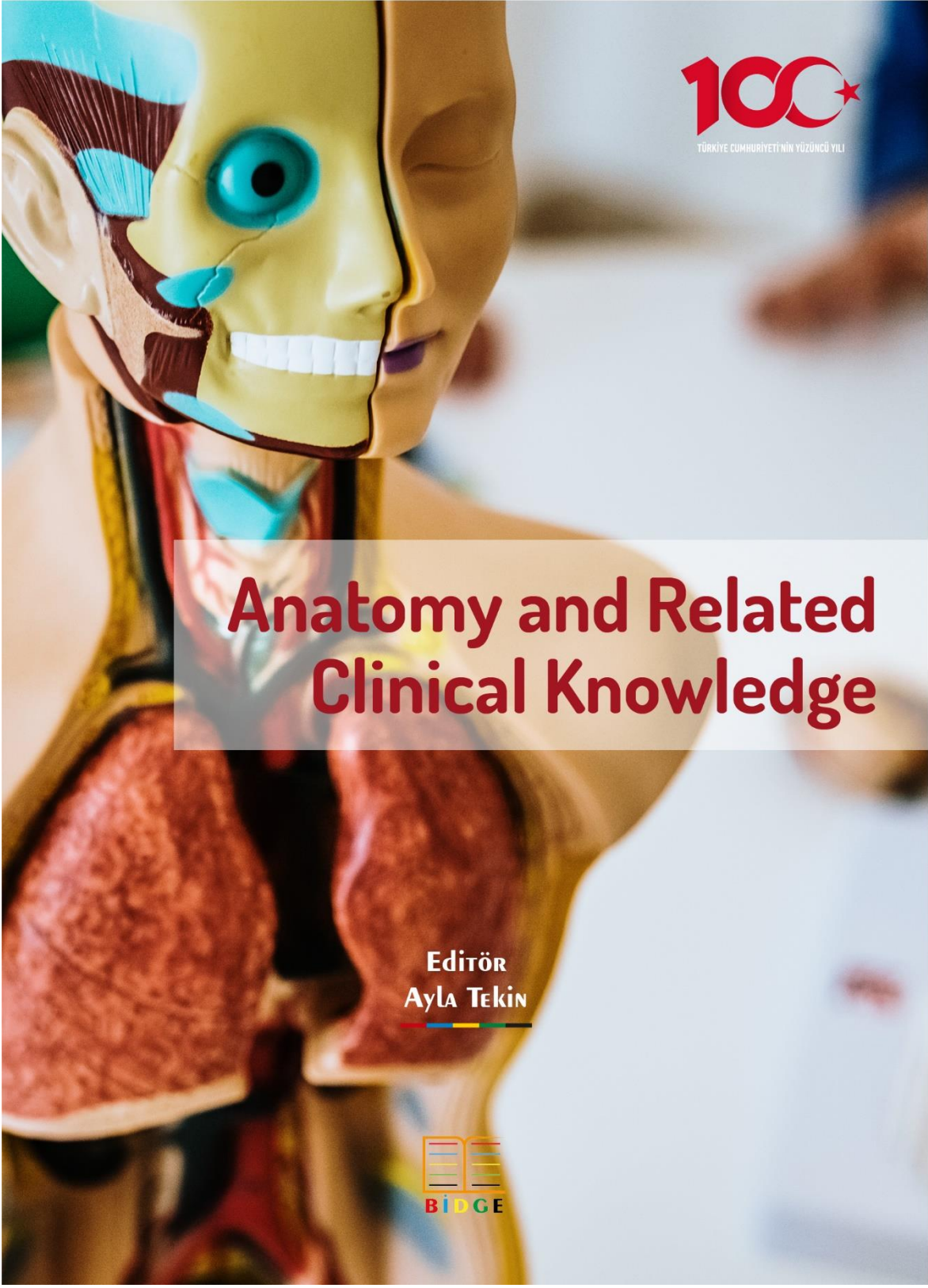

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Content

CHAPTER I

Musculus Piriformis Innervation And Piriformis Syndrome

Oğuzhan HARMANDAOĞLU[1]
Deniz ŞENOL[2]

1. Anatomy

Musculus (m.) piriformis is a short, pyramidal muscle with oblique extension. This muscle divides the foramen (for.) ischiadicum majus into for. suprapiriforme and for. infrapiriforme (Benzon, Katz &Benzon, 2003). M. piriformis starts from the anterior face of the sacrum and ends at the top of the trochanter major (Arifoğlu, 2021).

2. Function

The function of m. piriformis varies according to the position of the hip. M. piriformis causes external rotation (supination) when the hip is in neutral position and abduction when the hip is flexed. It

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helps to maintain a stable posture while standing and walking (Gonzalez, Pepper &William, 2008).

3. Innervation

Relationship between m. piriformis and nervus (n.) ischiadicus

N. ischiadicus is the thickest nerve in the body. N. ischiadicus usually passes through the for. infrapiriform and travels downwards over the external rotator muscles of the thigh. It descends down the midline behind the thigh. It usually divides into terminal branches called n. tibialis and n. peroneus (fibularis) communis in the 1/3 distal part of the thigh or at the apex of the fossa poplitea (Arifoğlu, 2021).

According to its appearance and formation in the gluteal region, n. ischiadicus and its branches are classified in different ways.

1- N. ischiadicus leaves the pelvis as a single trunk from for. infrapiriforme as is typical (72.5%) (Kadıoğlu, 2004). N. ischiadicus may leave the pelvis below the m. piriformis (76-96%) (Beaton & Anson 1938).

2-The terminal branches of the n. ischiadicus, called n. peroneus communis and n. tibialis, leave the pelvis via the for. infrapiriforme in separate nerve sheaths (7.5%) (Kadıoğlu, 2004).

3- N. peroneus communis pierces m. piriformis, n. tibialis reaches the gluteal region through for. infrapiriforme; these nerves merge at the lower edge of m. piriformis (10%) (Kadıoğlu, 2004). The n. tibialis branch of the n. ischiadicus can branch off and pass

under the m. piriformis and the n. peroneus communis branch can pass through the m. piriformis (2.5-34%) (Beaton & Anson 1938).

4-N. peroneus communis pierces m. piriformis, n. tibialis passes through for. infrapiriforme and reaches the gluteal region; these nerves travel in separate nerve sheaths along the posterior muscles of the thigh (7.5%) (Kadıoğlu, 2004).

5- From the pelvis, n. peroneus communis exits from for. suprapiriforme and n. tibialis exits from for. infrapiriforme and after exiting, they merge to form n. ischiadicus (2.5%) (Kadıoğlu, 2004). The n. tibialis branch of the n. ischiadicus may separate and pass below the m.piriformis, and the n. peroneus communis branch may pass above the m.piriformis (0,5-10%) (Beaton & Anson 1938).

6- The n.tibialis branch of the n.ischiadicus can separate and pass through the m.piriformis and the n.peroneus communis branch can pass above the m.piriformis (Beaton & Anson 1938).

7- N. ischiadicus can pass completely through the m. piriformis (0.5-2.2%) (Beaton & Anson 1938).

Studies conducted by Ergun and Hayran, Süzen, Schünke et al. revealed that m. piriformis is innervated by branches from L5, S1 and S2 (Ergun & Hayran 2014, Süzen, 2020, Schünke et al. 2007). Ozan stated that m. piriformis is innervated by the plexus sacralis (Ozan, 2005). Arifoğlu wrote that the m. piriformis is innervated by branches from the S1-S2 plexus sacralis (Arifoğlu, 2021). Moore wrote that m. piriformis is innervated by the ramus ventralis of S1 and S2 (Moore, 2006). Yıldırım wrote that m. piriformis is innervated by n. musculi piriformis (Yıldırım, 2013). Gilroy and Sarsılmaz reported that the innervation of the m. piriformis is by the

branches (S1-S2) coming directly from the plexus sacralis (Gilroy, 2008, Sarsılmaz, 2012). In his study, Özbağ stated that m. piriformis is innervated by n. musculi piriformis originating from S1-S2 segments of the plexus sacralis (Özbağ, 2023). In his study, Dere wrote that m. piriformis is a triangular muscle and its innervation is by the ramus ventralis of S1-S2 (Dere, 1994). Arıncı and Elhan defined the innervation of m. piriformis as n. musculi piriformis. They also stated that there may be variations perforated by n. fibularis communis. In such cases, he said that the muscle is bipartite and may be fused with the m. gluteus medius and may send fibres to the m. gluteus minimus or m. gemellus superior. He also stated that n. musculi piriformis may start only from the 2nd or 3rd segments of the sacrum, may terminate in the hip joint capsule instead of trochanter major, and sometimes may not be present (Arıncı & Elhan 2014).

Iwanaga et al. 2019, 5 white men and 5 white women examined the innervation of the 20-sided m. piriformis on 10 cadavers. As a result of the study, a total of 53 nerves innervating the m. piriformis were identified. 1 nerve innervated two sides, 2 nerves innervated seven sides, 3 nerves innervated nine sides, 4 nerves innervated one side, 5 nerves innervated no side, and 6 nerves innervated one side. When the contribution of the nerve branches to m. piriformis was analysed, it was found that it was innervated by n. gluteus superior on 14 sides, n. gluteus inferior on 1 side, L5 on 1 side, S1 on 17 sides and S2 on 14 sides. When the multiple contribution of the ventral roots of S1 and S2 and n. gluteus superior to m. piriformis was analysed; it was found that it was innervated by n. gluteus superior + S1 on 11 sides, n. gluteus superior + S2 on 11

sides, S1 + S2 on 11 sides, n. gluteus superior + S1 + S2 on 8 sides (Iwanaga et al. 2019).

In conclusion, no information about the innervation of the m. piriformis by the n. gluteus superior has been found so far in the literature. Iwanaga et al. 2019 showed that single nerve branch innervation of the m. piriformis is not common and that transection of a single nerve branch to the m. piriformis by surgeons may leave the muscle possibly partially innervated, resulting in the patient's symptoms still persisting (Iwanaga et al. 2019). We suggest that future studies on the innervation of the m. piriformis should include the n. gluteus superior in addition to the plexus sacralis.

4. Clinical reflection: Piriformis Syndrome

Piriformis syndrome is an entrapment neuropathy caused by compression of m. piriformis on n. ischiadicus (Boyajian & McClain 2008). It was first described by Yeoman in 1928 (Broadhurst et al. 2004). The etiology of piriformis syndrome includes hypertrophy, inflammation or anatomical variations of m. piriformis. Piriformis syndrome is divided into two as primary and secondary. Primary piriformis syndrome occurs as a result of anatomical variations. Secondary piriformis syndrome is caused by soft tissue inflammation, muscle spasm and muscle hypertrophies resulting from traumas (Byrd, 2005).

Patients with piriformis syndrome may have acute or chronic cramping or burning pain radiating to the hip or thigh (Barton, 1991). Hip pain is often associated with pain and tenderness by palpation in the region of m. piriformis from the sacrum to the trochanter major (Freiberg & Vinke 1934). There are special tests used in the

diagnosis of piriformis syndrome, but no test is reliable on its own. These tests are Freiberg, Beatty, Pace and Fair tests. Freiberg and fair tests are tested by passive stretching of the muscle, while pacing and beatty tests are tested by active use against resistance (Pace & Nagle 1976).

The piriformis syndrome described by Robinson in 1947 has 6 main features. These are

a- History of trauma to the sacroiliac and gluteal region,

b- Pain in the sacroiliac joint area, m. piriformis radiating to the extremities and causing difficulty in walking

c- Acutely worsening pain with weight lifting and forward bending, relieved by traction of the affected extremity

d- Detection of a sausage-like painful mass on palpation of m.piriformis

e- Positive laseque test

f- Gluteal atrophy in advanced cases (Robinson, 1947).

In the treatment of piriformis syndrome, non-steroidal anti-inflammatory and muscle relaxant drugs, rest, cold or hot application, stretching exercises, trigger point injection to m.piriformis, botox, steroid applications and very rarely surgical interventions are applied in treatment. If piriformis syndrome is detected early, 79 % respond well to conservative treatment (Hopayin et al. 2010).

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CHAPTER II

The Effects of PPI Usage on Tissues Due to pH Changes in the Stomach and Impairment of Mitochondrial Proton Pumps in Cells

Seçil Nazife PARLAK[1]

Introduction

The stomach, an elongated organ located in the upper left quadrant of the abdominal cavity, plays a vital role in digestion as it synthesizes the pepsin enzyme. An optimal level of acidity (pH≤3) is required for efficient digestion.

Parietal cells, which have a pyramidal structure, are acidophilic staining cells. They create stomach acid (HCl) by using proton pumps, which in turn lowers the pH of the stomach and enhances the activity of digesting enzymes.

Proton pump inhibitors (PPIs) are drugs employed for the long-term suppression of gastric acid. These medications hinder the activity of proton pumps located in the membrane of parietal cells, which are also present in mitochondria.

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Mitochondria generate ATP energy molecules via aerobic respiration. Proton pumps use anaerobic respiration for energy production, so inhibiting their activities can lead to health complications. PPIs can also impact extragastric cells by binding to proton pumps in these cells, owing to their chemical composition.

The Stomach

The stomach is a tubular organ located in the upper left part of the abdominal cavity. It is the largest part of the digestive tract and is located between the esophagus and duodenum (Singh 2014).

During the digestion phase, the pH of the stomach becomes 3 or lower than 3. There is a strongly acidic environment in the stomach. This situation is a physiological necessity and effective digestion of food only occurs in this pH environment. Optimal gastric acid secretion is critical not only for efficient digestion but also for nutrient absorption (Wright et al. 2001).

Protein foods encountering stomach acid and pepsin enzyme dissolve and the digestion process begins. The acidic stomach environment guarantees the elimination of harmful substances entering the digestive system. It ensures the destruction of harmful bacteria, toxins and carcinogenic substances (Wright et al. 2001).

Parietal cells

Parietal cells are responsible for stomach acid release. They play an important role in the digestive system's healthy function. They are mostly located in the crypts of the gastric mucosa. The fundus and corpus regions of the stomach contain the highest density of these cells (Sachs et al. 2003).

Parietal cells are pyramidal-shaped cells with intense acidophilic staining, containing numerous mitochondria and well-developed endoplasmic reticulum and Golgi bodies in their cytoplasm. They have an oval or circular-shaped nucleus, and their nuclei are centrally located. There are many microvilli in the apical region of the cell membrane, extending towards the stomach lumen.

The parietal cells use the ATPase enzyme to pump hydrogen ions from the H+/K+ pump towards the stomach lumen, replacing them with potassium ions. Parietal cells generate bicarbonate and hydrogen using water and carbon dioxide. Bicarbonate is replaced by chlorine at the base of the cell. Chlorine diffuses from the apical part of the cell into the stomach lumen, where it combines with hydrogen to form hydrochloric acid (Sachs et al. 2003).

Proton Pump Inhibitors (PPI)

Proton Pump Inhibitors (PPI) are a group of medications used to suppress stomach acid long-term. It contains chemicals ending in 'prazole'. Pantoprazole, lansoprazole, rabeprazole, esomeprazole, and dexlansoprazole are examples of these drugs. These medications are widely used to treat diseases such as heartburn, reflux, indigestion, and peptic ulcers. It is one of the most prescribed drugs in the United States and Turkey. Generally, a single daily dose keeps the stomach's pH above 4 for approximately 12–16 hours and significantly reduces the acidity (Sachs et al. 2006).

PPIs enter the cell to bind to proton pumps apical to parietal cells. PPIs inhibit stomach acid secretion by blocking the proton pump's function. This significantly reduces the stomach's acid production.

PPI group drugs are considered safe, but studies conducted in recent years have shown that these drugs have many negative effects. Long-term use of PPIs can cause adverse negative effects on various organs, including the stomach, small intestine, liver, kidney, heart, and skin (Eusebi et al. 2017).

The Effects of PPI Depending on pH Change in The Stomach

Long-term use of PPIs can cause significant decreases in the acid-secreting capacity of the gastric mucosa. A decrease in acid production can cause infections and inflammation of the gastric mucosa. Inadequate digestion can lead to the onset of gastroesophageal reflux disease, damage to the esophagus, stomach,

and duodenum, the development of ulcers and cancers in these organs (Lee et al. 2020).

Studies have shown that PPIs reduce the diversity of gut flora, which plays an important role in health. It is known that PPIs negatively affect the bacterial balance in the intestinal flora and can increase the number of pathogenic bacteria. These effects cause an increase in the risk of intestinal inflammation and negatively impact the immune system. According to reports, the use of PPIs causes the small intestinal villus structures to shrink and atrophy, and this villus structure deterioration reduces nutrient absorption.

Reduced absorption of important nutrients such as essential amino acids, calcium, iron, B12, and vitamin C can lead to metabolic problems. A deficiency of essential amino acids can cause mental health problems such as sleep disorders and depression. PPIs can negatively affect calcium absorption in the digestive tract. Long-term use of PPIs can lead to a decrease in bone mineral density and osteoporosis. Osteoporosis can significantly increase the risk of fracture (Jaynes & Kumar 2019).

Disruption in the intestinal flora may increase the immune system's sensitivity and the risk of autoimmune diseases through the passage of undigested proteins into the blood. Hypersensitivity to sunlight, erythematous, itchy skin rashes or eczema are examples of autoimmune reactions caused by PPIs.

Disruption of Mitochondrial Proton Pumps in Cells Due to the Effect of PPI

The stomach's parietal cell membrane does not contain only proton pumps. Mitochondria, present in all cells of the body, also include proton pumps. PPIs are believed to affect cell mitochondria, potentially leading to various health problems (Sun et al. 2013).

Mitochondria serve as the "energy factory" of the cell and produce ATP. It regulates the calcium balance within the cell. Mitochondria play a role in the process of cellular programmed death (apoptosis).

PPIs disrupt mitochondrial pH and ionic balance by blocking proton pumps. PPIs negatively affect the electron transport chain and ATP synthesis processes PPIs disrupt the calcium balance in mitochondria, which affects cell function. When cellular pH gradients are severely upset, mitochondria stop working properly. ROS accumulate, caspases activate, and cells die as a result. Additionally, factors such as mitochondrial membrane permeability, cytochrome c release, chromatin condensation, and caspase activation can trigger cell death. The decrease in energy production can compromise cellular functions and health. If proton pumps, PPI blocks these functions, preventing cells from obtaining sufficient energy. In this case, to obtain energy, they must resort to oxygen-free breathing. Blocking the pathway that provides efficient energy to other cells of the body could result in fatigue and numerous health issues (Schultz et al. 2001).

The Effects of PPI Depending on Mitochondrial Changes

Studies have shown the negative effects of PPI use on the cardiovascular system. PPIs can cause mitochondrial damage in cardiomyocytes, causing degenerative changes (Shiraev & Bullen 2018). PPIs can cause structural and functional changes in liver cells (hepatocytes). PPIs may cause an elevation of liver enzymes (ALT and AST). PPIs can cause structural and functional damage to renal tubules. PPI use may cause disruption of magnesium and sodium homeostasis. Long-term use of PPIs may lead to decreased kidney function (Lazarus et al. 2016). PPI use is known to deteriorate mental functions, including Alzheimer's and dementia. PPI disrupts the metabolism of amyloid protein, potentially leading to this condition. Studies on the negative effects of PPI use on mental functions have taken into account the role of proton pumps in neuronal communication. Proton pumps are known to provide the energy required for neuronal communication. Reports indicate that stopping proton pumps with PPI-group drugs negatively affects mental functions (Ortiz-Guerrero et al. 2018, Papazoglou et al 2021)

Conclucion

The stomach, the largest part of the digestive tract, is crucial for efficient digestion and nutrient absorption. Parietal cells, located in the gastric mucosa, release stomach acid, which plays a vital role in the digestive system's health.

Proton Pump Inhibitors (PPIs) are medications used to suppress stomach acid. Long-term use of PPIs can make the stomach epithelium less able to produce acid, which can cause infections, swelling, damage to the esophagus, stomach, duodenum, ulcers, and gastroesophageal reflux disease. They also negatively affect calcium absorption, bone mineral density, osteoporosis, autoimmune diseases,

PPIs inhibit the function of proton pumps in the membranes of parietal cells, which are also found in mitochondria. The adverse effects of proton pump inhibitors on mitochondrial functions may lead to clinical problems like cardiovascular problems, distribution of kidney function, mental functions like Alzheimer's and dementia. More research is required to investigate the safety of PPI use.

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CHAPTER III

Clinical Anatomy of Vertebral Column

Özden BEDRE DUYGU[1]

Introduction

Skeletal components of the back consist of the vertebrae and associated intervertebral discs. The skull, scapulae, pelvic bones, and ribs contribute to the bony framework of the back and provide sites for muscle attachment (Arıncı & Elhan, 2006).

Vertebral Column

There are 33 vertebrae. These are axamined five groups

based on location and morphology.

- The size of seven cervical vertebrae is small. These vertebrae have a foramen in transverse process.

- The twelve thoracic vertebrae are characterized by their articulated ribs; although all vertebrae have rib elements, these

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elements are small and are incorporated into the transverse processes in regions other than the thorax.

- The five lumbar vertebrae form the skeletal support for the posterior abdominal wall and their size is large.

- The five sacral vertebrae called the sacrum.

- The coccygeal vertebrae called the coccyx (Arıncı & Elhan 2006).

Typical vertebra

A typical vertebra has a posterior vertebral arch and a

vertebral body. Extending from the vertebral arch are a number of processes for muscle attachment and articulation with adjacent bone.

- The vertebral body is linked to adjacent vertebral bodies by intervertebral discs and ligaments.

- The vertebral arch forms the posterior and lateral sections of the vertebral foramen.

- The vertebral foramina create the vertebral canal. This canal contains the spinal cord.

- The vertebral arch has pedicles and laminae.

- A spinous process projects inferiorly and posteriorly from the junction of the two laminae and is a site for ligament and muscle attachment.

- A transverse process extends posterolaterally from the junction of the lamina and pedicle and is a site for ligament and

muscle attachment, and for articulation with ribs in the thoracic region.

- Also projecting from the region where the pedicles join the laminae are inferior and superior articular processes, which articulate with the inferior and superior articular processes, respectively, of adjacent vertebrae (Gökmen, 2008).

Cervical vertebrae

The size of seven cervical vertebrae is small. These vertebrae

has a foramen in transverse process. A typical cervical vertebra has the following features.

-The vertebral body is short in height and has a convex inferior surface and a concave superior surface.

- Each transverse process is trough shaped and perforated by a round foramen transversarium.

- The spinous process is bifid and short.

-The first and second cervical vertebra are specialized to accommodate movement of the head (Gökmen, 2008).

Atlas and axis

The atlas articulates with the head. The vertebral body of CI

fuses onto the body of CII during development to become the dens of CII. As a result, there is no intervertebral disc between CI and CII. When viewed from above, the atlas is ring shaped and composed of two lateral masses interconnected by an posterior arch and a anterior arch.

Each lateral mass articulates above with an occipital condyle of the skull and below with superior articular process of vertebra CII (the axis). The superior articular surfaces are bean shaped and concave, whereas the inferior articular surfaces are almost circular and flat.

The posterior facet of the anterior arch has an articular

facet for the dens, which projects superiorly from the vertebral body of the axis. The dens is held in position by a strong transverse ligament of atlas posterior to it.

The axis is characterized by the large tooth-like dens, which

extends superiorly from the vertebral body (Gökmen, 2008).

Thoracic vertebrae

A typical thoracic vertebra has superior and inferior costal articular surfaces. The superior costal facet is larger than the inferior costal facet. Each transverse process has a articular surface. The vertebral body of the vertebra is heart shaped. The vertebral foramen is circular (Öner, 2021).

Lumbar vertebrae

The size of five lumbar vertebrae is large. Transverse processes of lumbar vertebrae are long and thin. The vertebral body of a typical lumbar vertebra is cylindrical. The vertebral foramen is larger than the thoracic vertebrae and triangular in shape (Pınar, 2021).

Sacrum

The sacrum represents the five fused sacral vertebrae. It articulates below with the coccyx and above with vertebra LV. The

posterior surface of the sacrum has posterior sacral foramina, and the anterior part has anterior sacral foramina (Pınar, 2021).

Coccyx

The coccyx is a small and triangular bone. It articulates with the inferior surface of the sacrum. It represents three to four fused coccygeal vertebrae (Öner, 2021 & Pınar, 2021).

Intervertebral foramina

Intervertebral foramina are formed between adjacent parts of vertebrae and associated intervertebral discs. The foramina allow structures, such as vessels and spinal nerves, to pass in of the vertebral canal.

Each intervertebral foramen is a confined space surrounded by bone and ligament, and by joints. Pathology in any of these structures can affect structures within the foramen (Pınar, 2021).

In the clinic

Spina bifida

Spina bifida is a disorder in which the two sides of vertebral arches, fail to fuse during development. This is "open" vertebral canal.

- Spina bifida occulta is the commonest type. There is a change in the vertebral arch of LV or SI. It results in failure of the posterior arch to fuse in the midline. The patient is asymptomatic clinically, although physical examination may reveal a tuft of hair over the spinous processes.

-The severe form of spina bifida includes complete deficiency of fusion of posterior arch at the lumbosacral junction,

with a large protrusion of the meninges. It may comprise a portion of the spinal cord (a myelomeningocele) or cerebrospinal fluid (a meningocele).

These abnormalities may cause a variety of including problems with bladder function, walking and neurological deficits (Snell, 1997; Drake, Vogl & Mitchell, 2020).

Vertebroplasty

Vertebroplasty is a technique in which the body of a vertebra can be filled with bone cement. The indications for the technique include vertebral body collapse and pain from the vertebral body, which may be secondary to tumor infiltration. The procedure is most commonly performed for osteoporotic wedge fractures, which are a considerable cause of morbidity and pain in older patients.

Osteoporotic wedge fractures occur in the thoracolumbar region, and the approach to performing vertebroplasty is novel and relatively straightforward. The procedure is applied under light general anesthetic or sedation. Using X-ray guidance the pedicle is identified on the anteroposterior image. A metal cannula is placed through the pedicle into the vertebral body. Liquid bone cement is injected via the cannula into the vertebral body. The function of the bone cement is two-fold. First, it increases the strength of the vertebral body and prevents further loss of height. Furthermore, as the bone cement sets, there is a degree of heat generated that is believed to disrupt pain nerve endings (Snell, 1997; Drake, Vogl & Mitchell, 2020).

Scoliosis

Scoliosis is anormally an lateral curvature of the vertebral

column. A true scoliosis involves not only the right or left sided curvature but also a rotational element of one vertebra upon another.

The commonest types of scoliosis are those for which we have little comprehension about how or why they occur and are termed idiopathic scoliosis. There is some initial axial rotation of the vertebrae, which then alters the locations of the mechanical compressive and distractive forces applied through the vertebral growth plates, leading to changes in speed of bone growth and ultimately changes to spinal curvature.

These are never present at birth and tend to occur in either the infantile, juvenile, or adolescent age groups. The posterior elements and vertebral bodies are normal in scoliosis patients.

Congenital scoliosis is usually associated with other developmental abnormalities. There is a association with other abnormalities of the chest wall, heart disease and genitourinary tract in these patients. This group of patients needs careful evaluation by many specialists.

A rare but important group of scoliosis is that in which the muscle is abnormal. Muscular dystrophy is the commonest example. The abnormal muscle does not retain the normal alignment of the vertebral column, and curvature develops as a result. A muscle biopsy is needed to make the diagnosis.

Other disorders that can produce scoliosis include spinal cord tumors, bone tumors and localized disc protrusions (Snell, 1997; Drake, Vogl & Mitchell, 2020).

Kyphosis

Kyphosis is anormally curvature of the vertebral column in the thoracic region, producing a "hunchback" deformity. This condition occurs in certain disease states, the most dramatic of which is usually secondary to tuberculosis infection of a thoracic vertebral body, where the kyphosis becomes angulated at the site of the lesion. This produces the gibbus deformity. It is a deformity that was prevalent before the use of antituberculous medication (Snell, 1997; Drake, Vogl & Mitchell, 2020).

Lordosis

Lordosis is anormally curvature of the vertebral column in the lumbar region. This produce a swayback deformity (Drake, Vogl & Mitchell, 2020).

Variation in vertebral numbers

There are seven cervical vertebrae, although in certain diseases these may be fused. Fusion of cervical vertebrae can be associated with other abnormalities (Klippel-Feil syndrome, cardiac abnormalities, high-riding scapula etc.)

One of the commonest abnormalities in the lumbar vertebrae is a partial fusion of vertebra LV with the sacrum (sacralization). Partial separation of vertebra SI from the sacrum (lumbarization) may also occur.

A hemivertebra occurs when a vertebra develops only on one side (Snell, 1997; Drake, Vogl & Mitchell, 2020).

The vertebrae and cancer

The vertebrae are common sites for metastatic disease. When cancer cells grow within the posterior elements and the vertebral bodies. They interrupt normal bone cell turnover, leading to either

bone formation or destruction and destroying the mechanical properties of the bone. A minor injury may therefore lead to vertebral collapse. Cancer cells have a much higher glucose metabolism compared with normal adjacent bone cells. These metastatic cancer cells can therefore be detected by administering radioisotope-labeled glucose to a patient and then tracing where the labeled glucose has been metabolized. Importantly, vertebrae that contain extensive metastatic disease may extrude fragments of tumor into the vertebral canal. These compress the spinal cord and nerves (Drake, Vogl & Mitchell, 2020).

Osteoporosis

Osteoporosis is a pathophysiologic condition in which bone quality is normal but the bone quantity is deficient. It is a metabolic bone disorder that occurs in women commonly.

Factors affect the development of osteoporosis, including level of activity and nutritional status, genetic predetermination, and, in particular, estrogen levels in women.

Typical complications of osteoporosis include “crush” vertebral body fractures, hip fractures and fractures of the radius.

With increasing age, patients are more susceptible to fracture. Healing tends to be impaired in these elderly patients, who consequently require prolonged rehabilitation and long hospital stays (Drake, Vogl & Mitchell, 2020).

Conclusion

Large gaps exist between the posterior components of adjacent vertebral arches in the lumbar region. These gaps between

adjacent laminae and spinous processes become increasingly wide from vertebra LI to vertebra LV. The spaces can be widened further by flexion of the vertebral column. These gaps allow relatively easy access to the vertebral canal for clinical procedures.

Degenerative diseases of the vertebral column account for the vast majority of spinal disorders. Neoplastic disease, trauma and developmental anomalies account for most of the remainder of spinal problems. Medical management of spinal disease are dependent on accurate clinical diagnosis. These are reliant on comprehending of the anatomy of the vertebral column (Drake, Vogl & Mitchell, 2020).

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