

ORIGINAL ARTICLE

Hamstring Muscle Flexibility among KONI Volleyball Players of DKI Jakarta Province – A Pilot Study for Sport Injury Prevention.

Hendriko¹, Tirza Z Tamin¹, Nyoman Murdana¹, Aria Kekalih²

¹ Department of Physical Medicine and Rehabilitation, Cipto Mangunkusumo Hospital, Jakarta

² Department of Community Medicine, Indonesian University, Jakarta

ABSTRACT

Objectives: To find hamstring muscle flexibility among KONI Propinsi DKI Jakarta's volleyball players, based on age, sex and playing position particularly.

Methods: A cross sectional study performed in 25 female and 24 male athletes using Sit and Reach Test (SRT) box had done 3 times trial with the best score was recorded.

Results: Hamstring muscle's mean value score was 18.21 (SD 6.5) cm, male athletes was 17.6 (SD 6.5) cm, female athletes was 18.8 (SD 6.6) cm, *middle adolescence* 14-16 years old was 15.55 (SD 6.1) cm, *late adolescence* 17-20 years old was 19.91 (SD 6.9) cm, *young adulthood* 21-24 years old was 18.79 (SD 4.6) cm, hitter was 18.8 (SD 6.6) cm, center was 15.5 (SD 6.3) while allround players was 20.4 (SD 5.9).

Conclusions: Average value of hamstring flexibility among volleyball athletes of KONI DKI Jakarta based on SRT was 18.21 ± 6.5 cm, particularly within middle adolescence (14-16 years old) was 15.55 ± 6.1 cm, late adolescence (17-20 years old) was 19.91 ± 6.9 cm, and young adulthood (21-24 year old) was 18.79 ± 4.6 cm. While by sex was 17.6 ± 6.5 cm among male and 18.8 ± 6.6 cm among female. Based on playing position, hitters were 18.8 ± 6.6 , setters were 15.5 ± 6.3 and all-round player were 20.4 ± 5.9 cm.

Keywords: *Flexibility, Hamstring muscle, SRT*

INTRODUCTION

Muscle is one of many important components on sport activities. Volleyball is one of many sport which needed muscle as important factors beside mental, strategies and playing techniques.¹ There are several dominancy activities among volleyball athlete that conclude on six basic skill technique eg. servis, dig, volley or set, smash or spike, block, and defence.

Volleyball game needs skill that correlated with physical fitness such as agility, flexibility, kecepatan, power and endurance¹. However,

good fleksibility is important for doing volley or high in front set, overhead and jumping, smash or spike, block, both on defence or moving action as well as in front dropping off. Flexibility is very important for the movement of the joints due to good physical requirement particularly for ease to improve speed and jumping in volleyball. Flexible muscles can give a good reaction to the action without causing excess strain rate nor require a long time to return to the initial state. The importance of increasing the flexibility of the joints and muscles in volleyball is to increase the tensile strength of muscles and joints in the order to reducing risk of injury.

In 2004 an estimated 100 injuries, or 2.6 injuries per thousand hours of all events.³ Incidence in 2007 was 4.58 injuries per 1,000

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Correspondence Address: Hendriko, Apotek Yasmin Raya, Jl. Yasmin Raya No.4 Sektor III, Bogor, Jawa Barat.

game and 4.1 injuries per practice 1,000.⁴ The volleyball team made up of various types of players that can generally be divided into three parts, namely the hitter, setter and all-round player.

There are characteristic differences between the three as the hitters were tall and smart players jump, setter that has great endurance, reaction and speed as well as good jumping power while round player had a great game dynamism. The flexibility of the hamstring muscles is one of the elements forming the body flexibility to produce motion and jump technique.²

It has been defined by a variety of cross-sectional studies in both adolescence and adulthood, and female are better flexibility than men.^{2,6,7} In old age, muscle fibers degenerate and are slowly replaced by fibrotic connective tissue and become stiffness.⁸⁻¹⁰

Most common muscle strains and sprains affected the sport volleyball is consecutively hamstring, rectus femoris, and medial gastrocnemius as well as deltoid anterior.¹¹ Measuring the flexibility to determine the ability of the muscle to tendon extends eccentric at the time of the movements.^{2,11} Measurements that commonly done is Sit and Reach Test (SRT).

Various health professionals involved in prescribing exercise flexibility on sports injury prevention both primary and secondary. These professions include sports doctor, physical medicine and rehabilitation, orthopedics, physiotherapists, trainers and athlete.¹² Based on the above, this study will assess the flexibility of the hamstring muscle on the profile of volleyball athletes Indonesian National Sports Committee (KONI) DKI Jakarta and the difference in flexibility between sexes, ages and the various positions of volleyball players.

METHODS

This was a cross-sectional study to measure the flexibility of the hamstring muscle in volleyball players of KONI DKI Jakarta. The study was conducted at the sports complex Bung Karno and Ragunan volleyball court with number of sample was 49 person. Population affordable that

meets acceptance criteria and are not included in the criteria for rejection, to the fulfillment of the sample research and are willing to follow the study by filling out the informed consent; volleyball players that joined in DKI Jakarta KONI, without deformity of all extremities (inflammation signs, arm/leg the same length, full LGS, normal MMT), having a normal body weight, obtain approval of the manager/coach of the club to participate in research.

Subjects' positions in the team games and training period were recorded before general physical examination was performed. They were asked to wear only their athletes' clothes without their footwears. After they were explained about how to measure the body flexibility in brief, they performed hamstring muscles stretching. After that, they began to be measured as the following instruction: sitting on the floor with fixation of knees straightly by the inspectors while ankle in neutral position and stepping foot on a vertical pedestal flexiometer; hand position was on the other whilst attaching to the panel's edge, which is expressed as point A; and pushing the body slowly forward to the farthest reach and keep the position for 3 seconds, this expressed as point B. Every subject was required to repeat the measurement for three times, the farthest value was taken. Measurement result is the difference between point A and B that are expressed in a unit of centimeter (cm) with precision of 1 digit behind the comma.

The data obtained are recorded in the pages of the study, processed and analyzed and made interpretations. Statistical analysis is shown in the form of descriptive analysis for each variable were observed. Descriptive analysis showing the frequency tables or graphs as needed.

RESULTS

This study raised the subject of 49 people split evenly between genders male and female. The position is a hitters that most (57%). Some 60% of the players are still junior high school (65%), while the rest are students, private sector employees, military-police and athletes. The data can be seen in table 1 and 2.

Table 1. Baseline Characteristics

Variable		n	%
Position	All-round	8	16.3%
	Setter	13	26.5%
	Hitter	28	57.1%
Gender	Men	24	49.0%
	Women	25	51.0%
Senior-Junior	Senior	20	40.8%
	Junior	29	59.2%

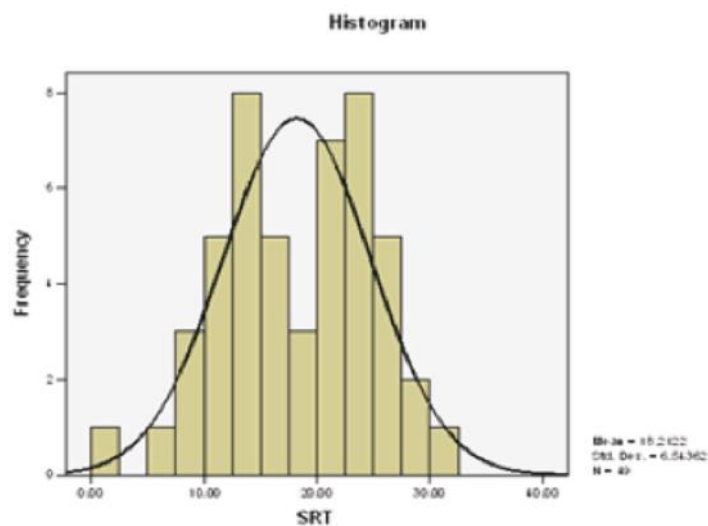
The average age of athletes 18.37 ± 2.77 years old playing median of 4 years, which is a

minimum of 1 year to 11 years of playing. Body Mass Index (BMI) athletes averaged 21.79 ± 1.8 .

Parameter	Age (years old)	Body Weight (kg)	Body Height (cm)	BMI (kg/m ²)	Volleyball Period (years)
Mean	18.4	68	175.6	21.79	4.51
Median	18	67.2	176	21.5	4
Std. Deviasi	2.8	6.7	8.2	1.8	2.2
Min	14	56.9	157	19	1
Max	24	89.8	189	27	1.1

From 49 athletes, the results obtained flexibility median is 18.21 cm with the lowest value of 1.5 cm and 31.2 cm maximum reach.

The group is the most versatility ranges between 12.5 to 15 cm and 22.5 to 25 cm. The data can be seen in figure 1 below.

**Figure 1. SRT Result Histogram**

Value of hamstring muscle flexibility demonstrated that the best ability to reach it was the age of 17, 18 and 21 years with a value of 20.5; 16.2; 16.2% respectively compared to the overall average. Value of flexibility by gender shows that female tend to have higher flexibility than men. Flexibility is best for all-round player, then the hitters and the lowest was setter.

DISCUSSION

This study involved 50 volleyball athletes KONI DKI Jakarta scattered in places such as training in Jakarta Sports Arena (GOR) Ragunan, GOR Senayan, sand pitch Bung Karno (GBK). One subject did not meet the acceptance criteria for BMI > 30. Forty-nine subjects of this study constitute the entirety of the two groups of athletes are the male and female. Group of male and female are each divided into senior and junior groups.

The ratio of the number of male and female study subjects in this study was almost the same level of 24 (49%) and 25 (51%). The composition of the senior male volleyball athlete as many as 11 players (22%), male junior athletes were 13 players (27%), senior female athletes as much as 9 players (18%), and junior female athletes as much as 16 players (33%) with a mean age, 37 ± 2.77 years.

Duncan et al (2005) in a study of volleyball players included 25 athletes with a mean age of 17.5 ± 0.5 years old.¹³ Overall the subjects in this study are male athletes of British junior team members. Unlike Duncan, in this research not only examined athletes male but female athletes also with a mean value of the junior older age between them.

Fauzee et al (2010) examined the fitness level vocational school sports by age and sex, and involved 51 men and 27 female with an age range of 20 to 45 years old.⁴⁴ Amusa and Toriola (2003) involving 13 runners sprint athletes with a mean age of 24.3 ± 2.8 tahun.⁴⁵ Amusa and Toriola try to find mekanomuskular performance factors and reported that one of them is SRT. Hitters have dominancy in this study which is 28 athletes or 57.1% of the total study subjects.

Based on Body Mass Index (BMI), which

is included in the BMI 20-20.9 group is the subject of most studies with a total sample of 18 athletes or 36.7% of the total, followed by the study subjects with a BMI of 22-22.9 athlete or as many as 4% of the total sample. The results of other studies, as reported by Mali (2009), had found mean body weight and BMI of 73.00 ± 5.90 kg and 21.58 ± 1.56 kg.m⁻² respectively. Mali's research shows the body composition profile in the Czech Republic female's national athletes in the form of a high proportion of fat-free mass and fat mass conversely low proportion compared with the non-athletes.⁴⁶ It can be seen that the average value of weight and BMI values anthropometry in these study subjects were more large.

This study found dominance mean height and weight on the hitters, however BMI is equal to the all-round player. Ideal posture as adequate height and low weight are required by the hitters. It is important for a variety of characteristics of movement for attacking positions such as jump serve, smash or spike as well as block. This study also found that hitters weight was greater than all-round player. Position of setters does not require a high height but should have great durability and reactions, speed and jumping ability also.

From 10 highest values of flexibility, hitters has the highest number, followed by all-round player and setters, consecutively. The age range is between 17 to 21 years with the dominance of female athletes by 60%. Instead SRT 10 lowest mean value results dominated by setters, 80% of whom were male.

Differences acquisition research hamstring considerable flexibility as done by Fauzee et al SRT scores mean age of 20-24 years by 5.4 ± 2.3 cm for male and female by 3.7 ± 2.1 cm. Amusa et al SRT scored on 23 athletes runners sprint by 34.1 ± 5.4 cm. Acquisition value is higher than the study.⁴⁵

Normative data of the mean results of the SRT Australian sports commission in male basketball athletes (2000) of 4.4 ± 11.2 cm, netball female by age 21 of 17.3 ± 6.2 ; 16.3 ± 19 at 5, 3; 17 of 11.6 ± 5.9 ; men's soccer by 7.4 ± 12.4 and 15 ± 7 female, 12.1 ± 7 softball. Compared with the sport then the results of this study SRT value was still higher when compared with the total.

Unlike the men, the female aged <20 years have a value of 18.4 cm or less were categorized. Similarly, the group of female with an age range 20-29 years have an average value of 21.4 cm.³⁶

These findings illustrate the potential for injury in volleyball athletes KONI DKI Jakarta. From sports injury and physical medicine rehabilitation, it is necessary for hamstring muscles stretching exercises, either in the form of warming up or cooling down in all athletes, particularly among female. The low value of the average achievement of hamstring flexibility as well as the tendency of a greater weight on the hitters is one component of intrinsic injury incidence.⁴² These injuries may include muscle tissue and tendon injuries along with primarily microtrauma repetitive like muscle sprain or jumper's knee.

Weight-bearing surface of the knee articulation to exceed the largest body weight can result in a maximum isometric extension contraction.⁵⁰ It will producing femorotibial compression pressure up to 1.6 times body weight and increasing threefold weight at 60 degree position. Tibiofemoral pressure increased during the stance phase will be distributed equally on both knees and will decrease with the swing phase.

Pressure on the tendon quadriceps femoris would enhance patellofemoral joint compression pressure. At the resultant knee extension will result in a low pressure. This occurs due to compression forces on the tendons and ligaments in a straight line. Quadriceps torque increased muted by flexion of the knee with patella lever arm distance change along intercondylar groove. Knee flexion will increase the pressure resultant of patellofemoral joint. Pressure of the patellofemoral joint will react as 15° isometric contraction of quadriceps maximum increase of 0.8 times body weight. Pressure increases to 2.6 times body weight as 90° knee flexion.

Absence of leg length discrepancy, muscle weakness and imbalance are factors intrinsic preventive owned by subjects.⁴² The highest value of the SRT according to age is consistent with the theory that suggests the foundation for the growth phase of bone growth rate followed by muscle dimension. In the period of the

child's age into adolescence, bones grow faster than muscles stretch. This implies an increase in muscle-tendon tightness.⁶ Irfannuddin (2003) found SRT mean value in his pre-puberty study subjects, male were 10.3 ± 0.9 and females at the age of 9.9 ± 0.8 .³⁴ Muscles that are too short are generally rigid and antagonistic muscles hold remain in a state of eccentric contractions.

During the growth phase, there is a change in the proportion of fiber types. There is a growing number of low-ATPase muscle fibers (type I muscle) and conversely decrease high muscle ATPase (type II). Although there are changes in the proportion of muscle type, but there was no difference in the number of muscle fibers. Nerve supply to the muscles is an important factor in the conversion mechanism changes muscle type.¹⁸

Myofibrils longitudinal growth associated with an increased number of sarcomeres in series arrangement. Additional length of the sarcomere, during elongation, suggesting at least sarcomeres in series arrangement. Muscle elongation is related to the separation of the vertical axis and the Z disc insertion sarcomeres along the myofibrils and isoform differentiation of titin.¹⁸

Joint stiffness can caused shock transmission effects that are potentially injured the joint from distal to proximal. Flexion of the small joints of the knee joint and the high momentum when the eccentric phase when spike and increased knee angular velocity be other risk factors patellar tendinopathy on volleyball players.⁴² However, in this study playing duration do not reflect the achievement of high SRT value.

Relationship analysis of flexibility to gender shows that female tend to have higher flexibility than male. Some of factors that influence are anatomical and physiological differences such as a smaller muscle mass, geometry of the joint and muscle collagen structure. Adaptation for growth has implications on myofibrillar system changes that are part of the contractile elements. The mean length of experience playing volleyball in common between the sexes over the past 4.5 years but still there are different types of exercise among the four groups of athletes.

Lee and Wong (2002) as quoted by Lee (2006) examine contributions lumbar and hip in healthy subjects during flexion - extension and found that the ratio of the maximum movement of the pelvis toward the spine forms a backbone similar but have a greater contribution during the early stages movements along with pelvic rotation that occurs around fulcrum of pelvis.⁴⁷ Although the link flexibility by gender showed that the female had a higher flexibility but get value checks the length of the arms and legs lower in female than male. The ratio of length of the arms and legs male and female are 60 and 58.5%, respectively. This is consistent with what obtained by Irfanuddin (2003) who concluded that the flexibility of the hamstring muscles have the highest correlation to the results of SRT and various modifications and reverse that variable (ratio) long arms and legs have no correlation with the value of SRT.³⁴

The position has the best flexibility is all-round player, and the lowest is setters. However, there is a range of values SRT substantial results between the three is 15.6 cm in rounders, followed by the range of 29.7 cm to 18.3 cm in the hitters and setters. Thus it can be seen the range of greatest value to the hitters SRT results compared with the other 2 groups

Same with this result, Duncan et al (2006) reported the sequence starting height of hitters, followed by all-round player and the latter is the setters.⁶ Moreover he reported that the type of posture and the value of SRT have significant differences in anthropometric or physiological profiles among volleyball athletes. It is assumed that hitter's maneuvering movements tend to be more explosive and become potential for injury.

In this study looks mean age of the group was 18.5 years hitters with a mean length play for 4.89 years. Viewed from the age, that mean age of subjects hitters were 3.9% older than the other two groups. According to historical of playing volleyball, attackers had a 19.3% higher than the all-round player and 25.4% longer than setters. There were no gender dominance within this group. This is due to the popularity of the applied strategy of attacking volleyball game today.

Almost all male and female athletes using techniques landing by two foot. Subjects landed

with a lower GRF, increased knee valgus angles were not as steep as the initial contact with the ground, increased knee flexion angle peak, and increasing the speed of angulation than 1 foot landing technique (Pappas et al., 2007; Yeow et al., 2010 as quoted by Wang, 2011).⁴⁸

Posture is relatively short with body weight tended to be larger can be transformed with a variety of techniques such as forming a volleyball game movement passive block where the player's body and both arms straight up in the air without the need for the highest possible from the net. Solgard et al (1995) found that generally the injury occurred in the area around net.⁴⁹

Knee injury that occurred, at 17 volleyball athletes Denmark, with an age range 11-45 years, including patello-femoral dislocation, anterior cruciate ligament injury, combined with a medial collateral ligament, as well as repetitive traumatic knee injury. Furthermore, this knee injury occurred in the age range 18-45 years, with almost all causes due to non-contact jumping. This resulted in a knee injury sidelined the duration of the exercise for 1-3 months, and only 66.7% were able to return to his earlier activities as before cedera.⁴⁹

All-rounders group has the highest value of flexibility to the difference with other groups of 8.4% to 31.9% with hitters and setter, respectively. In this study, all-rounders have similar mean value of height between the two other groups but had the lowest body weight and the majority were female. The presence of all-round player is absolutely necessary in today's typical game where the game often requires changes in the pattern of defensive and offensive in a short span of time. This player game is expected to drive the system through the system allows the combination of penetration and readiness to attack.¹

CONCLUSIONS

Average value of hamstring flexibility among volleyball athletes of KONI DKI Jakarta based on SRT was 18.21 ± 6.5 cm, particularly within middle adolescence (14-16 years old) was 15.55 ± 6.1 cm, late adolescence (17-20 years old) was 19.91 ± 6.9 cm, and young

adulthood (21-24 year old) was 18.79 ± 4.6 cm. While by sex was 17.6 ± 6.5 cm among male and 18.8 ± 6.6 cm among female. Based on playing position, hitters were 18.8 ± 6.6 , setters were 15.5 ± 6.3 and all-round player were 20.4 ± 5.9 cm.

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ORIGINAL ARTICLE

Ankylosing Spondylitis: Rare but Not to be Forgotten**Ferius Soewito¹, Angela BM Tulaar²**¹ Department of Physical Medicine and Rehabilitation, Bethsaida Hospital, Tangerang² Department of Physical Medicine and Rehabilitation, Cipto Mangunkusumo Hospital, Jakarta

Ankylosing spondylitis (AS) is one of a group of the rheumatic disease that affects the spinal column, the sacroiliac joints, and the peripheral joints. It consists of enthesitis and synovitis.¹⁻³ In general, the prevalence is between 0,2% to 1,4%.⁴

Though rare, AS is commonly found in young and productive age. From a study in Greece population, the incidence rates is higher in the age group 35 to 44 years for men and in the age group 25 to 34 years for women.⁵ During the course of AS, many young patients develop a progressive ankylosis of the spine, resulting in restricted mobility, disability and decreased quality of life. Patients with severe disease have higher rates of withdrawal from the labour force because of AS.⁶ Since AS affects productive population and causes disability, it obviously causes high economic burden,⁷ and can be met in physiatrist's office.

Pathology and pathogenesis of Ankylosing Spondylitis

The enthesis, the site of ligamentous attachment to bone, is thought to be the primary site of pathology in AS, particularly in the lesions around the pelvis and spine. Enthesitis is associated with prominent edema of the adjacent bone marrow and is often characterized by erosive lesions that eventually undergo ossification.²

Sacroiliitis is usually one of the earliest manifestations of AS, with features of both enthesitis and synovitis. The early lesions consist of subchondral granulation tissue, infiltrates of lymphocytes and macrophages in ligamentous and periosteal zones, and subchondral bone

marrow edema. Synovitis follows and may progress to pannus formation with islands of new bone formation. The eroded joint margins are gradually replaced by fibrocartilage regeneration and then by ossification.²

Ultimately, the joint may be totally obliterated. In the spine, early in the process there is inflammatory granulation tissue at the junction of the annulus fibrosus of the disk cartilage and the margin of vertebral bone. The outer annular fibers are eroded and eventually replaced by bone, forming the beginning of a bony syndesmophyte, which then grows by continued enchondral ossification, ultimately bridging the adjacent vertebral bodies. Ascending progression of this process leads to the "bamboo spine" observed radiographically.²

Other lesions in the spine include diffuse osteoporosis, erosion of vertebral bodies at the disk margin, "squaring" of vertebrae, and inflammation and destruction of the disk-bone border. Inflammatory arthritis of the apophyseal joints is common, with erosion of cartilage by pannus, often followed by bony ankylosis. Bone mineral density is significantly diminished in the spine and proximal femur early in the course of the disease, before the advent of significant immobilization.²

Peripheral arthritis in AS can show synovial hyperplasia, lymphoid infiltration, and pannus formation, but the process lacks the exuberant synovial villi, fibrin deposits, ulcers, and accumulations of plasma cells seen in rheumatoid arthritis (RA). Central cartilaginous erosions caused by proliferation of subchondral granulation tissue are common in AS but rare in RA.²

The pathogenesis of AS is incompletely understood but almost certainly immune mediated. The dramatic response of all aspects of the disease to therapeutic blockade of tumor necrosis factor alfa (TNF- α) indicates that this cytokine plays a central role in the immunopathogenesis of AS.² The inflamed sacroiliac joint is infiltrated with CD4+ and CD8+ T cells and macrophages and shows high levels of TNF- α . No specific event or exogenous agent that triggers the onset of disease has been identified, although overlapping features with reactive arthritis and inflammatory bowel disease (IBD) suggest that enteric bacteria may play a role. Elevated serum titers of antibodies to certain enteric bacteria are common in AS patients, but no role for these antibodies in the pathogenesis of AS has been identified.²

HLA-B27 is found in more than 90% patients.⁸ Evidence that HLA-B27 plays a direct role is provided by the finding that rats transgenic for HLA-B27 spontaneously develop spondylitis, along with colitis, peripheral arthritis, and other lesions characteristic of the spondyloarthritides. Some evidence has accumulated for autoimmunity to the cartilage proteoglycan aggrecan. Sharing of proteoglycan antigenic epitopes may be a possible explanation for the distribution of pathologic sites in AS.²

There are some hypotheses regarding the role of HLA-B27 in AS pathogenesis. One hypothesis relates the similarities of HLA-B27 with *Klebsiella pneumoniae*. Recent research showed that certain subtypes of HLA-B27 significantly increase the risk of AS, especially B*2705, B*2704 and B*2702. The differences between malignant and benign subtype lies in the numbers of amino acids located in the B pockets. One proposed hypothesis suggests that HLA-B27 misfolding in the reticulum endoplasmic influence the intracellular signaling and change the gene expression that may account for certain non-antigen presentation effects of HLA-B27.³ It is also thought that HLA-B60 and B-61 plays some role together with HLA-B27.^{9,10}

Features of Ankylosing Spondylitis

Ankylosing spondylitis should be considered in any young adult patient who complains of

insidious onset of worsening, dull, lumbosacral back pain with progressive morning stiffness.^{1,2} The median age in western countries is 23. In 5% of patients, symptoms begin after age 40.²

Pain in area of sacroiliac joints and prolonged stiffness after inactivity are common.¹ The pain has usually become persistent and bilateral.^{1,2} Pain is the most reported symptoms, along with fatigue and stiffness. In a survey of 1950 patients with AS, pain was considered a predominant disabling domain by 34% of the patient, while stiffness by 25% and fatigue by 6%.¹¹ Neurologic symptoms, such as paresthesias and motor weakness are absent.¹

Nocturnal exacerbation of pain that forces the patient to rise and move around may be frequent. In some patients, bony tenderness (presumably reflecting enthesitis) may accompany back pain or stiffness, while in others it may be the predominant complaint. Common sites include the costosternal junctions, spinous processes, iliac crests, greater trochanters, ischial tuberosities, tibial tubercles, and heels. Occasionally, bony chest pain is the presenting complaint.^{2,12}

Arthritis in the hips and shoulders ("root" joints) occurs in 25 to 35% of patients, in many cases early in the disease course. Arthritis of peripheral joints other than the hips and shoulders, usually asymmetric, occurs in up to 30% of patients and can occur at any stage of the disease. Neck pain and stiffness from involvement of the cervical spine are usually relatively late manifestations. Occasional patients, particularly in the older age group, present with predominantly constitutional symptoms such as fatigue, anorexia, fever, weight loss, or night sweats.²

AS often has a juvenile onset in developing countries. In these individuals, peripheral arthritis and enthesitis usually predominate, with axial symptoms supervening in late adolescence. Initially, physical findings mirror the inflammatory process. The most specific findings involve loss of spinal mobility, with limitation of anterior and lateral flexion and extension of the lumbar spine and of chest expansion. Limitation of motion is usually out of proportion to the degree of bony ankylosis, reflecting muscle spasm secondary to pain and

inflammation. Pain in the sacroiliac joints may be elicited either with direct pressure or with maneuvers that stress the joints. In addition, there is commonly tenderness upon palpation at the sites of symptomatic bony tenderness and paraspinous muscle spasm.^{2,12}

The Schober test is a useful measure of lumbar spine flexion. The patient stands erect, with heels together, and marks are made directly over the spine 5 cm below and 10 cm above the lumbosacral junction (identified by a horizontal line between the posterosuperior iliac spines). The patient then bends forward maximally, and the distance between the two marks is measured. The distance between the two marks increases by 5 cm in the case of normal mobility and by 4 cm or less in the case of decreased mobility.²

Chest expansion is measured as the difference between maximal inspiration and maximal forced expiration in the fourth intercostal space in males or just below the breasts in females. Limitation or pain with motion of the hips or shoulders is usually present if either of these joints is involved. It should be emphasized that early in the course of mild cases, symptoms may be subtle and nonspecific, and the physical examination may be completely normal.²

The course of the disease is extremely variable, ranging from the individual with mild stiffness and radiographically equivocal sacroiliitis to the patient with a totally fused spine and severe bilateral hip arthritis, possibly accompanied by severe peripheral arthritis and extraarticular manifestations. Pain tends to be persistent early in the disease and then becomes intermittent, with alternating exacerbations and quiescent periods. In a typical severe untreated case with progression of the spondylitis to syndesmophyte formation, the patient's posture undergoes characteristic changes, with obliterated lumbar lordosis, buttock atrophy, and accentuated thoracic kyphosis.²

There may be a forward stoop of the neck or flexion contractures at the hips, compensated by flexion at the knees. The progression of the disease may be followed by measuring the patient's height, chest expansion, Schober test, and occiput-to-wall distance. Occasional individuals are encountered with advanced

physical findings who report having never had significant symptoms.²

In some but not all studies, onset of the disease in adolescence correlates with a worse prognosis. Early severe hip involvement is an indication of progressive disease. The disease in women tends to progress less frequently to total spinal ankylosis, although there is some evidence for an increased prevalence of isolated cervical ankylosis and peripheral arthritis in women. In industrialized countries, peripheral arthritis (distal to hips and shoulders) occurs overall in about 25% of patients, usually as a late manifestation, whereas in developing countries, the prevalence is much higher, with onset typically early in the disease course.²

The most serious complication of the spinal disease is spinal fracture, which can occur with even minor trauma to the rigid, osteoporotic spine. The cervical spine is most commonly involved. These fractures are often displaced and cause spinal cord injury. The most common extra articular manifestation is acute anterior uveitis, which occurs in 30% of patients and can antedate the spondylitis. Attacks are typically unilateral, causing pain, photophobia, and increased lacrimation. These tend to recur, often in the opposite eye. Cataracts and secondary glaucoma are a frequent sequelae.¹⁰

Up to 60% of patients have inflammation in the colon or ileum. This is usually asymptomatic, but in 5 to 10% of patients with AS, frank IBD will develop. Aortic insufficiency, sometimes producing symptoms of congestive heart failure, occurs in a few percent of patients, occasionally early in the course of the spinal disease but usually after prolonged disease. Third-degree heart block may occur alone or together with aortic insufficiency. Subclinical pulmonary lesions and cardiac dysfunction may be relatively common.^{2,12} Cauda equina syndrome and slowly progressive upper pulmonary lobe fibrosis are rare complications of long-standing AS. Retroperitoneal fibrosis is a rare associated condition. Prostatitis has been reported to have an increased prevalence in men with AS. Amyloidosis is rare.²

Several validated measures of disease activity and functional outcome have been developed for AS recently. Despite the

persistence of the disease, most patients remain gainfully employed. The effect of AS on survival is controversial. Some, but not all, studies have suggested that AS shortens life span, compared with the general population.²

Study in Korea report hip, shoulder and peripheral joint involvement in about 60% of patients. Patients peripheral joint diseases showed better outcome in spinal symptoms, Schober test and spinal radiologic conditions.¹³ Mortality attributable to AS is largely the result of spinal trauma, aortic insufficiency, respiratory failure, amyloid nephropathy, or complications of therapy such as upper gastrointestinal hemorrhage.²

No laboratory test is diagnostic of AS. In most ethnic groups, B27 is present in approximately 90% of patients with AS. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are often, but not always, elevated. Mild anemia may be present.² Patients with severe disease may show an elevated alkaline phosphatase level. Elevated serum IgA levels are common. Rheumatoid factor and antinuclear antibodies are largely absent unless caused by a coexistent disease. Synovial fluid from peripheral joints in AS is nonspecifically inflammatory.² In cases with restriction of chest wall motion, decreased vital capacity and increased functional residual capacity are common, but airflow measurements are normal and ventilatory function is usually well maintained.²

Radiographically demonstrable sacroiliitis is usually present in AS. The earliest changes by standard radiography are blurring of the cortical margins of the subchondral bone, followed by erosions and sclerosis. Progression of the erosions leads to "pseudo widening" of the joint space; as fibrous and then bony ankylosis supervene, the joints may become obliterated. The changes and progression of the lesions are usually symmetric. In the lumbar spine, progression of the disease leads to straightening, caused by loss of lordosis, and reactive sclerosis, caused by osteitis of the anterior corners of the vertebral bodies with subsequent erosion, leading to "squaring" of the vertebral bodies. Progressive ossification leads to eventual formation of marginal syndesmophytes, visible

on plain films as bony bridges connecting successive vertebral bodies anteriorly and laterally. In mild cases, years may elapse before unequivocal sacroiliac abnormalities are evident on plain radiographs.

A fat-suppressed image employing a short tau inversion recovery (STIR) sequence shows acute sacroiliitis on the right side, with edema in the juxtaarticular bone marrow (asterisks), in the region of the synovium and joint capsule (thin arrow), and in the region of the interosseous ligaments (thick arrow). Early chronic changes, including cortical erosions and joint space widening, were evident in the right sacroiliac joint in T1-, contrast-enhanced T1-, and T2-weighted images (not shown).

The patient subsequently developed radiographically evident bilateral sacroiliitis, fulfilling the criteria for ankylosing spondylitis. (CT) and magnetic resonance imaging (MRI) can detect abnormalities reliably at an earlier stage than plain radiography. MRI is highly sensitive and specific for identifying early intraarticular inflammation, cartilage changes, and underlying bone marrow edema in sacroiliitis. In suspected cases in which conventional radiography does not reveal definite sacroiliac abnormalities or is undesirable (e.g., in young women or children), dynamic MRI is the procedure of choice

for establishing a diagnosis of sacroiliitis. Reduced bone mineral density can be detected by dual-energy x-ray absorptiometry of the femoral neck and the lumbar spine. Falsely elevated readings related to spinal ossification can be avoided by using a lateral projection of the L3 vertebral body.

Diagnosis of Ankylosing Spondylitis

It is important to establish the diagnosis of early AS before the development of irreversible deformity. Modified New York criteria (1984) are widely used for diagnosis.

These consist of the following:

- (1) a history of inflammatory back pain;
- (2) limitation of motion of the lumbar spine in both the sagittal and frontal planes;
- (3) limited chest expansion, relative to standard values for age and sex;

(4) definite radiographic sacroiliitis.

The presence of radiographic sacroiliitis plus any one of the other three criteria is sufficient for a diagnosis of definite AS. The use of MRI to demonstrate sacroiliitis significantly increases the sensitivity of these criteria. The presence of B27 is neither necessary nor sufficient for the diagnosis, but the B27 test can be helpful in patients with suggestive clinical findings who have not yet developed radiographic sacroiliitis.

Moreover, the absence of B27 in a typical case of AS significantly increases the probability of coexistent IBD. AS must be differentiated from numerous other causes of low back pain, of which are more common than AS.

The inflammatory back pain of AS is usually distinguished by the following five features:

- (1) age of onset below 40,
- (2) insidious onset,
- (3) duration 3 months before medical attention is sought
- (4) morning stiffness
- (5) improvement with exercise or activity.

The most common causes of back pain other than AS are primarily mechanical or degenerative rather than inflammatory and do not show these features. Less common metabolic, infectious, and malignant causes of back pain must also be differentiated from AS.

Ochronosis can produce a phenotype that is clinically and radiographically similar to AS. Marked calcification and ossification of paraspinal ligaments occur in diffuse idiopathic skeletal hyperostosis (DISH). Ligamentous calcification and ossification are usually most prominent in the anterior spinal ligament and give the appearance of “flowing wax” on the anterior bodies of the vertebrae.

Intervertebral disk spaces are preserved, and sacroiliac and apophyseal joints appear normal, helping to differentiate DISH from spondylosis and from AS, respectively. DISH occurs in the middle-aged and elderly. Patients are frequently asymptomatic but may have stiffness. Radiographic changes are generally much more dramatic than symptoms.

MANAGEMENT

Pharmacologic management

Recent treatment for AS is infliximab (chimeric human/mouse anti-TNF-monoclonal antibody) or etanercept (soluble p75 TNF- α receptor-IgG fusion protein). Both of them have shown rapid, profound, and sustained reductions in all clinical and laboratory measures of disease activity. Patients with long-standing disease and even complete spinal ankylosis have shown striking improvement in both objective and subjective indicators of disease activity and function, including morning stiffness, pain, spinal mobility, peripheral joint swelling, CRP, and ESR. MRI studies indicate substantial resolution of bone marrow edema, enthesitis, and joint effusions in the sacroiliac joints, spine, and peripheral joints.^{2,6,7}

Although these potent immunosuppressive agents have so far been remarkably safe, six types of side effects have been seen: (1) serious infections, including disseminated tuberculosis; (2) hematologic disorders such as pancytopenia; (3) demyelinating disorders; (4) exacerbation of congestive heart failure; (5) systemic lupus erythematosus-related autoantibodies and clinical features; and (6) hypersensitivity infusion or injection site reactions. Increased incidence of malignancy is of theoretical concern.²

Although serious complications have been uncommon, neither the incidence of side effects nor the long-term effects of these agents are yet known. Moreover, the currently available anti-TNF- α agents are quite expensive. Thus, uncertainty remains as to which patients with AS and other spondyloarthritides should be given this form of therapy.²

Previously, the mainstay of treatment for AS was nonsteroidal anti-inflammatory drug (NSAID) therapy with drugs such as indomethacin or more recently COX-2 inhibitors, combined with exercise programs designed to maintain posture and range of motion.²

The AS is a chronic progressive disease with a significant impact on productivity and quality of life. Although there are patients with mild AS whose pain is well controlled with NSAID therapy and whose disease shows little

radiographic progression, many, if not most, patients have axial pain, stiffness, and disease progression despite conventional therapy. Thus, should anti-TNF- α agents, or similarly potent biologicals, prove reasonably safe and continuously effective, it can be predicted that eventually these agents will become standard therapy for most patients with AS.²

The most common indication for surgery in patients with AS is severe hip joint arthritis, the pain and stiffness of which are usually dramatically relieved by total hip arthroplasty. A small number of patients may benefit from surgical correction of extreme flexion deformities of the spine or of atlantoaxial subluxation.²

Attacks of uveitis are usually managed effectively with local glucocorticoid administration in conjunction with mydriatic agents, although systemic glucocorticoids or even immunosuppressive drugs may be required in some cases. The response of uveitis to anti-TNF- α therapy has not been as predictable as that of other features of AS.²

Coexistent cardiac disease may require pacemaker implantation and/or aortic valve replacement. Management of osteoporosis of the axial skeleton is at present similar to that used for primary osteoporosis, since data specific for AS are not available.²

Rehabilitation Management

Physical therapy and home exercise programs may improve spine mobility and lead to improvements in flexibility. Exercise programs include aerobic, stretching and pulmonary exercise. The benefit of these programs is lost once the exercise is discontinued.¹ Patients should be educated to maintain exercise and upright posture.^{1,14-16}

Early morning warm-ups should be prescribed to facilitate daily activities. This consists of having the patient assume the "all-four" position (on his/her hands and knees in the bed), in which, he/she rock back onto the heel, rock forward onto the shoulders, alternate stretch one arm and opposite leg, and indeed to crawl when necessary to facilitate mobility.¹⁴ Hip range of motion with regular stretching using the contraction-relaxation stretching

technique can be practiced. Strengthening of back and hip extensors should follow the flexibility exercises.¹ Neck and back extension strengthening exercise can be practiced from the "all-four" position. Both upper extremities, neck and upper back are extended against gravity as far as possible while in this position.¹⁴ Other exercise thought to maintain erect posture include push-up and "walking into corners" with the hands on the occiput and the shoulders abducted.¹⁵ Neck extension and posture can be reinforced by having the patient attempt to place the occiput against a wall or door and slide up and down doing partial knee bends. Rotation of the spine should always be exercised also.¹⁴

Aerobic activities may maintain chest expansion. However, an exercise stress test should be considered before an aerobic program if aortic insufficiency is suspected. There is no evidence that one type of aerobic exercise is better than another.² Those who exercise will maintain greater aerobic capacity, although it is unrelated to chest expansion.¹⁵

Splinting and spinal orthoses are not effective, but foot orthotics may help with calcaneal enthesopathies.¹ One report describes the use of Jewett spinal orthotic as an effective treatment for increasing spinal mobility and reinstating the lumbar curve.¹⁶ A firm mattress may help with sleep, along with a small cervical pillow that may help maintain cervical lordosis.^{1,14-16}

Rehabilitation Evaluation

Since AS is a progressing disease, evaluation should be placed as an important practice. Manifestations other than musculoskeletal disorders should always be sought. Functional capability should be evaluated using structured questionnaires¹⁷ (Bath Ankylosing Spondylitis Disease Activity Index/BASDAI,¹⁸ The Bath Ankylosing Spondylitis Functional Index/BASFI,¹⁹ or Bath Ankylosing Spondylitis Global Score/BAS-G¹⁹), Schoberg test, finger to floor distance, occiput to wall distance, chest expansion and endurance test.^{1,14-16} Structured questionnaire can also be used to evaluate psychological status which can not be neglected in facing chronic disease patients such as AS patients.²⁰

CONCLUSION

AS is a rare disease, but the impact on patient functional status make it a not-to-be-neglected-disease for physiatrist. Though it is a progressive disease, physiatrists play an important role in treating various clinical and functional problems so the patient can achieve the optimal quality of life.

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