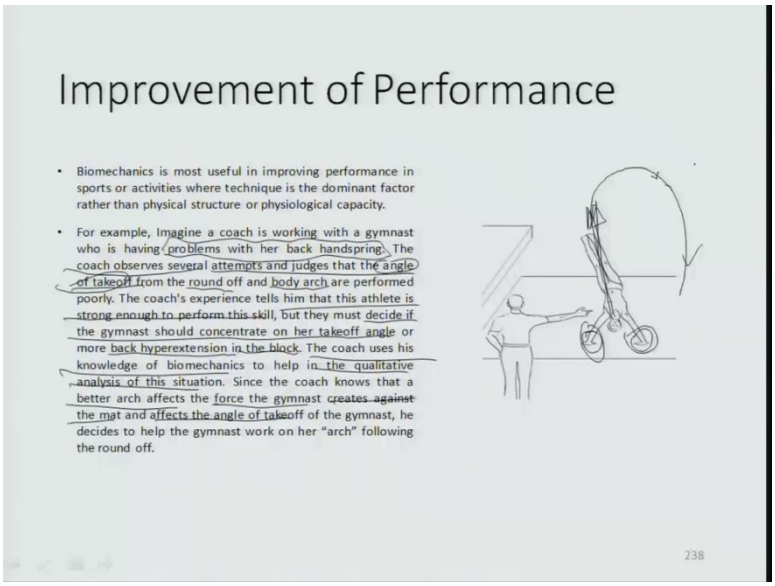

So, let us look at the example problem of a gymnast and a coach where biomechanics is such an important domain to solve the problems so that a proper athletic motion can be executed by the gymnast. Let us say that there is a coach which works with gymnast and whose goal is to have corrective actions for the problems related to the back handspring of the particular gymnast subject in the course of just, the coach observes the several attempts and tries to

judge whether the angle of takeoff which is so backhand spring is basically as a gymnast kind of take support of her hands and throws her body in a manner, so that the body arches.

So, first it goes at a certain angle and then it sort of rounds off and then it arches so that you know the gymnast can turn around in this manner through a back hand spring attempt. So, the coach observes several attempts and judges various things like what is the angle of take off for example, of the particular gymnast or maybe all the way from round off to the body arch what are the body movements which are performed and which are the areas which need attention by performance is poor.

So, the coach's experience tells him that this athlete is strong enough to perform a particular skill, but the question is whether the decision need to be taken for concentrating on the gymnast on the takeoff angle or more on the back hyperextension in the block and so basically either this angle needs to be changed so that more appropriate posture can come and the these spring back can be performed adequately or even while arching if without focus on the angle of the initial takeoff person arches more still it can lead to a good posture final posture because of the spring back.

So, the coach in this case uses the knowledge of biomechanics to qualitatively sort of analyse the situation solve the problem and the coach from his experience knows that better the arch affects the force of the gymnast force that the gymnast creates against the mat and affects in turn the angle of take off of the gymnast. So, it decides to help the gymnast work on an arch rather than the angle of take off.

So, even if the angle of take off is slightly loose because of the arching process the gymnast can still conduct enough force so that the operation can be in place and the spring back can be successful. So, this is a sort of a case which says that how important would be biomechanics in terms of analysing different sub motions from the overall process of the back hand spring back handspring activity of a gymnast and trying to work on that domain according to the built of the body or according to the built of the concerned person or the strength of the concerned person. So, that over all the posturing at various stages including the start of the spring back the takeoff the arching or he round off of the body at all these different stages the postures are well maintained. So, that is how biomechanics is really very helpful in providing solutions particularly athletic solutions in this particular case as can one can see in this particular case.

So, there is a lot of redesigning that is needed for equipments particularly equipments with which humans would like to perform activities.

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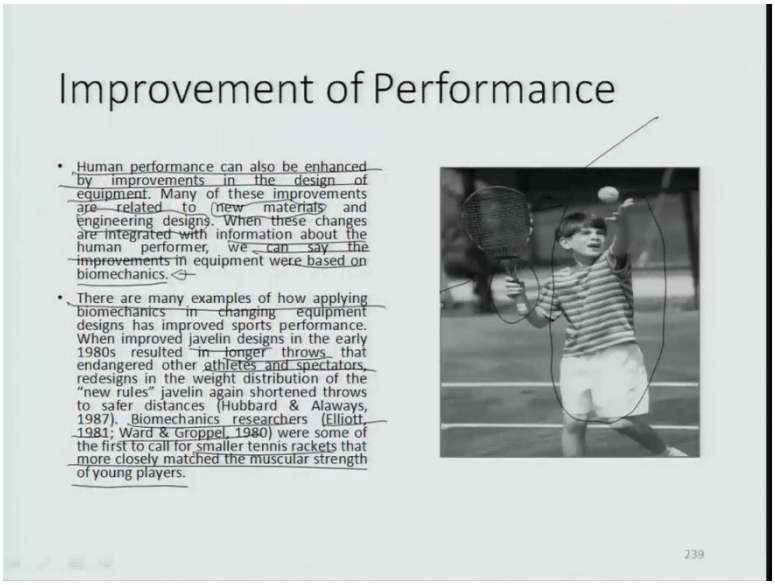

One of the finest examples is designing of this small handle racket for kids of a certain age group they could perform better in terms of their ability to hit tennis balls if the racket handle the shortened, there is an organised study on this through this area of biomechanics which indicates such a strategy and so therefore, the sporting equipment design or redesign can be done according to age group to argument the performance.

So, human performance obviously, can be enhance by improvements in design of various equipments and many of these improvement are probably related to the overall weight. So, new materials are in question if you wanted to make lightweight equipments even the engineering designs like just I pointed out in case of this racket here the lower size handle would give you give the concerned a better in petals or so better control of hitting let say tennis balls.

So, when this changes are integrated with the information about the human performer we can say that the improvements in the equipments is based on biomechanics principles. So, therefore, what I am referring here as this particular age domain age group concerns set of individuals with similar kind of strength similar kind of arm movements or hand movements and also foot movements and then there is also a requirement based on how fast a ball should be hit how many times over the frequency at which the ball should be hit and what is the kind

of foot movement in between the two hits.

So, all these would try to you know much organised manner suggest the best possible equipment that can be used for improving the performance of the sport or any other activity. So, there many examples of how applying biomechanics in changing human designs as the improved sports performance for example, let us consider javelin throws. So, in 1980s javelin designs were altered significantly that is because you know improve javelin designs in 80's resulted in longer throws and that started endangering the other athletes were around in the arena where such a throw would take place or even the spectator sometimes and so therefore, redesign was called for redesign was needed.

So, that even you know the new rules for set up actually so that such sports does not become health hazard or let us say injury hazard to people who are in closer distances. So, biomechanics researcher also particularly Elliot in 1981 or Ward and Groppel in 1980 were some of the first to call for smaller tennis rackets that more closely match the muscular strength of young players based on which distance is came up. So, you can see how improvement in performance in activities could take place through biomechanics.

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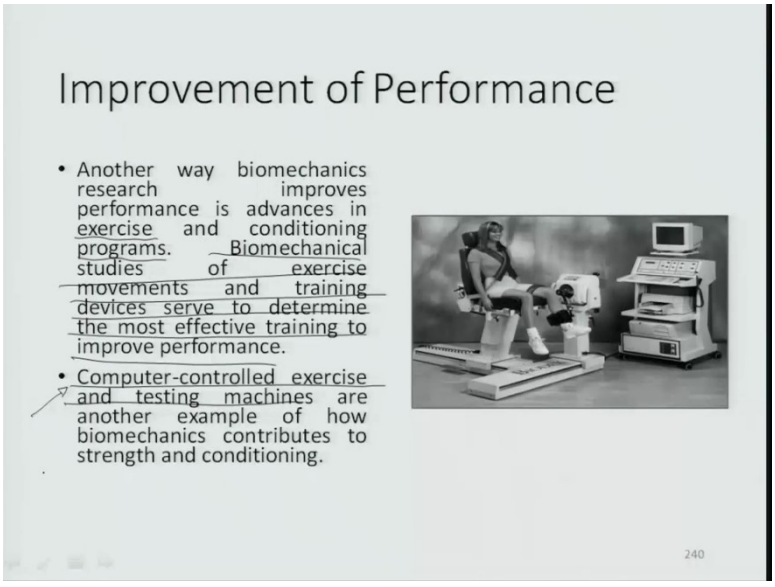

Some other models of performance improvements are listed here for example, you know body conditioning is a major aspect in today's fast changing world and you know body conditioning does happen through exercise and pack programs people are generally interested to over all you know shape and size the body in a particular manner. So, that the overall

energy level goes up and so, biomechanical studies of exercise movements and training devices, so you have to determine the most effective training to improve performance.

So, in line with all these activities are computer controlled exercises particularly testing machines which actually are in business because they want to monitor at every instants how musculoskeletal performance changes between different activities and how such movements would affect the body on a regular basis or vice versa such movements would affect the job at hand regular basis. So, there has to be some computer controlled performance monitoring for which comes out from the fundamentals of biomechanical principles to and very organised were looked at the way people do body conditioning and toning.

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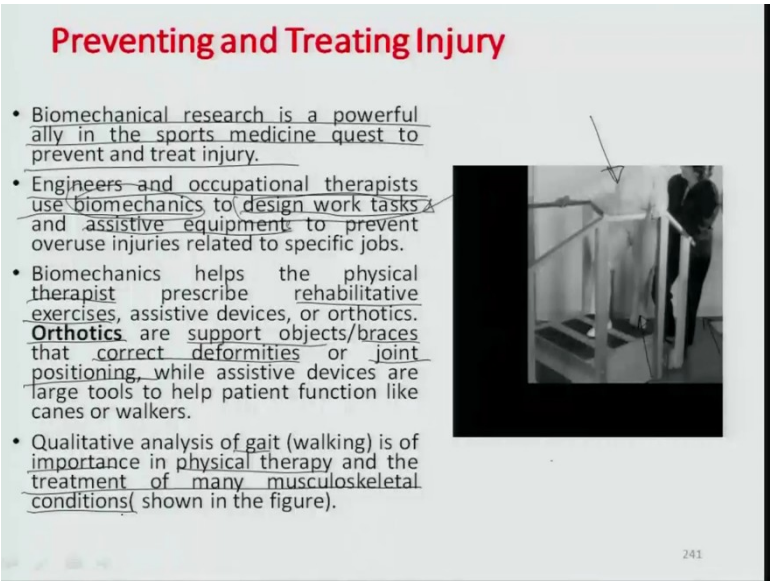

So, biomechanical researches powerful ally in sports medicines particularly in its quest to prevent injury or treat injury it is important that such research is immediately utilised there can be because of fast movements change in the lime structure which may result in this location damages muscles pulls and so if there is an organised study about what impacts and what way it can be utilised for quick treatment. So, that the player or the athlete can up in run in a few minutes and can join back the competition of the tournament.

So, also engineers and occupational therapist use biomechanics on a regular basis this is important to design work tasks also some assistive equipments this is again a very important domain equipments make a huge mode of difference to life in terms of lessoning the degree of thee human effort and by giving you know passive leverage or some other assistance and

so therefore, it is important that the knowledge of biomechanics is use to develop such a such techniques or even to design the overall work tasks in a proper manner. So, that there are less injuries while delivering the task for a job specific job.

Biomechanics can also help to prevent physical therapist help; help the physical therapist to prescribe rehabilitative exercises particularly important are these orthotics which are support objects or braces which would correct birth deformities. You already know about the dental treatment and how braces are used in dentistry so that overall there is a certain way in which growth can take place and generally there is a correction of the overall shape of the human mouth based on such braces one over a long amount of time. So, you could actually do correct joint positioning.

So, of significant mention is this qualitative analysis of gait of the walking behaviour of person is of a lot importance particularly in physical therapies you can see a person here trying to climb up an elevation with the certain posture and the posture being changed or validated trough a therapist. So, qualitative analysis of gait particularly is a very is of a high importance in physical therapy and treatment of many musculoskeletal conditions can generate because of just doing such qualitative analysis in a way person walks and the posture it takes walking and climbing.

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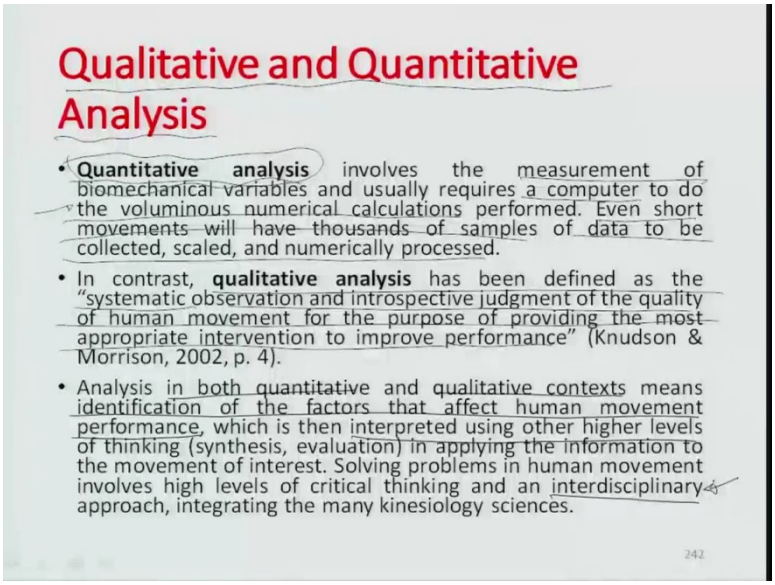

So, typically you could either you do a quantitative or a qualitative analysis as regards these fields of biomechanics. So, when we talk about quantitative analyses is more about

measurements. So, it should involves measurements of biomechanical variables typically such movements do need high speed computers particularly for acquiring the data and also sometimes to do voluminous amount of numerical calculation you could actually try to stimulate muscular or musculoskeletal motion by using finite element analysis or other such thing techniques. So, even short movements will have thousands of samples of data to be collected scale numerically processed before any such tool is developed for predicting motions.

So, in contrast qualitative analysis becomes sort of introspective judgement and looking at some motions trying to categorised those motions into once which are good once which are in appropriate. So, ideally we should use the combination of both quantitative as well as qualitative or judgemental analysis in order to study the whole area of motions related to limbs. And basically we can say that in both quantitative and qualitative contexts identification of the factors that affect human movement and performance is really what can be sort of observed quantified, recorded, organised, and interpreted at different levels of thinking and so the idea is with all this learning experience tools can develop were they can have the capability of predicting based on quantitative as well as qualitative aspects any human movement and solve generally the problems related to such movements.

So obviously, this whole area is highly interdisciplinary nature because there is a part which is directly related to the physiology human body and the part which is related to concepts of mechanics and therefore, it is really an integrated science I would say where multiple stack holders are involved. Let us look at some example problems and try to see how biomechanics can be utilised just like to mention about this stoop or squat positions for lifting of weight in a particular set up.

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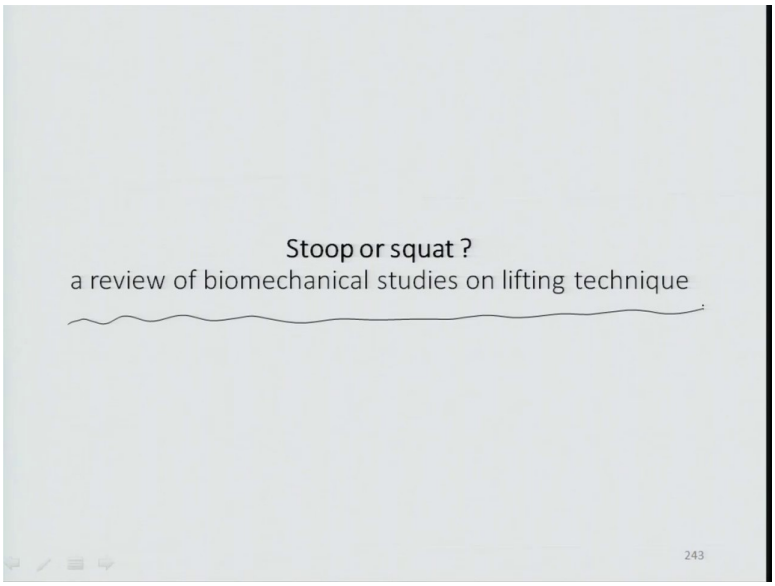

It is a sort of a review for different lifting techniques which are round by stoop or squat I want to or what I mean is basically these two different motions. So, this is known as a stoop lifting technique similarly this is called a squat lifting technique.

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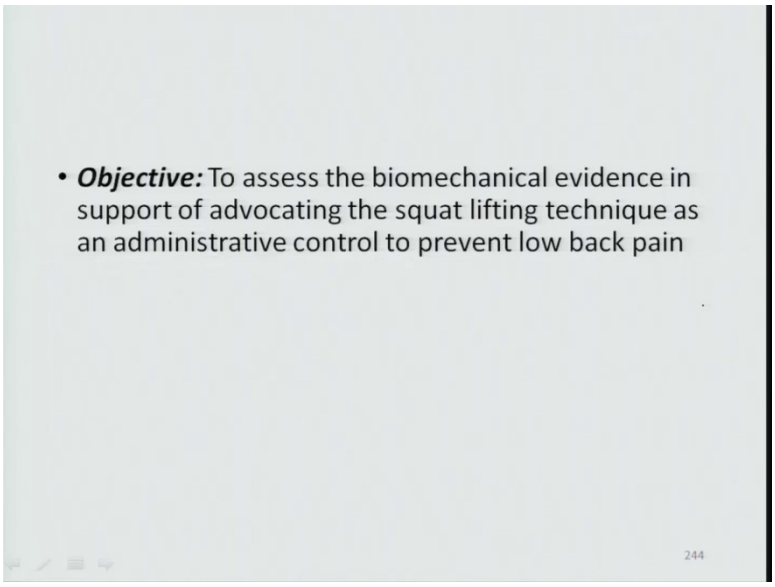

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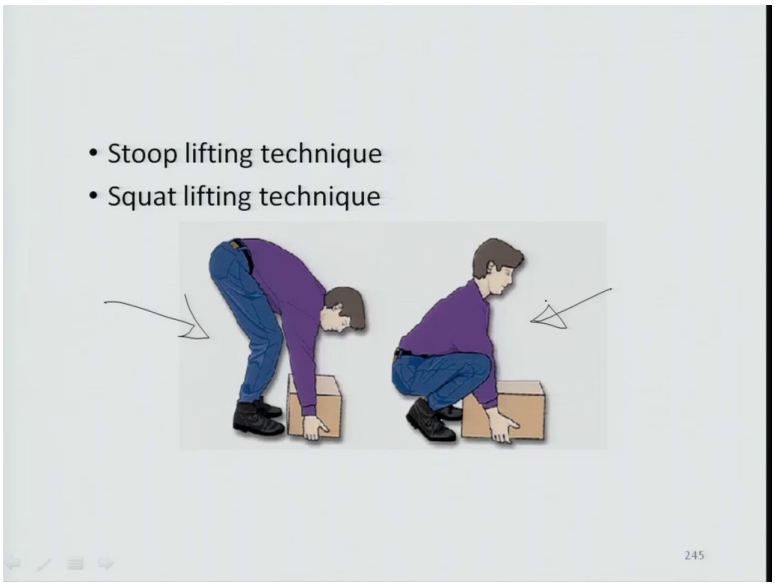

And if I looked at how the forces are applied to the musculoskeletal structure in the both the cases that quite different and quite different; in a way that in some cases the forces are applied to more cross section of the musculoskeletal structure in some force in some cases it is applied to a very less section and there is a possibility of more damage.

So, the objective of all this study is really about assessing the biomechanical evidence in support of advocating the squat lifting technique over the stoop lifting technique and this can be a sort of a medical administrative technique to or medical administrative practice to control either low back pain or even injury back injury.

So, let us look at some tools for assessing both these techniques and try to understand. So, I will basically partially cover this area today the interest of time and then maybe take this up for a feature module again probably which will be which will probably given to you the next week.

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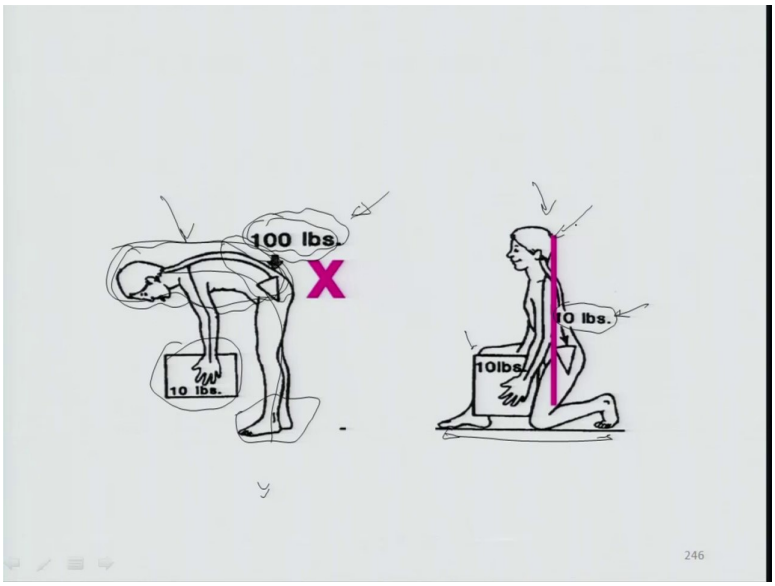

So, here the idea is that if I looked at the force diagrams and how different cross sections of the human body or musculoskeletal structures are exposed in case person is lifting lb weight you can see that the amount of impact to which comes to particularly this portion of the human body the musculoskeletal structure here is significantly high you know. So, primarily because it is like cantilever orientation that we are talking about the fixed and is really this there a feet which is having a reaction motion and then there is a this whole skeletal structure that is there is having almost a let us say transfer of this force, so that it can hold back the weight of 10 kg or 10 pounds.

So, on the other hand if I looked at the other motion that is the squat motion you can see that a signification portion of weight of the body there is no for example, cantilever orientation here. For example, you can see the overhang in this particular area which is causing an additional force components to this skeletal system where as in this particular orientation you can see that 10 lbs almost amounting to a 10 lb force on the musculoskeletal system. Preliminarily because the weight of the human body is adjusted on to a broader base there is very chance less of toppling and so there is no reverse talk which actually comes in this particular position and it makes life easier for this human being in this position to lift 10 lb, 10 pounds weight in comparison to the other one here in stooping position.

So, from an intuitive level from a qualitative level certainly it appears to be better here. But you do have a very good quantitative measurement based analysis as well which gives you

most accurately the data which is going to conclude the same and there are many fascist which get involved in the process which can advocate the squatting motion over the stooping motion for purpose of administrative control on let us say back pain or back injuries so on so forth.

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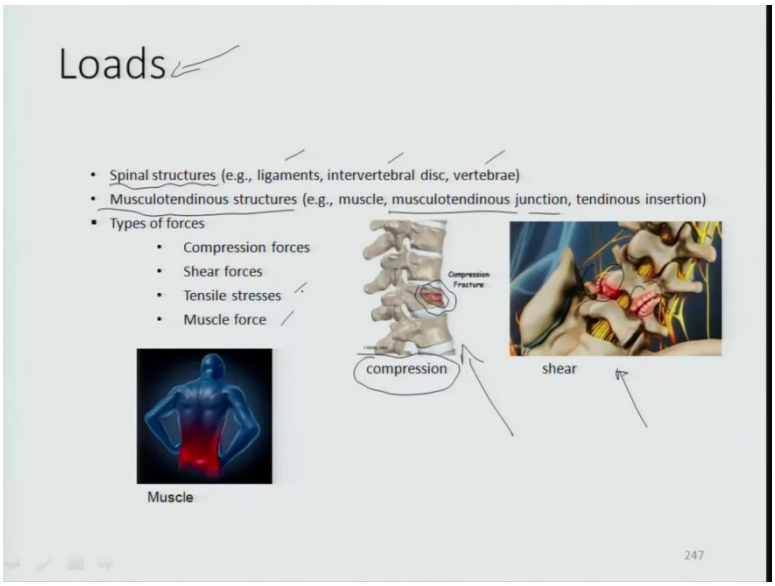

So, if I look at loads and look at the musculoskeletal structure and how it gets oriented, so you can see this final structure of any subject human being having ligaments intervertebral disc and vertebrae, there also these musculotendinous structures comprising of muscles musculotendinous junctions tendinous insertions and various types of forces are subjected to such structures for example, this here right here shows compressive force which is created the fracture. So, you can see one of the damages created to one of these vertebraes here which is because of a compression fracture.

Similarly, there can be damages related to shear to tensile stresses and muscular forces when it comes to different loads. So, probably we will like to end this module here, but in the next module we will take up and very organised manner by giving ratings to the different measurements which come for the different factors like compression shear tensile a muscular forces based on which we can make conclusions about the right posture for picking up this load. So, I like to end this lecture here.

Thank you very much.