

THE UNIVERSITY OF TOLEDO MEDICAL CENTER

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THE UNIVERSITY OF TOLEDO MEDICAL CENTER
ORTHOPAEDIC MONTHLY

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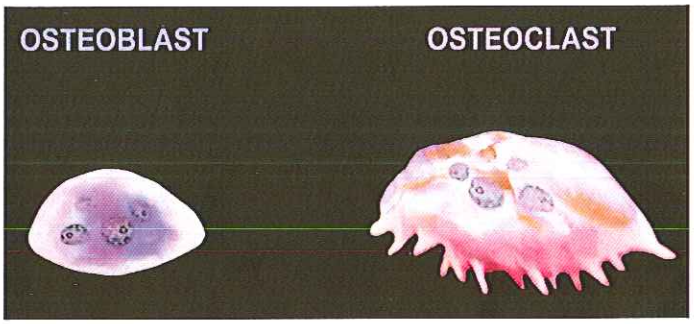
Osteoblast & Osteoclast

The osteoblast is different from the osteoclast and both cells are needed for bone remodeling. Osteoblast makes bone. Osteoclast removes bone. The shape and life span of these cells are different. They are two completely different cells. The osteoblasts are cuboidal cells that line along layers of immature osteoid to synthesis bone matrix. The osteoclast is a multinucleated giant cell and has a ruffled border which touches the bone and increases the surface area for one resorption. The osteoblast life span varies. It could be days when they make woven bone or could be weeks when the lamellar bone is made. It could be years until the osteoblast becomes an osteocyte. The osteoclast life span is days. The osteoclast does not live long, and it is very destructive, so it should not live forever. Osteoblasts are derived from mesenchymal stem cell lineage. The transcription factors called Cbfa1 and RUNX2 make the mesenchymal stem cell become an osteoblast. The osteoblast lineage cells are regulated by various molecules and signaling pathways, including the Wnt pathway. The Wnt pathway stimulates the osteoblastic activity and increases bone formation. Sclerostin has an inhibitory effect on the Wnt signaling, reducing osteoblastic activity and bone formation. Osteoclasts arise from monocytes. The monocytes fuse together to form multinucleated osteoclast cells. The osteoclast becomes distant to become an osteoclast from the monocytes. This needs the help of RANK L which is produced by the osteoblast and other factors may be involved to develop the osteoclast. RANK L is required for osteoclast differentiation, survival, and activity. The PTH receptor on the osteoblast binds to the PTH, which leads to expression of RANK L. RANK L binds to the RANK receptor on the osteoclast to stimulate bone resorption. Osteoclasts have RANK receptors and calcitonin receptors. The RANK L produced by the osteoblasts



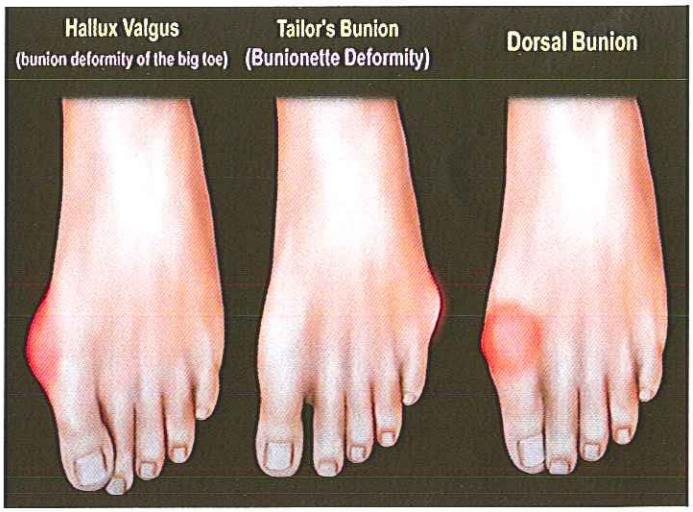
activates the osteoclasts and the calcitonin inhibits the osteoclasts. Osteoprotegerin (OPG) inhibits osteoclast differentiation and activation. OPG is produced by the osteoblasts and bind to RANK L (acts like a decoy receptor). The osteoclasts bind themselves to the bone through integrin (it is a protein). The function of the osteoblast is to make osteoid bone and control mineralization. It produces collagen Type I, osteocalcin, RANK L, and bone morphogenic proteins (BMP). It also makes and secretes alkaline phosphatase enzymes. Osteoclast cells act as a destructive machine. It takes about 100-150 osteoblasts to replace bone removed by one osteoclast. It takes about 3 months to fill bone removed by one osteoclast in 1-2 days. The bone is absorbed by the osteoclast at the Howship's Lacunae. The osteoclast has a ruffled border which touches the bone and increases the surface area for absorption of the bone. As the ruffled border of the osteoclast contacts the bone, it secretes acid that lowers the pH level, and the osteoclast then dissolves and absorbs the mineralized bone matrix. Cathepsin K (CTSK) is an enzyme that removes the osteoid at the ruffled border.

Bunion Types

Hallux Valgus is a bunion deformity of the big toe. Tailor's bunion or bunionette deformity is a deformity of the 5th metatarsal. Another bunion type is a dorsal bunion. Hallux valgus is a common foot deformity with a lot of misconceptions about them. People sometimes describe this deformity as a bump on the side of the big toe. This visible bump (bunion) is usually associated with a lot of changes in that part of the foot. The big toe will deviate laterally (point towards the second toe), and this will throw the bone out of alignment, creating the bunion. It is a progressive problem that may cause pain or soreness, burning sensation, inflammation or redness, and women are more likely to have bunions than men. It is more prevalent in aging females. Bunions are usually progressive,


Bunion Types

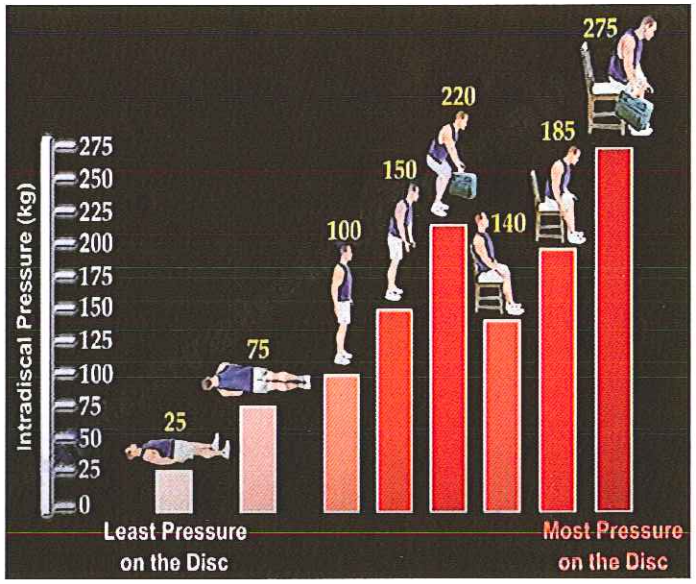
and they do not disappear. The symptoms occur when wearing shoes with a tight shoe box or when wearing high heels. Etiology is multifactorial, which includes chronic exposure to narrow toe box shoes and maybe some genetic predisposition. The valgus deviation of the proximal phalanx promotes varus positioning of the first metatarsal which displaces the metatarsal head medially, leaving the sesamoid complex laterally translated relative to the metatarsal head. The first line of treatment of hallux valgus is shoe modification, pads, orthosis, or spacers. Surgical correction is done if the symptoms persist despite conservative treatment, including shoe modification. The type of surgery depends on the severity of the condition. It is a prominence of the lateral part of the fifth metatarsal head. It is more common in females. It is usually bilateral and has three types. In Type I, the fifth metatarsal head is enlarged or there might be lateral exostosis. In Type II, there is bowing of the fifth metatarsal. In Type III, there is increased four and five intermetatarsal (IM) angle. It is the most common type. Nonoperative treatment of Tailor's Bunion is anti-inflammatory medications, shoe modification, or orthotics. Surgery is done if conservative treatment fails to relieve the symptoms. Do lateral condylectomy (excise the bump) for Type I. Do distal metatarsal osteotomy for Type II. Do oblique diaphyseal osteotomy if the intermetatarsal (IM) angle is more than 12 degrees. Dorsal bunion occurs due to dorsal flexed first metatarsal, over activity of the tibialis anterior muscle. The tibialis anterior muscle is an antagonistic muscle to the peroneus longus muscle. Dorsal bunion can also occur due to weakness of the peroneus longus tendon. Dorsal bunion can occur as a residual deformity after correction of a clubfoot deformity. The imbalance between a strong tibialis anterior tendon and a weak gastrocnemius soleus complex, which is compensated by strong secondary plantar flexors, such as the flexor hallucis longus and brevis will lead to the development of dorsal bunion. Over time, the



contracture of this tendon results in plantar flexion of the big toe and a dorsal bunion. The patient complains of a deformity such as dorsal callosities and metatarsalgia. The shaft of the first metatarsal is dorsiflexed, and the great toe is plantar flexed, resulting in a prominent head of the first metatarsal. The condition is usually treated with tibialis anterior lengthening or flexor hallucis longus transfer to the plantar aspect of the first metatarsal head, and maybe plantar flexion osteotomy of the first ray. In general, dorsal bunion occurs due to a normal tibialis anterior muscle overpowering a weak peroneus longus, which results in elevation or dorsiflexion of the first ray, and this is usually seen in patients with a history of a club foot. Usually the gastrocnemius soleus is weak due to prior surgery. This is compensated by plantar flexion of the big toe by using the flexor hallucis brevis.

Body Positions Affecting Disc Pressure

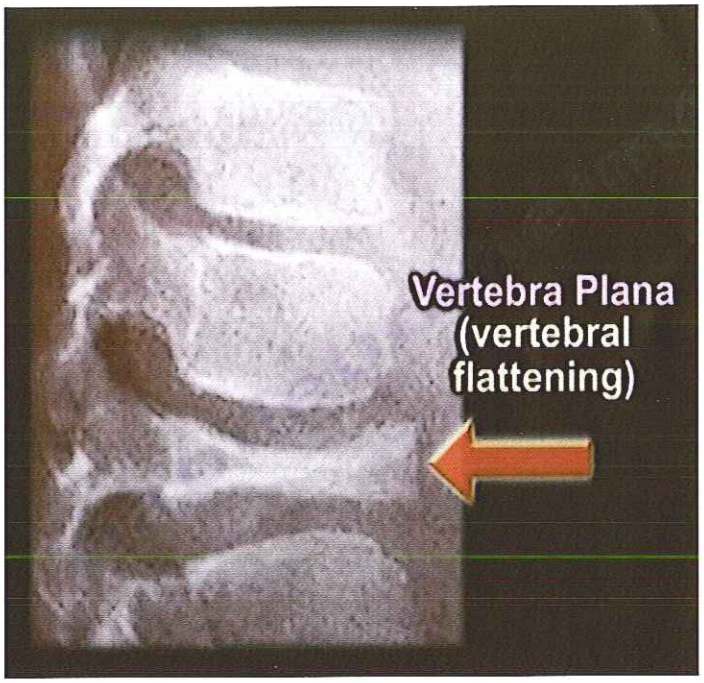
Postural changes have varying effects on lumbar disc pressure at various positions. Lowest disc pressure is measured while lying in the supine position. Disc pressure measured at 75kg when lying on the side. Disc pressure is 100kg while standing. There is 150kg of disc pressure while standing and leaning forward. There is 220kg of disc pressure when holding a load and leaning forward. There is 140kg of disc pressure while sitting. Sitting and leaning produces 185kg of disc pressure. Highest disc pressure is measured while sitting and 20 degrees forward leaning with 20kg in arms. Intradiscal pressure associated with the seated position and postural changes is greater in comparison to the same position performed while standing. By keeping the weight of the load close to the body, this reduces the compressive forces being placed on the lumbar spine. Yoga activities and exercises performed during sitting probably have less pressure being placed on the discs. These body positions can affect the disc pressure and can cause low back pain. Common physical factors leading to low back pain include lack of fitness, heavy lifting of objects, operating motor vehicles, prolonged sitting, job dissatisfaction, and history of smoking. Holding the loads close to



the body is important to reduce the compressive forces being placed on the lumbar spine. Job dissatisfaction or lack of interest in the profession may lead to psychological factors that can cause low back pain. Nicotine causes disc degeneration. In the Straight Leg Raising Test, elevation of a painful limb causes sciatica and radicular pain. The test is positive when the pain occurs with less than 60 degrees of hip flexion. The test can be modified by bending the knee. When the knee is bent, the pain gets better due to relaxing of the sciatic nerve. Once the patient feels the pain, lower the leg slightly and dorsiflex the foot. Dorsiflexion of the foot also reproduces sciatic pain in this position. Range of motion tests involving flexion of the spine in patients who have disc related disorders. Patients with spinal stenosis or spondylolisthesis will also demonstrate pain during extension of the lower back. Because of the pain suffered during extension of the spine, people suffering from spinal stenosis get relief from leaning forward. With extension, there is a decrease in foraminal area and pinching of the nerve. With flexion, the foraminal area increases and relaxes the nerve, relieving the nerve from pressure. The Faber test is a provocative test to determine the presence of sacroiliac joint problems. The purpose of this test is to stretch the SI joint in order to reproduce pain. Diagnostic injection of the SI joint is probably better than the clinical diagnosis and other clinical tests in confirming the diagnosis of SI joint problems.

Eosinophilic Granuloma Vertebral Plana

Vertebra Plana is a flattened vertebra in the spine, and it is associated with eosinophilic granuloma. Eosinophilic granuloma is a tumor like condition due to proliferation of the histiocytes. It is called histiocytosis X or Langerhans histiocytosis X. Eosinophilic granuloma can occur in any bone in the skeleton. It can also occur in the skin and in the skull. Eosinophilic granuloma also has a visceral involvement. Eosinophilic granuloma is called the great imitator. It looks similar to many lesions such as osteomyelitis, Ewing's sarcoma, leukemia, lymphoma, and fibrous dysplasia. The condition of cosinophilic granuloma is common in the spine, and it may cause flattening of the vertebra called "vertebra plana". Vertebra plana has many names such as "pancake vertebra" or "coin on edge vertebra". The vertebral body loses its height anteriorly and posteriorly, and it is most common in the thoracic spine. This complete compression of the vertebra can lead to back pain or neck pain and kyphosis. If this magnitude of compression occurs in the elderly patient, usually it is due to osteoporosis. If it occurs in the younger patient (usually between 2-10 years old), then it is due to eosinophilic granuloma. It is usually a single vertebra is affected. With collapse of multiple vertebrae, look for other reasons such as lymphoma, Gaucher disease, mucopolysaccharides and metastatic disease. When eosinophilic granuloma is seen in bones, it usually appears as a focal destruction of bone and is usually seen in children under the age of 10 years. The lesion may appear very aggressive; however, it is benign, self-limited, and it will heal spontaneously. It affects the vertebral body more than the posterior elements of the spine. Biopsy is usually not needed, especially if the patient has the characteristic history and x-ray appearance. The disc height is maintained and no involvement of the posterior element. There will be large cells. The histiocytes have a clear cytoplasm and a single large, oval nucleus or "bean shaped" nuclei. These cells do not have nuclear atypia or nuclear mitosis, so it is not malignant cells. These cells are called Langerhans cells. The Langerhans cells are grouped "coffee bean shaped" nuclei with abundant cytoplasm. You also find eosinophils (smaller cells) with bilobed nuclei and eosinophilic cytoplasm (pink). The eosinophils may be found in large numbers. You may also find



birbeck granules under electron microscopy (tennis racket shaped structures) inside the Langerhans cells. Ewing's sarcoma will have round, blue nuclei. Osteomyelitis will have mixed inflammatory cells. Eosinophilic granuloma is self-limited, usually managed conservatively. The spine lesions usually resolve spontaneously. Bracing may prevent progressive deformity of the spine and correct the deformity in the majority of cases. Vertebral lesions usually regain about 50% of its height back. If the patient has no neurological deficit, then follow the lesion and treat it nonoperatively. 10% of the patients with a spine lesion may need surgery for deformity correction or to relieve severe neurologic deficit. Low dose radiation (about 500-900 rads) may be indicated if there is neurological deficit, especially if surgical decompression of the lesion is not possible.

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Tibial Plateau Fractures Total Knee Arthroplasty

10 years after tibial plateau fracture surgery, only 7.3% of patients had a total knee arthroplasty. This is about 5.3 times increase in likelihood compared with the matched group from the general population. Older patients, patients with severe fractures, fractures with malalignment, patients with higher comorbidities bicondylar fractures and tibial plateau fractures requiring meniscal repair are patients who more likely will need total knee arthroplasty after repair of their tibial plateau fractures. Displaced intra-articular tibial plateau fractures were considered a risk factor for the development of arthritis and are usually treated by ORIF. The rate of total knee arthroplasty is low after ORIF of tibial plateau fractures (about 7.3% at 10 years after fixation). This low rate of future total knee arthroplasty explains why we shouldn't use surgical approaches that may be needed for future total knee arthroplasty such as a single midline incision and justifying it by the fact that we will need future total knee salvage surgery. At 10 years, only 7.3% will have the surgery, so we don't need incisions that may or may not help us in the future for surgery that the patient may or may not need. We will need incisions to help fix the fracture. The incisions can be medial or lateral incisions, or the incisions can be lateral and posteromedial incisions or combinations of any of these incisions. Two separate incisions for the fracture is better than one long midline incisions that will have many soft tissue complications.

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