Human Physiology
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Lecture - 05

Hello everyone, welcome to another brand-new class of human physiology. So, in today's class, we will discuss various diseases of the skeletal system and some kinds of therapies that we will briefly discuss as well. I hope you like the last few classes where we discussed bone, joints, muscles, neuromuscular transmission, and in this class, we will see what different types of diseases can happen in the skeletal system. Hope you enjoy that class. So, which concepts and content will we cover in this class, mostly like different bone-related diseases, their causes, symptoms, and how to diagnose them, and we will also briefly discuss some therapeutics for bone diseases. Then we will discuss different muscle diseases, how to diagnose them, some therapies, the different types of connective tissue diseases, their causes, symptoms, and their diagnosis and therapy.

So, to start, the first condition we will discuss is osteoporosis. So, mostly like this, we will discuss different conditions, and we will see what their symptoms, diagnoses, treatments, and all are. This class does not have too much of a mechanistic aspect or a lot of in-depth discussion. Mostly straightforward about certain diseases, and if the disease occurs, what the symptoms would be and what type of treatment we can have.

So, the first kind of condition is osteoporosis. So, by the name, you can understand this is a condition of our bones and joints, right? So, what osteoporosis is like is a systemic skeletal disease, right? This is characterized by low bone mass. Right of the bone tissue, how can it happen? So, mostly osteoporosis happens due to age-related issues, right? Like, with growing ages, what happens, if you remember, is osteoclastic activity. So, if you remember, in the last class we discussed, we have two different types of cells: one is osteoblasts and the other is osteoclasts. In the early stages of growth, osteoblastic activity is more prevalent, but as old age occurs, osteoclast activity surpasses that of osteoblasts.

This is the role of osteoclasts; they essentially break down old bone cells and begin degrading the bone, creating more pores. So, because of age-related issues with a lack of minerals like calcium and phosphate, a lack of calcification can also occur, and with increased osteoclastic activity, overall bones become more porous, resulting in a decrease in bone mass. So, what are the different symptoms if there might be bone fractures, and where can it mostly happen, like in the spine area, hip area, or wrist area? So, we will have a huge amount of pain in this area; mostly it can be due to osteoporosis. A bone density scan can be done, or even an X-ray can also provide us with certain observations; after that, a detailed bone density scan can identify specific cases of osteoporosis. We need to ask the doctor what treatments doctors generally prescribe, such as various types of supplements like calcium and vitamin D.

Right apart from that, this type of drug can also be used, like bisphosphonates and denosumab, so this type of drug can help recover the osteoporosis situation. Okay, so complications, as you know, like osteoporosis, can cause a huge amount of pain, fractures, and disability for proper movement. This is a serious condition that is mostly seen in older ages, but.

.. In certain cases, it may be due to a lack of minerals in the body or due to other issues that can also cause early onset of osteoporosis, although those conditions are very rare. Next disease that can occur in children is osteoporosis, which is mostly seen in old age; however, in this case, rickets or osteomalacia can happen in childhood. So, what is rickets? So, bone softening disorder rickets is mostly observed in cases of children, and osteomalacia can also occur in cases of adults. These are the conditions where weakened and softened bones can be found, mostly due to the deficiency of calcium, vitamin D, or phosphate. So, mostly the causes are the deficiency of phosphate, calcium, and vitamin D due to a lack of proper diet or possibly due to a lack of proper metabolic activity or absorption of minerals; this type of cause of rickets can happen.

So, if rickets occur, what would be the early symptom? We can see bowed legs, knock knees, delayed growth, or persistent bone pain, right? This can happen in cases such as early ages among children, and in very young ages, less than 10 years, you can observe these symptoms of rickets. In cases of adulthood, like osteomalacia, bone pain and muscle weakness can occur, which can cause significant difficulty in walking or other types of muscle activity. A diagnosis can be made by blood test, X-ray, or bone density scan, and generally, treatments are similar to supplements like vitamin D and calcium supplements. You can also have increased sun exposure, especially when it is not a significant condition of decay, but you will observe that during the wintertime, when there is a lack of exposure to the sun, you can observe bone pain because vitamin D is synthesized less in the body. So, at that time, the body can observe certain early signs of this type of osteomalacia, which can cause tremendous bone pain.

The next disease that can occur mostly in old age, but sometimes in early age as well, is osteoarthritis; this is a disease of wear and tear that can affect our bones and joints. It can cause issues in our bones, and it can affect our articular cartilage, leading to a huge amount of joint pain, stiffness, and functional limitation. Mostly, it is like age-related wear and tear, where certain structural degeneration happens, and that can further cause a lot of significant injury. What are the symptoms? Mostly like joint pain, stiffness that can cause osteoarthritis can cause a huge amount of unbearable pain. How can it be diagnosed? It can be diagnosed the same way by bone density x-ray, sometimes maybe even by physical examination or by MRI as well.

Treatment mostly involves non-pharmacological approaches like weight management, physical therapy, and exercise; this type of thing can be done apart from that, and there can be pain relievers. So, it will, of course, not cause any treatment for the condition, but it will kind of manage your pain, right? So, pain reliever anti-inflammatory drugs, such as corticosteroids or glucocorticoids, can be given to mitigate the situation of osteoarthritis or in chronic conditions when there is significant damage in the knee or elbow joints, mostly in the knee or hip; complete surgical removal and surgical replacement can also occur. But of course, this type of surgery is very complicated; it can also contribute to a significant amount of cost. So, not everyone can afford this, but in cases of complete immobilization, a surgical intervention can also be considered by the doctor. The next one is also a type of arthritis called rheumatoid arthritis.

This mostly happens due to the overactivity of the T cells, right? Mostly T cells. If you remember our immune classes we discussed, the T cell is one of the very important immune cells in our body. And what this type of immune cell does is essentially eliminate any type of infection, including cancer cells. So, immune cells are generally good for our body, right? This is because they help to mitigate all types of infections and sometimes tumor formation, but

consider what will happen if these T cells become overactive. Then these overactive immune cells, including overactive T cells and other immune cells, can cause destruction in a certain part of our organs.

In the endocrine class, we will discuss this overactive T cell activity related to creating type 1 diabetes. In those cases, T cells attacked the pancreatic beta cells and destroyed all the cells. In the case of rheumatoid arthritis, these overactive immune cells will destroy our bone cells, causing a huge amount of bone pain. So, in the same way, blood tests by measuring rheumatoid factor and anti-CCP antibodies, or by imaging techniques like X-ray, bone density X-ray, and MRI, you can determine the condition of rheumatoid arthritis, and it can also cause bending or bowing of our fingers. So, if we have our fingers in a normal shape, they will stay like this, right? But a significant rheumatoid arthritis condition will cause bending of these fingers.

This is a condition, and it generally starts on both sides of our body; sometimes it may start on one side, but mostly it can affect both sides of our body. This is a very serious condition; the problem with rheumatoid arthritis is that it can also progress to many other parts of our body, causing significant damage to other organs as well. So, this is kind of a life-threatening disease. What are the different treatments, such as various types of glucocorticoids, different kinds of steroids, methotrexate, and various biological inhibitors, including IL-6 inhibitors, IL-2 inhibitors, and JAK inhibitors? Right, you can use maybe anti-inflammatory drugs; a lot of new therapies are also being explored. A lot of new developments in anti-inflammatory drugs are ongoing.

Maybe some anti-inflammatory drugs we may also cover in our other classes, but just remember that rheumatoid arthritis is a very life-threatening disease. In the last few discussions, we talked about ortho-related issues, such as normal arthritis, osteoarthritis, osteoporosis, and rickets; those are not life-threatening diseases. But rheumatoid arthritis, once it is detected, if left untreated, can also cause mortality. Okay, then dugout, this is also like an old age type of disease; what happens is that in cases of high uric acid levels, the uric acid crystals can deposit in the joints area, and as you know, uric acid is not very soluble in water. So, this can cause a significant amount of damage because these uric acid crystals will deposit on the joints, causing a huge amount of pain.

And there would be significant friction. So, how can it be diagnosed? You can kind of measure the knee fluid or joint fluid; if the fluid level goes down significantly and there is an increased level of uric acid in the blood, it can be considered a gout-like condition. An anti-inflammatory drug can be given, or sometimes in cases of progressive stages where significant swelling may occur, there might be new therapies involving injectable hydrogel or injectable softeners that can be added to the joint area to facilitate normal movement. Because it basically dries up, it dries up the joint area and increases the friction. So, you can inject some modern therapies of injectable soft gel so that this friction can be reduced.

But this is not a life-risk type of disease; it can be somewhat associated with life, but many elderly people suffer from this type of gout condition. What other than next is osteomyelitis? This is like an infection in the bone; mostly, it can be due to bacteria, but other types of microbial infections can also occur. Infection can also progress to a huge amount of inflammation. So, mostly how it can be treated is that you can use antibiotics, anti-inflammatory drugs, and in most of these types of situations, recovery can occur very quickly. Next is the herniated disc, especially in the vertebrae area, because it has small bones, as we

discussed in the spinal cord, and one disc can kind of go to another disc and merge with it, causing a huge amount of friction and pain.

So, in these cases, one disc can perturb another inside the disc. This is a hugely painful type of situation causing significant pain. Back pain can happen, and leg pain can be observed. Doctors can examine these using an MRI or other physical examinations. Mostly, these are like surgeries that are the only option in cases of a serious type of herniated disc condition.

Otherwise, naturally, rest is a good option. You may be doing certain exercises that can somewhat mitigate your pain, but the condition cannot be completely reversed if there is a significant herniated disc; surgery is the only option. Then scoliosis, which is also an abnormal curvature of the spine, can happen. This can happen due to wrong posture, as you may remember from our childhood; our grandparents used to say that we should walk with the right posture. That means we should walk in an upright position with our back straight.

If we are kind of walking in a bent movement or if we walk in a sitting position with a bent posture for a significant amount of time, it can take a lot of time to cause this condition, but this type of situation can happen, resembling a bow or the curvature of the spine. Eventually, it can cause uneven shoulders, uneven hips, and this is a painful situation, mostly during the growing ages. In old age, you can observe that early detection can help; you can change your lifestyle, you can change your posture, and maybe in some way, you can recover from this condition. Sometimes, the condition can be genetic, of course; sometimes it is rare. Also, the treatment, of course, like some sort of exercise, can be done or surgery.

There is not enough treatment available because these are structural changes in the body. Another type of spondylitis can also be genetic; although the exact cause is unknown, genes like HLA-B27 can lead to this type of ankylosing spondylitis situation in the body. Of course, spondylitis can cause severe back pain, lower back pain, stiffness, and spinal pain. Anti-inflammatory drugs can be given, but there is no cure because spondylitis and similar conditions involve structural changes in the body. You can have pain management, and maybe in certain cases, surgery can be done.

Then this is a rare genetic disorder that is similar to Duchenne muscular dystrophy. You remember we discussed the role of dystrophin protein in the body. So, in cases like this, it is like an X-linked type of recessive genetic disorder; if it happens, there will be defective dystrophin production, or the right quantity of dystrophin may not be produced. That can eventually cause the hampering of normal muscle function, and the hampering of muscle function in the early stages can also lead to muscle loss, loss of muscle mass, and eventually, in the progressive stages of DMD, can cause fibrosis of the muscle that can eventually shut down muscle function slowly, one by one. It can initially affect our esophagus in the gastrointestinal area; with a progressive DMD condition, it can affect our lungs, and it can even affect our heart and brain, causing all muscle actions to slowly stop.

Nowadays, it has become very common; DMD is becoming very prevalent and is no longer almost rare, as many households have children, mostly kids, who are being affected by DMD. There are only one or two genetic therapies present in the market, but they are not currently available in India. The treatments are highly costly; they can range from 5 crore to 10 crore rupees in the United States of America. A regulatory agency like the FDA recently approved gene therapy for DMD, and a lot of research is currently ongoing on how to cure this type of genetic condition. There can be different types of strategies, such as gene therapy and cell

therapy, but I hope we will soon find many effective therapies that will reduce these types of unbearable, life-threatening situations for children.

Mostly, these are affected in children, sometimes in older age as well. Then muscle atrophy, which is a type of atrophical muscle-related disease, can also involve neurogenic atrophy observed in the muscle; muscle size and strength can reduce with the progression of the disease, leading to muscle weakness and a decrease in muscle size or mass. There is not enough significant therapy present, but nutritional support can be given; physical exercise or physical therapy can manage the pain or the underlying cause. There are other diseases also; I will not discuss all of them, but the class slide will be with you. So, go through all these tests; all these things, like this one, can happen: this tendinitis can occur in the tendon, which is an inflammatory condition of the tendon.

Right, and if there is inflammation in the tendon, this can happen due to sports-related injuries, other sorts of accidental injuries, or sometimes, in rare cases, some sort of infection. A lot of pain, inflammation, and swelling can occur in the tendon unless the tendon is completely torn apart. Mainly, rest and physical exercise can help recover some amount of tendon activity in that local area. But overall, anti-inflammatory drugs can be given in cases of infective tendonitis; you can also give antibiotics or any type of steroid. Then, bursitis like this is a condition in our knee joint.

So, in cases of significant, maybe in cases of progressive stages of arthritis, what will happen is our joints will mostly dry up, and in these cases, friction can cause a lot of pain, and with the growing amount of friction, it can further cause fluid accumulation. So, an increased condition of inflammation might result from various conditions that can eventually lead to this one, but ultimately, infection or injury can cause water sac formation in our joints, leading to a significant amount of swelling and pain. Generally, anti-inflammatory steroid drugs can be given in cases of progressive stages of bursitis. The doctor can also remove the fluid from the knee joint using a syringe. This is commonly seen in cases of soccer players or sports players, right? There is a famous video that you can check on YouTube featuring a famous Pakistani bowler named Shoaib Akhtar.

He said that during some World Cup matches, he did not remember exactly which year it was; it might have been 1999 or 2003. He was playing with immense pain in his knee. And he observed this situation of bursitis where, on a daily basis, when he played after coming back from his match, he would notice a swollen knee and a significant amount of fluid accumulation in the knee joint. He does not have any options because, again, the next match may be in the next two days, and he would not get enough recovery time. So, the only option would be for a doctor to remove that fluid from the knee joint using a needle and syringe.

So, you can imagine that sometimes sportspeople undergo so much pain and they do not have enough time for recovery, right? So, the last but not least bone can also be affected by tumor formation or cancerous cells, such as osteosarcoma, which is a very common form of bone cancer; chondrosarcoma can occur in cartilage cells; and Ewing sarcoma, which is a very rare but aggressive form, typically affects children and young adults. So, these are some forms of cancer. It can be detected through physical observation, various biomarker analyses, different types of imaging analyses such as X-ray, MRI, CT scan, or biopsy by performing tissue histology. There can be chemotherapy, radiation therapy, or a combination of therapies, and nowadays, immunotherapy is also very popular in the market; different types of cell therapies and genetic therapies are also emerging. So, as you know, cancer is very common nowadays;

it affects almost all the organs, right? But as you remember, we discussed that in cases of the heart, heart cancer is very rare.

Do you remember why heart cancer is very rare? However, cancer does not leave almost any part of our body untouched. So, I hope you know that these classes were very informative in terms of many diseases, their symptoms, and some types of therapies as well, but it is very important for us to understand that whenever we observe a certain situation or condition in our body, such as bone pain or swelling, we should not ignore any condition or symptom. We should immediately go to the doctor, have the right diagnosis, and find out the cause of the disease. If treatments or any type of intervention methods are available, we should try to recover from the condition.

So, I hope you enjoyed the class. This is one activity question. So, consider Messi playing a high-voltage soccer match, like when Barcelona is playing, or maybe he is playing with the Argentina team. Maybe Barcelona versus Real Madrid is happening right now, and this guy, Sergio Ramos from Real Madrid, tackled Messi in the leg, hitting his knee, which resulted in a significant injury to Messi's knee, creating a very dangerous situation for the whole football world. That injury can lead to a condition like fluid sac or water sac development. Like his team doctor will say to Messi, maybe go to a doctor for a full checkup to see if there is any ligament injury or not, or maybe an injury in his cartilage, or if it is just a fluid sac or water sac condition, then just drain the water from your knee.

Can you tell me what the exact condition of that is? We discussed many different bone conditions, right? Can you identify what the exact disease, symptom, or condition is? In this case, Macy is observing how the doctor will be able to mitigate or cure the condition. This is your task. Hope you enjoyed the different types of bone diseases and their therapy class. We will come back to another new class of human physiology. Thank you very much.