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History of Tuberculosis

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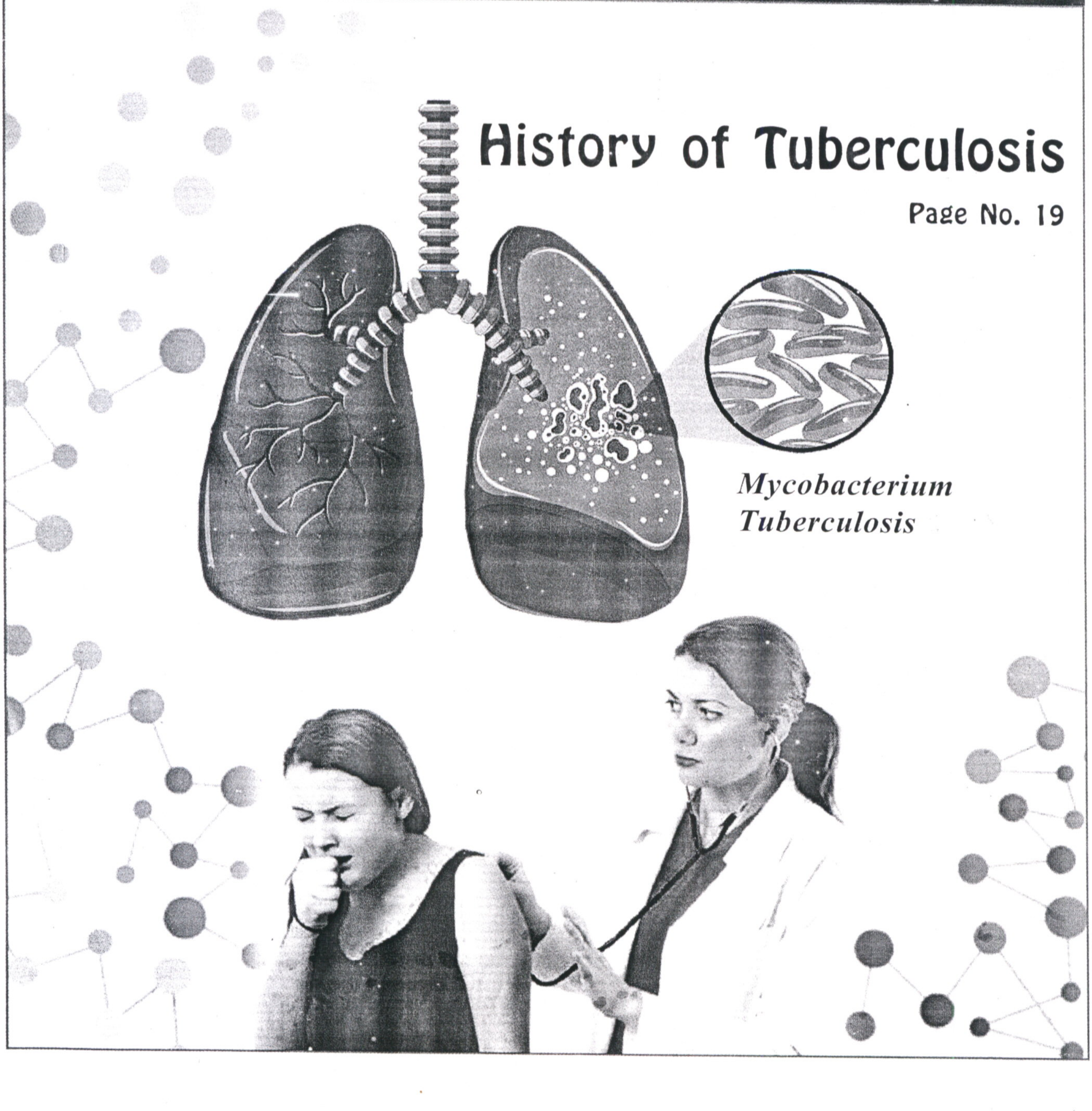

The Spine : A Unique Identity of Human Being

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ABSTRACT

The human species considered as the most evolved and advanced species among all in every aspect. The upright posture of human makes it more advanced. This all credit of upright posture goes to highly evolved and most unique creation – the skeletal spine. It has to maintain the posture as well as to balance the body and to protect the spinal cord. Human spine carries all these responsibilities due to its unique design which comprises the coiled curves, shock absorbing intervertebral discs, tough vertebras, firm ligaments, strong musculature, highly delicate spinal cord and various vertebral processes. Every activity of the spine is an output put of magnificent coordination and performance of all these structures. Which makes the human spine a unique creation?

Introduction

The central nervous system, with its complex sensory and motor functions, allows for an enormous amount of flexibility in a vertebrate's activities. As these systems evolved over millions of years and became more crucial to the survival of our early ancestors, they required the corresponding development of a protective structure that allows free movements but it is stable enough to offer protection to these vitals despite of delicate tissues. That structure, the skeletal spine, is perhaps nature's most elegant and intricate solution to these dual demands. As part of the body, the spine is a unique and complex structure. The spine is composed of living bone, cartilaginous elements, joints, a spinal cord, nerve roots, ligaments, tendons, muscles, and a vascular system. The anatomy and design of the human spine is unique in the animal world to support the upright posture of a human being. The most unique difference about it is its ability to carry our skull with the greatest ease and balanced at top in an almost perfectly upright structure. It is because of this uniqueness in design to accommodate upright posture we have paid a price. In certain ways we have become more vulnerable and more fragile to various spine related diseases.

Aim

To study the uniqueness of human spine with respect to its structural design.

Objective

To study literature regarding anatomy of human spine.

To study evolution of spine with respect to human species.

Spinal Curvatures

The spine is made of 33 individual bones stacked one on top of the other. This spinal column provides the main support for the body, allowing standing upright, bending, and twisting, while protecting the spinal cord from injury. Strong muscles and bones, flexible tendons and ligaments and sensitive nerves contribute to a healthy spine. The human spine is unique among all mammals differ in that it exhibits both primary and secondary curves. The primary curve of the spine comprises the kyphotic thoracic and sacral curves; the secondary, lordotic curves are present in the cervical and lumbar regions. Only a true biped require both these curves; tree-swinging and knuckle-walking primates have some cervical curve, but no lumbar lordosis, which is why they can't walk comfortably on two legs for long.

The primary (kyphotic) curve was the first front–back spinal curve to emerge as aquatic creatures made the transition to land. As a human stays in watery origins in utero, the entire spine is in a primary curve It changes shape for the first time when the head negotiates the hairpin curve of the birth canal and the neck experiences its secondary (lordotic) curve for the very first time. As your postural development proceeds from the head downward, the cervical curve continues to develop. After you learn to hold up the weight of your head at about three to four months and fully forms at around nine months, when you learn to sit upright after crawling and creeping on the floor for months, you must acquire a lumbar curve to bring your weight over the feet. At 12 to 18 months, as you begin to walk,

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the lumbar spine straightens out from its primary kyphotic curve. By 3 years of age, the lumbar spine starts to become concave forward (lordotic), although this won't be outwardly visible until 6 to 8 years of age. It is only after the age of 10 that the lumbar curve fully assumes its adult shape.

The curves of the spinal column

1. The lateral undulations that propel fish, snakes, and lizards through their environments cease to be useful for a creature that supports its belly off the ground on four limbs. The successful early quadrupeds would have been those that arched their bellies away from the earth so that their weight-bearing and movement forces were distributed into the limbs and away from the vulnerable center of the spine.
2. This parallels the fact that the cervical spine was the site of the first development of a secondary curve as our quadrupedal ancestors found a survival benefit to lifting their heads and gazing from the ground immediately in front of them, out to the horizon.

The spinal column has anterior to posterior curves (front to back) the purpose of which is to reduce the load due to the force of gravity on upright posture. Upright posture and the serpentine curves of the spinal column make humans unique in the mammal world. When viewed from the side, an adult spine has a natural S-shaped curve. The neck (cervical) and low back (lumbar) regions have a slight concave curve, and the thoracic and sacral regions have a gentle convex curve. The curves work like a coiled spring to absorb shock, maintain balance, and allow range of motion throughout the spinal column. The muscles and correct posture maintain the natural spinal curves. Excess body weight, weak muscles, and other forces can pull at the spine's alignment:

- An abnormal curve of the lumbar spine is lordosis, also called sway back.
- An abnormal curve of the thoracic spine is kyphosis, also called hunchback.
- An abnormal curve from side-to-side is called scoliosis.

Balancing of forces in the spine

To understand the overall architecture of the spine, it is useful to view it as two separate columns, in its front-to-back. Dimensions can be roughly divided in half between a column of vertebral bodies and a column of arches. Functionally, this arrangement very clearly evolved to contend with the dual requirements of stability and plasticity. The anterior column of vertebral bodies deals with weight-bearing, compressive forces, whereas the posterior column of arches deals with the tensile forces generated by movement. Within each column, there is a dynamic relationship of bone to soft tissue; there is a balance of sthira and sukha. The vertebral bodies transmit compressive forces to the discs, which resist compression by pushing back. The column of arches transmits tensile forces to all the attached ligaments. Which resist stretching by pulling back. In short, the structural elements of the spinal column are involved in an intricate dance that protects the central nervous system by neutralizing the forces of tension and compression.

Muscles in relation with spine

The two main muscle groups that affect the spine are extensors like erector spinae and flexors. The extensor muscles extends the vertebral column thus enable us to stand up and lift objects. The extensors are attached to the back of the spine.erector spinae has two layers Superficial and deep. Superficial erector spinae is divided in three groups – Spinalis, Longissimus, and Iliocostalis. Deep muscles include quadrates lumborum and multifidus, psoas major. The flexor muscles are in the front and include the abdominal muscles. These muscles enable us to flex, or bend forward, and are important in lifting and controlling the arch in the lower back. The back muscles stabilize the spine. Also trapezius. Levator scapulae, splenius, semi spinalis helps to stabilize cervical spine and to balance the head.

Vertebrae

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx. Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. The vertebrae in each region have unique features that help them perform their main functions.

Cervical (neck) - the main function of the cervical spine is to support the weight of the head. The seven cervical vertebrae are numbered C1 to C7. The neck has the greatest range of motion because of two specialized vertebrae that connect to the skull. The first vertebra (C1) is the ring-shaped atlas that connects directly to the skull. This joint allows for the nodding or "yes" motion of the head. The second vertebra (C2) is the peg-shaped axis, which has a projection called the odontoid, that the atlas pivots around. This joint allows for the side-to-side or "no" motion of the head.

Thoracic (mid back) - the main function of the thoracic spine is to hold the rib cage and protect the heart and lungs. The twelve thoracic vertebrae are numbered T1 to T12. The range of motion in the thoracic spine is limited.

Lumbar (low back) **-** the main function of the lumbar spine is to bear the weight of the body. The five lumbar vertebrae are numbered L1 to L5. These vertebrae are much larger in size to absorb the stress of lifting and carrying heavy objects.

Sacrum **-** the main function of the sacrum is to connect the spine to the hip bones (iliac). There are five sacral vertebrae, which are fused together. Together with the iliac bones, they form a ring called the pelvic girdle.

Coccyx region **-** the four fused bones of the coccyx or tail bone provide attachment for ligaments and muscles of the pelvic floor.

From the top of the cervical spine to the base of the lumbar spine, individual vertebrae are dramatically different in shape, based on the functional demands of the varying regions of the spine. The vertebral bodies in human have greater width and depth than other animal in order to give more stability than other animals which are devoid of upright posture. Also human vertebrae has lesser height than others.

Vertebral arch & spinal canal

On the back of each vertebra are bony projections that form the vertebral arch. The arch is made of two supporting pedicles and two laminae. The hollow spinal canal contains the spinal cord, fat, ligaments, and blood vessels. Human being has wider and deeper spinal canal than other animals. Under each pedicle, a pair of spinal nerves exits the spinal cord and passes through the intervertebral foramen to the body. Seven bony processes arise from the vertebral arch to form the facet joints and processes for muscle attachment. Those are spinous process, two transverse processes, two superior facets, and two inferior facets.

Ligaments

The ligaments are strong fibrous bands that hold the vertebrae together, stabilize the spine, and protect the discs. The three major ligaments of the spine are the ligamentum flavum, anterior longitudinal ligament, and posterior longitudinal ligament. They prevent excessive movement of the vertebral bones and stabilize the vertebral column. As only human being is gifted by upright posture he needs a strong support to stabilize it. In serpentines and quadrapedals this support is shared by limb or the bodily structures itself. The ligaments fulfills this need.

These ligaments are -

- Supraspinous ligament
- Interspinous ligament
- Ligamentum flavum
- Facet joint capsule
- Intertransverse ligament
- Posterior longitudinal ligament
- Anterior longitudinal ligament

Spinal cord

The spinal cord is about 18 inches long and is the thickness of your thumb. It runs within the protective spinal canal from the brainstem to the 1st lumbar vertebra. At the end of the spinal cord, the cord fibers separate into the cauda equina and continue down through the spinal canal to tailbone before branching off to legs and feet. The spinal cord serves as an information super-highway, relaying messages between the brain and the body. The brain sends motor messages to the limbs and body through the spinal cord allowing for movement. The limbs and body send sensory messages to the brain through the spinal cord about what we feel and touch. Sometimes the spinal cord can react without sending information to the brain. These special pathways, called spinal reflexes, are designed to immediately protect our body from harm. The nerve cells that make up the spinal cord itself are called upper motor neurons. The nerves that branch off the spinal cord down to back and neck are called lower motor neurons. These nerves exit between each of the vertebrae and go to all parts of the body.

Spinal nerves

Thirty-one pairs of spinal nerves branch off the spinal cord. The spinal nerves carry messages back and forth between the body and spinal cord to control sensation and movement. Each spinal nerve has two roots. The ventral (front) root carries motor impulses from the brain and the dorsal (back) root carries sensory impulses to the brain. The ventral and dorsal roots fuse together to form a spinal nerve, which travels down the spinal canal, alongside the cord, until it reaches its exit hole - the intervertebral foramen. Once the nerve passes through the intervertebral foramen, it branches; each branch has both motor and sensory fibers. The smaller branch (called the posterior primary ramus) turns posterior to supply the skin and muscles of the back of the body. The larger branch (called the anterior primary ramus) turns anteriorly to supply the skin and muscles of the front of the body and forms most of the major nerves. The spinal nerves are numbered according to the vertebrae above which it exits the spinal canal. The 8 cervical spinal nerves are C1 through C8, the 12 thoracic spinal nerves are T1 through T12, the 5 lumbar spinal nerves are L1 through L5, and the 5 sacral spinal nerves are S1 through S5. There is 1 coccygeal nerve.

Coverings & spaces

The spinal cord is covered with the same three membranes as the brain, called meninges. The inner membrane is the pia mater, which is intimately attached to the cord. The next membrane is the arachnoid mater. The outer membrane is the tough dura mater.The space between the pia and arachnoid mater is the wide subarachnoid space, which surrounds the spinal cord and contains cerebrospinal fluid (CSF). The space between the dura mater and the bone is the epidural space.

Intervertebral discs

If you look deeper, you can also see how sthira and sukha are revealed in the components of an intervertebral disc: The tough, fibrous layers of the annulus fibrosis tightly enclose the soft, spherical nucleus pulposus. In a healthy disc, the nucleus is completely contained all around by the annulus.The annulus fibrosis is itself contained front and back by the anterior and posterior longitudinal ligaments, with which it is closely bonded. This tightly contained arrangement results in a strong tendency for the nucleus to always return to the center of the disc, no matter in which direction the body's movements propel it. As well as axial rotation (twisting movements), produce symmetrical (axial) compressive forces that flatten the nucleus into the annulus, which pushes back, resulting in a decompressive reaction. If the compressive force is high enough, rather than rupture, the nucleus will loose some of its moisture to the porous bone of the vertebral body. When the weight is taken off the spine, the hydrophilic nucleus draws the water back in, and the disc returns to its original thickness. That is why humans are a bit taller right after getting out of bed.

Types of Spinal Movement

There are generally thought to be four possible movements of the spine: flexion, extension, axial rotation (twisting), and lateral flexion (side bending). These four movements occur more or less spontaneously in the course of life: as you bend over to tie your shoes (flexion), reach for something on a high shelf (extension), grab a bag in the car seat behind you (axial rotation) or reach your arm into the sleeve of an overcoat (lateral flexion). A more thorough look into the nature of the four ranges of motion of the spine shows that there is a fifth possibility called axial extension. This motion doesn't happen spontaneously in the normal course of daily movements.

Intrinsic Equilibrium in the human spine

The full glory of nature's ingenuity is apparent in the human spine—more so than in any other vertebrate structure. From an engineering perspective, it's clear that humans have the smallest base of support, the highest center of gravity and the heaviest brain (proportional to total body weight) of any other mammal. As the only true biped mammals on the planet. Humans are also earth's least mechanically stable creatures. Fortunately, the disadvantage of having a bowling-ball-weighted cranium balancing on top of the whole system is offset by the advantage of having that big brain. Between the contradictory requirements of rigidity and plasticity. The structural balancing of the forces of sthira and sukha in our living body relates to a principle called intrinsic equilibrium. If you were to remove all the muscles that attach to the spine, it still would not collapse. As Intrinsic equilibrium is the concept that explains not only why the spine is a self supporting structure but also any spinal movement produces potential energy that returns the spine to the neutral. The same arrangement exists in the rib cage and pelvis, which, like the spine, are bound together under mechanical tension. In the case of intrinsic equilibrium, a deep level of built-in support for the core of the body is involved. This built-in support does not depend on muscular efforts because it is derived from the relationships between the noncontractile tissues of cartilage, ligament, and bone.

Elements of Linkage between the Vertebrae

The spinal column as a whole is ideally constructed to neutralize the combination of compressive and tensile forces to which it is constantly subjected by gravity and movement. The 24 vertebrae are bound to each other with intervening zones of cartilaginous discs, capsular joints, and spinal ligaments. This alternation of bony and soft tissue structures represent a distinction between passive and active elements. The vertebrae are the passive, stable elements and the active, moving elements are the intervertebral discs, facet (capsular) joints, and a network of ligaments that columns the spine. There is an integration of these passive and active elements.

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Glossary

Dorsal: the back or posterior side of the body.

kyphosis: an abnormal forward curvature of the thoracic spine, also called hunchback.

Lordosis: an abnormal curvature of the lumbar spine, also called swayback.

Scoliosis: an abnormal side-to-side curvature of the spine.

Ventral: the front or anterior side of the body.