What is HARA chair?

Young Jae Huh, M.D.
Orthopedic Surgery

April 2015

1. Correlated human anatomy
2. Changes in the spine & pelvis during a single-seat chair seating
3. The characteristics of HARA chair

페이지 1 / 12
1. Correlated human anatomy

1) Spine anatomy

Vertebral column consists of 33 vertebrae, which are 7 cervical spine, 12 thoracic spine, 5 lumbar spine, 5 sacral spine and 4 coccygeal bones.

Cervical, thoracic and lumbar spine is called flexible spine due to asunder lifetime, and sacral and caudal vertebrae are fused to the sacrum and the coccyx respectively, called fixed spine. From the skull to the pelvic bone, vertebral column forms connected each other with strong pelvic ligaments and muscles to the bone, can be divided into the front of the vertebral body (vertebral body) and the arch of the back of the spine (vertebral arch). Vertebral arch forms the spine tube (vertebral canal) that is continuous between the vertebrae, and the spinal cord is protected in it.

Fig.1 Vertebral column

Fig.2 Spine movements in flexion and extension in sagittal plane
When viewed in terms of the curvature of the spine, cervical spine curvature is from the odontoid process of the second cervical vertebra (C2) to the middle to the end of the second thoracic vertebra (T2), forms the smallest lordotic curvature (lordosis). Thoracic curve is from the middle of the 2nd thoracic vertebra to the middle of the 12th thoracic vertebra, forms kyphotic curvature (kyphosis). Lumbar curve is from the middle of the 12th thoracic vertebra to the upper end of sacrum (lumbosacral angle), more significant in women than in men. Pelvic curvature is between the upper end of sacrum and the end of the coccyx, which forms kyphosis.
The muscles that maintain posture and gait are most effective when the head and torso are located just above of the pelvis. Thus, the vertical line drawn down from the highest point of the column in upright posture shall be located close to the center in the lowest portion of the spinal column. Vertical line from the odontoid process of 2nd cervical vertebra in the coronal plane passes the vicinity of the first sacral spinous process, and in the sagittal plane onto the rear through the cervical vertebrae and 7th cervical body, thoracic anteriorly, lumbar posteriorly and then passes through the rear edge of the first sacrum. The thoracic kyphotic angle in normal young adults is up to 50 degrees from 20 degrees and 20 degrees in the average. The normal lumbar lordotic angle relative to the lower epiphysial plate and the first sacral epiphysial plate of the 12th thoracic vertebrae is between 31 degrees and 79 degrees and average is 59. The lumbar lordosis increases to descend from the upper to the lower; two-thirds of this curvature is formed L4/S and L5/S1 area.

Fig.5 Normal spine curvature in sagittal plane

The joints of the spine

In the cervical through sacral spine joints are cartilaginous joints, vertebrae adjacent to each other form a semi-articulation. Intervertebral discs and vertebral bodies alternately stacked with each other and attached ligaments like tape on the back and front of the spine that helps to maintain flexibility as pole. Thick tape-like ligaments called anterior longitudinal ligament (ALL) anteriorly, and posterior longitudinal ligament (PLL) attached in the backside of the body. Posterior vertebral joints are articulating also with yellow ligaments, interspinous ligaments and supraspinous ligaments, contributing to the posterior ligamentous stability of the spine.

The back of the spinal column characterizes the scope of the movement of the spinal joints made to meet each other as a posterior articulation. The range of motion is determined in a category that does not damage the spinal cord in the formation of spinal canal.

2) Pelvis anatomy

Pelvis consists of a sacrum, coccyx and 2 in nominate bone. In rear portion a pair of innominate bones and sacrum articulates the sacroiliac joint (SI joint), and as forward portion two innominate bones combined and consist pubic bone (symphysis pubis). Those bone formation forms a ring-shaped circle (pelvic ring). Innominat bone consists of the long bones (ilium), the ischial bone (ischium), and the pubic bone (pubis); the combination is formed through the fusion at hip joint cup at puberty. The sacrum is located as a wedge between the two innominate bones. The upper half of the sacrum is in combination with the rear portion of the ilium as sacroiliac joints. Pelvis is heading forward upward as the whole direction of the sacrum with respect to the longitudinal axis of the body.

Pelvis has two main features; transmit the bodyweight to the pelvis and the sacrum through top three segments of sacrum, the sacroiliac joint and the hip joint from the spinal column (vertebral column) to the lower extremity. Secondly, protect the organs therein.
The Ligaments of pelvic ring are divided into four types: 1) the sacrum and ilium, and 2) the sacrum and ischium, 3) on both sides pubis, 4) ligament that connects the sacrum and coccyx.

Fig. 6 Pelvis

Sacroiliac joint (SI joint) is divided into anterior, interosseous, and posterior part. Especially posterior ligamentous portion is most important to maintain the stability of the pelvic ring, ligamentous bond between the sacrum and innominate bones.

There are many important organs in the pelvis including hypogastric artery, iliac artery, sacral nerve plexus, the lower colon and bladder. The lower part of the pelvic ring (pelvic outlet) is called the perineum (pelvic floor), where the symphysis pubis, both ischial tuberosity and coccyx outlined diamond-shaped area. Striated muscle covers this flat area and reinforces to prevent fall down of upper organs like a tent. There are several important organs like male urethra, prostate, female vaginal opening, bladder and anus.

- Ref. The textbook of orthopedic surgery 6th edition, Korea

Fig. 7 perineal organs and pelvic floor
2. Single-seat chair on the health impacts

Changes in the spine & pelvis during a single-seat chair seating

The bodyweight is delivered when it began from the skull in a standing position then forwarded to the sacral spine. It is passed through the sacroiliac joint to the hip joint. But it changes that the loading delivered to the hip joint on standing is transferred to bilateral ischial tuberosity when seat in the chair. The lowest part of the pelvic bone, which contacts the seat, bears almost all of the weight of the upper body. Some weight transfer to the feet touch the ground.

The ischial tuberosity is origin site of hamstring muscle. The sciatic nerve is located lateral side of the ischial tuberosity on sitting position. Hamstring travels to the proximal side of lower leg (tibia bone) to insert. According to the minor problems of hamstring contracture, which is common in people in the city, ischial tuberosity has been forced pulling anteriorly compared to a standing position. In result, posterior sagittal rotation force of innominate bone to the sacroiliac joint as the central axis has occurred.

Fig. 8 Axial loading of bodyweight on pelvis sitting on single-seat chair.
Acetabular Anteversion with CT in Supine, Simulated Standing, and Sitting Positions in a THA Patient Population, CORR 2011 Apr; 469(4) 1103-1109

Fig. 9 Characteristics of chronic non-specific musculoskeletal pain in children and adolescents attending a rheumatology outpatient’s clinic: a cross-sectional study O’Sullivan et al., Pediatric Rheumatology 2011, 9:3

Now, ischial tuberosities are subjected to force in a direction away from each other outwardly in single-seat chair sitting.

The distance between the points of maximum pressure is predicted by gender, stature and the angle of the pelvis rotation. For each 108 of rotation, the distance is changed by about 4 mm. As was expected, it decreases for forward rotation and increases for backward rotation.

Variation in sitting pressure distribution and location of the points of maximum pressure with rotation of the pelvis, gender and body characteristics.

Ergonomics Vol. 50, No. 4, April 2007, 536–561)

Fig. 10 - Fig. A1. Circular disc model of the ischial tuberosities.
This mechanism stretches out perineum, also increases applied loading on it. As peak pressure increases under ischia, as body weight loading concentrates on perineum, center of the weight bearing area. This is a characteristic of a single-seat chair leaning weight transfer to the ischial tuberosity region. (Please note pressure distribution graph data) Due to the backward rotation of the pelvis, more posterior rotation torque increases. This conforms to the sacroiliac joint and the rear ligaments worthy to tension takes place on both sides, resulting in sacroiliac joint pain syndrome. At the same time, the rotation of the sacrum adjusts the lumbar lordosis disappear (slump sitting).

This of course increases the abnormal pressure on the low back disc deterioration, such as HIVD (herniated intervertebral disc), facet joint pain and etc., and, as well as results in applying stress to the muscles and ligaments associated with the thoracolumbar spine.

Fig. 10 Lumbar lordosis disappears along the backward pelvic rotation

Variation in sitting pressure distribution and location of the points of maximum pressure with rotation of the pelvis, gender and body characteristics.

Ergonomics Vol. 50, No. 4, April 2007, 536–561

Many people working sitting in a chair almost whole day can hardly maintain the posture-doctor-recommended. That’s because lordosis disappearing mechanism of single-seat chair that tends to eliminate the principles as described above. Since slump sitting gets longer, lower body is prone to enter the desk and you can see only someone’s head above the desk finally. Simply this posture change is not the only problem of spine and pelvis because it is easy to understandable visually. Some parts of the prostate and rectum & anus of perineum are directly subjected to pressure causing circulatory disorders, concentrated pressure on the ischial tuberosities affects to blood, lymph circulation disability and sciatic nerve irritation as a consequence. Indirectly, the problems coming from slump posture can also be expected. Once slump posture set, abdominal organs can be affected in majority like squeezing force; Stomach, intestine, and etc. Increased stress applied to the digestive tract is never being good. In other words, sit in slump posture causes prolong adverse effects not only in the digestive system, but catastrophic effect on the metabolism of the whole body also. Those who have underlying medical conditions (diabetes, overweight, metabolic syndrome, etc. associated hypertension) increase the risks even more its adverse effects will be. These adverse effects on the body have been discussed broadly that on the mental state of the individual and the surrounding community relations, Anthropometrics, Pediatrics, etc. As a result, more than 8 hours of sedentary modern life style have health problems already at a moment to sit in a chair.

Reference examples.

1. A rapidly developing body of recent evidence has identified prolonged sitting time as a population-wide, ubiquitous health risk. In adults, too much sitting is related to risk for type 2 diabetes, cardiovascular disease, breast and colon cancer and poor mental health outcomes. In children, sedentary time is related to overweight and obesity, some cardio-vascular risk factors (eg, elevated systolic blood pressure) and poorer cognitive development (eg, language delay).

2. In the psychosocial domain CNSMSP subjects had increased levels of anxiety and depression, and had more somatic pain complaints. In the lifestyle domain CNSMSP subjects had lower physical activity levels, but no difference in television or computer use compared to pain free subjects. Physically, CNSMSP subjects
tended to sit with a more slumped spinal posture had reduced back muscle endurance, increased presence of joint hypermobility and poorer gross motor skills.

Characteristics of chronic non-specific musculoskeletal pain in children and adolescents attending a rheumatology outpatient’s clinic: a cross-sectional study
O’Sullivan et al. Pediatric Rheumatology 2011, 9:3)

3. Sedentary behavior is an increasingly recognized health risk factor, independent of physical activity. Although several correlates of sedentary behavior are known, little research has identified them among U.S. veterans, a population that faces disproportionate chronic disease burden. In the multivariate model, higher depression (B=7.8), BMI (B=5.1), functional impairment (B=4.2), and self-rated health (B=68.5) were significantly associated with higher sitting time, and leisure time physical activity (B=-.10) and being employed (B=-71.3) were significantly associated with lower sitting time.


4. Sitting time was associated with adverse cardiometabolic risk factors consistently across sex and race groups in a representative US sample, independent of other risk factors. Excessive sitting warrants a public health concern.

Sitting time and cardiometabolic risk in US adults: associations by sex, race, socioeconomic status and activity level.

Fig. 11 Posture difference of lumbar spine sitting in a single-seat chair in sagittal plane.

- Increase peak pressure under Ischia
- Lower extremity vessels and nerve compression increasing
- Perineum compressive pressure increasing
- Sacroiliac joint tension stress increasing
- Anti-lordotic force increasing (slump sitting)
- Increased abnormal compressive pressure to intervertebral disc
- Energy consuming posture
- Adverse effects on metabolic syndrome patients
SO...

Bad for your spine and low back pain

Changes to Not-sexy-at-all posture (kyphosis)
3. The characteristics of HARA chair

HARA chair is specially designed inspired by ideal body ergonomics. Both bottom seats have been separated longitudinally, when body weight is applied to each seat, it is designed to tilt toward the center of the body. This ergonomic mechanism has decisively distinctive features from those existing single-seat chairs on the market.

First, HARA chair does not put pressure on the perineum. Therefore it does not affect the blood circulation of the perineum, and does not interfere with the circulation of air.

Second, HARA chair helps support the ischial tuberosity to each other in the closer direction. On the contrary to the single-seat described above, HARA chair pelvic supporting system has more power to rotate the pelvis forward efficiently. This relieves the tension and compressive force on the coccyx, and also reduces the stressful tensile force in the sacroiliac joint ligaments. It consumes less energy to hold the lumbar lordosis in the body naturally. In addition, by distributing the weight on the lower body contact surface with the chair most evenly, the circulation problems pointed out in previous papers have been solved very clearly.

Fig. 13. Concept of HARA chair separated seats. Reinforced ischial supporting power has been engaged; forward sacral rotating power helps maintain lumbar lordosis easier.

It has been conducted several research studies to improve some potential problems when seated in the traditional single-seat bar, and they suggested some possible technical ideas.

HARA chair is the first chair that solved problems perfectly.

Sample reference:

Sitting with reduced ischial support and fitted backrest to the lower spine altered the contact area, reduced peak pressure under the ischia, reduced muscular activity, maintained total and segmental lumbar lordosis, rotated the sacrum forward, and increased lumbar intervertebral disc heights, which could potentially reduce low back pain.

Sitting with Adjustable Ischial and Back Supports: Biomechanical Changes
Makhsous et al.
Spine 2003;28:1113–1122

Perineal relaxation, perineum air circulation, evenly distributed seat contact pressure, sacroiliac joint tension relaxation, maintained normal lumbar lordosis, and reduced spinal muscles and ligaments activity promote virtuous cycle affection. In addition, HARA chair also cater for the lower lumbar support, which is an important condition of concept of the ideal chair.

You can feel prompt improvement of circulation on perineal organs such as rectum, prostate, female organs and bladder, etc. Exerted adverse pressure on the digestive system and internal organs derived from the slump posture eliminated also. The above virtuous cycle persists people feel the chair with such clear differences in regard to collateral circulation, posture, as well as comfort immediately.
Fig. 14 Sitting X-ray in **HARA chair** on sagittal plane

- Health Positive chair

- Perineum relaxation
- Perineal air circulation
- Evenly distributed contact pressure on the seat
- Reduce compressive pressure on neurovascular bundle of lower extremity
- Reduce stressful tensile force on sacroiliac joint
- Promote sacral forward rotation
- Helps maintain normal lumbar lordosis
- Reduce back muscle activity
- Reduce abnormal pressure on intervertebral disc
- Reduce energy consumption to maintain right posture

People who are suffering from low back pain, patients such as prostatitis, anorectal disorder who should avoid direct contact that area, youth in the growth, sitting whole day such as students and office worker, overweight and lack of exercise that high probability of metabolic disease, retired people, chin problem(TMJ) will be helped.

The history of the new chair has been started in **HARA chair**

To be continued ...

- written by Young Jae Huh, M.D., Orthopedic Surgeon.