Clinical Significance of the Straight-Leg-Raising Test

(伸脚挙上テストについての研究)

井戸田　仁

井戸田

仁

論　文　目　録

報告番号	※　第　　　号	氏名	井戸田　仁

主論文

題目　　　　　　　　　　　　　　　　　　　　　　　　　　　　冊

Clinical Significance of the Straight-Leg-Raising Test

（伸脚挙上テストについての研究）

The Journal of the Japanese Orthopaedic Association

Vol. 65, No.11, 1991, 11月

日本整形外科学会

（既に印刷公表したものについては、その方法および年月日、未公表のものについては、公表の方法および時期を記入すること。）

副論文

題目　　　　　　　　　　　　　　　　　　　　　　　　　　　　冊

（　　　　同　　　　　　　　　　上　　　　）

参考論文

題目　　　　　　　　　　　　　　　　　　　　　　　　　　　　冊

（　　　　同　　　　　　　　　　上　　　　）

① 主　論　文

Clinical Significance of the Straight-Leg-Raising Test

（伸脚挙上テストについての研究）

井戸田　仁

吉田　徹

HITOSHI IDOTA

Department of Orthopaedic Surgery, Nagoya University School of Medicine, Aichi

(Director : Prof. Takayuki Miura)

TOHRU YOSHIDA

Yoshida Orthopaedic Hospital, Aichi

The Journal of the Japanese Orthopaedic Association Vol. 65, No.11, 1991

〔日本整形外科学会雑誌　第65巻 第11号　平成3年〕

日整会誌(J. Jpn. Orthop. Assoc.) **65** : 1035~1044 1991

Clinical Significance of the Straight-Leg-Raising Test

(Received for Publication, Feb. 5, 1991)

HITOSHI IDOTA

Department of Orthopaedic Surgery, Nagoya University School of Medicine, Aichi

(Director : Prof. Takayuki Miura)

TOHRU YOSHIDA

Yoshida Orthopaedic Hospital, Aichi

Key words : Straight-leg-raising test (伸脚挙上テスト), Tension sign (緊張徴候), Lasègue test (ラゼーグテスト), Finger floor distance (FFD) (指尖床間距離), Tight hamstrings (膝屈筋緊張)

Abstract The results of conventional sciatic nerve stretching tests are usually evaluated regardless of patient age, gender or movements of the hip joint and spine. In this study, we correlated data on the leg raising angle and changes in tension signs according to age, gender, and movement of the pelvis during the SLR-test and Lasègue-test. Results suggest that increased tension in the pelvic and leg muscles due to rapid skeletal growth contributes to the limited range of SLR in growing persons, while the Lasègue-test is less influenced by age and shows less pelvic rotation than the SLR-test.

INTRODUCTION

The most commonly used nerve stretching test is the straight-leg-raising test (SLR-t), which uses manual manipulation to apply tension on the nerves and induce neuralgia. This method was first reported by Lasègue in 1864, and subsequently by Forst[5]. The SLR-t, which involves flexing both the hip joint and knee joint to a 90° angle and then gradually extending the knee, differs somewhat from the so-called Lasègue test[5] (Lasègue-t). Although the two tests are thought to have similar diagnostic significance, it is believed that tension signs differ somewhat between the two depending on age and gender[12]. At present, however, the two tests are generally used with little attention given to such differences. Furthermore, when using the angle of elevation of the lower limbs as a yardstick for quantitative evaluation, the results must be interpreted while keeping in mind that practically no allowance has been made for physiological differences stemming from age and gender in the movements of the pelvis, hip joint and vertebrae[7,8,13,16]. Additionally, because it is difficult to keep the pelvis completely still during the SLR-t, any assessment should take into consideration factors such as rotation of the pelvis and length of the hamstrings. This subject has not been reported in details[2,4,9,11]. The present study attempts to clarify the clinical significance of the SLR-t and Lasègue-t by : (1) analyzing gender and age-dependent variations in the angle of possible flexion of the hip joint with the knee in an extended position (physiological SLR degree) in normal subjects, (2) studying the changes in tension signs during the growth period, and (3) making precise measurements of the scope of pelvic movement in healthy persons and in subjects with herniated disks.

Reprint requests to : HITOSHI IDOTA, Department of Orthopaedic Surgery, Nagoya University School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya-shi, Aichi 466 JAPAN

SUBJECTS AND METHODS

(1) Age and gender-dependent variations in SLR angle

Subjects: The subjects comprised outpatients at Nagoya University Hospital and its associated hospitals, as well as members of the general public who underwent physical checkups at neighboring kindergartens, elementary schools, junior and senior high schools, factories and offices, etc. The subjects ranged in age from 1 to 89 years, with 2,928 men and 2,971 women (total of 5,899 subjects and 11,798 limbs). Subjects with known or suspected problems of the spine, hip joint or knee joints as judged by the medical history and clinical findings were excluded from consideration.

Methods: A goniometer was affixed to the wall, and the subject was directed to rest supine on a level bed in such a way that the center of the capitus of the hip joint (determined by palpating the trochanter major and making an anterior adjustment at a width of two to three fingers, depending on the subject's size and build) was aligned with the center of the goniometer. The examiner placed the knee of the limb being studied in an extended position while an assistant gripped the opposite knee to prevent it from moving. The examiner then elevated the knee and read the angle of greatest maximum elevation according to the goniometer on the wall. The angle thus created between the horizontal plane of the bed and the lower limb, namely, the skeletal axis of the femur and the lower leg, was designated as the SLR angle (Fig. 1). The ankle was maintained in a standard position so that changes in the SLR-angle would not be influenced by any dorsiflexion of the leg joint[10]. In addition, the limb was raised in a neutral position to avoid changes in the SLR angle due to hip rotation[11,13]. Measurements for all subjects were then categorized as to right or left limb, age and gender.

(2) Measurements of (A) growth rate (height in cm/year), (B) SLR angle, (C) Lasègue angle (in the Lasègue-t, the dorsal angle between upper and lower leg; Fig. 2) and (D) finger-floor distance (FFD) during the growth period (12-15 years).

Fig. 1 Measuring the SLR angle
With the patient in the supine position on a flat bed, the examiner extends the knee of the leg under study while an assistant grips the contralateral leg. The angle of greatest maximum elevation is read from the goniometer on the wall aligned with the center of the capitus of the hip joint.

Fig. 2 Measuring the Lasègue angle
Hip joints are locked into place with the patient in the supine position on a flat bed. A leg brace made with a protractor is fitted to the leg and knee under study while the hip joint is flexed to a 90° angle as shown. The lower leg is then transversely extended as straight as possible from the 90° flexed position. The dorsal angle thus created between the femur and the tibia at maximum extension is measured.

Subjects: The subjects comprised 1,230 junior high school students who underwent physical checkups at school (7th graders: 382 boys, 405 girls; 9th graders: 233 boys, 210 girls).

Children with known or suspected problems of the spine, hip or knee joints determined according to the medical history and clinical findings were excluded.

Methods:

(A) Growth rate, or specifically, the increase in physical height, was determined by comparing the measured height at the current physical examination with that recorded at the physical examination of the previous year. The difference in growth was expressed in centimeters.

(B) SLR angle was measured according to the procedure described in (1).

(C) The Lasègue angle (which refers to the dorsal angle between the femur and the tibia at maximum extension) was measured by flexing the hip joint of the limb being studied to a 90° angle, then hyperkinetically extending the lower leg.

(D) FFD was measured in accordance with the guidelines for sports testing stipulated by the Physical Education Bureau of the Japanese Ministry of Education[8]. 0cm indicates floor level. The distance in cases in which fingers did not touch the floor was expressed as (−) cm, with extension beyond floor level expressed as (+) cm.

Measurements obtained in this way were then grouped as to age and gender to test for possible correlations.

(3) Measurement of the degree of pelvic motion during the SLR-t and Lasègue-t.

Subjects: A total of 50 subjects ranging in age from 9 to 78 years were studied. Forty-four of these (24 men and 20 women) were healthy (mean age 33.5 years), while the remaining six men aged 11-20 (mean age 17.3 years) had surgically confirmed disk herniation. The subjects were divided into two age groups: 23 subjects aged ≤20 years, and 21 subjects aged ≥20 years. The men aged ≤20 years were further divided into two groups consisting of 13 normal subjects and 6 subjects with herniated disks.

Method: To measure pelvic motion, we used an acceleration transducer (model ATS-16S, manufactured by Toyoda Koki) with hundred-fold the sensitivity of a standard resistance line strain gauge. The apparatus consists of a weight, a spring board, and a fixed stand (Fig. 3). It measures 41mm×22m×16mm and weighs 40g. Its operable sensitivity is guaranteed at temperatures of 0-50°C. Its mechanism is based on the piezo-resistance effect, by which distortions induced by acceleration are expressed as electrical output through variations in the resistance of a semiconductor element embedded in the spring board. Output voltage is linear[14] within a range of 0-10G (gravitational acceleration: 1G=979.7cm/sec).

Two such transducers were used, with one attached to the outer surface of the lower limb being examined and the second attached to the sacral vertebrae. Both were then adjusted to the zero point. The

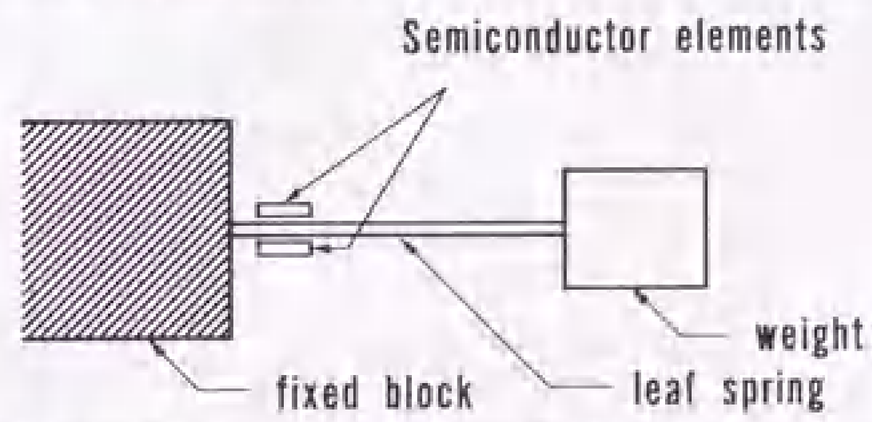


Fig. 3 Structure of the ATS-16S acceleration transducer (Toyoda Koki, Japan) used to measure pelvic motion
Dimensions: 41×22×16mm; Weight: 40g; Rated operational sensitivity: 0−50°C; Output voltage: linear (ranging 0−10G).

test was conducted at a set speed with signals from the acceleration transducer fed through an AC amplifier (model AA3004 by Toyoda Koki) and simultaneously recorded on a desktop-model automatic-recording equilibrium meter (Nippon Denshi Kagaku Company, Type U-228,500) (Fig. 4). The pelvic rotation angle, SLR-angle and Lasègue-angle were calculated using the scale obtained from amplitudes measured in the graphs. We considered that the value of the pelvic rotation angle thus subtracted from the SLR-angle and Lasègue-angle represented the true values for the SLR-angle and Lasègue-angle (Fig. 5 a, b, c).
Student's t-test was employed for statistical analysis.

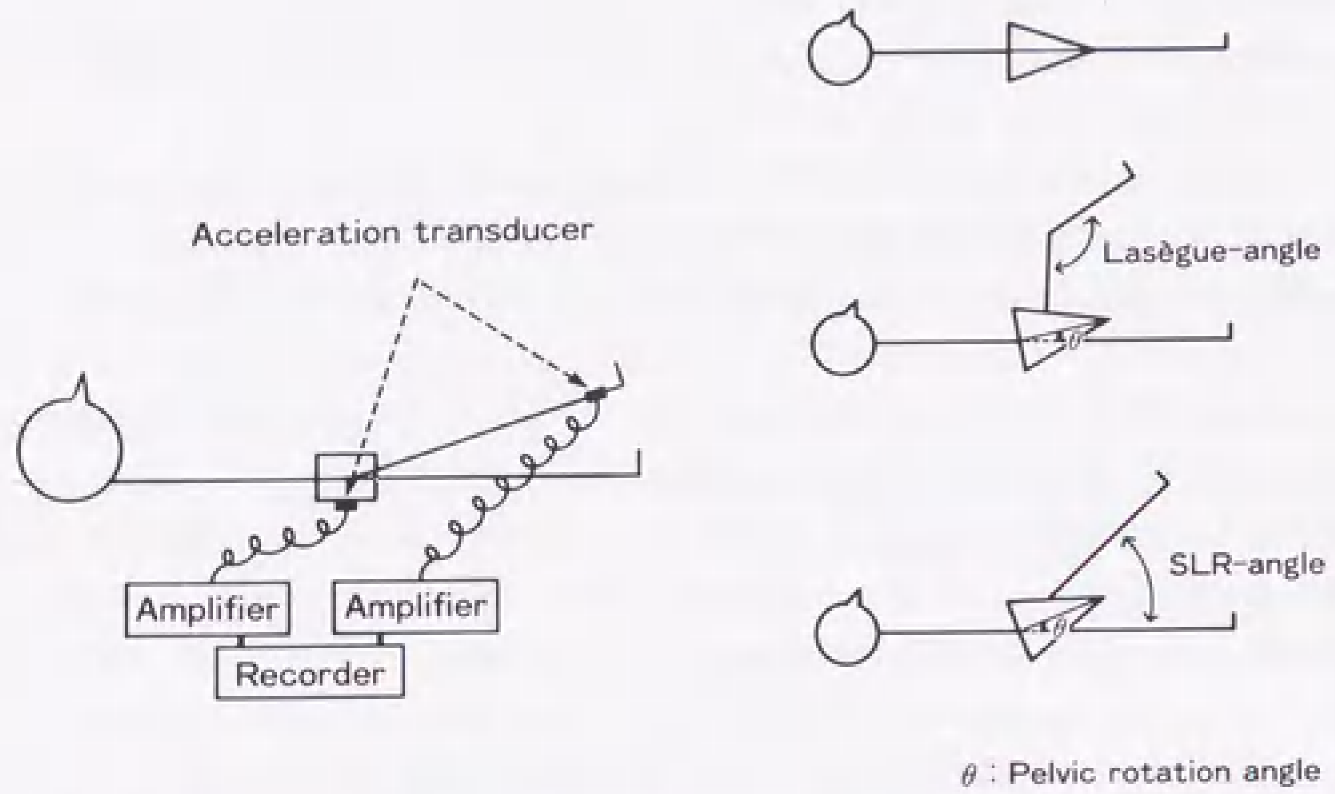


Fig. 4 Set-up of the acceleration transducer system for recording the pelvic rotation angle, Lasègue angle and SLR angle

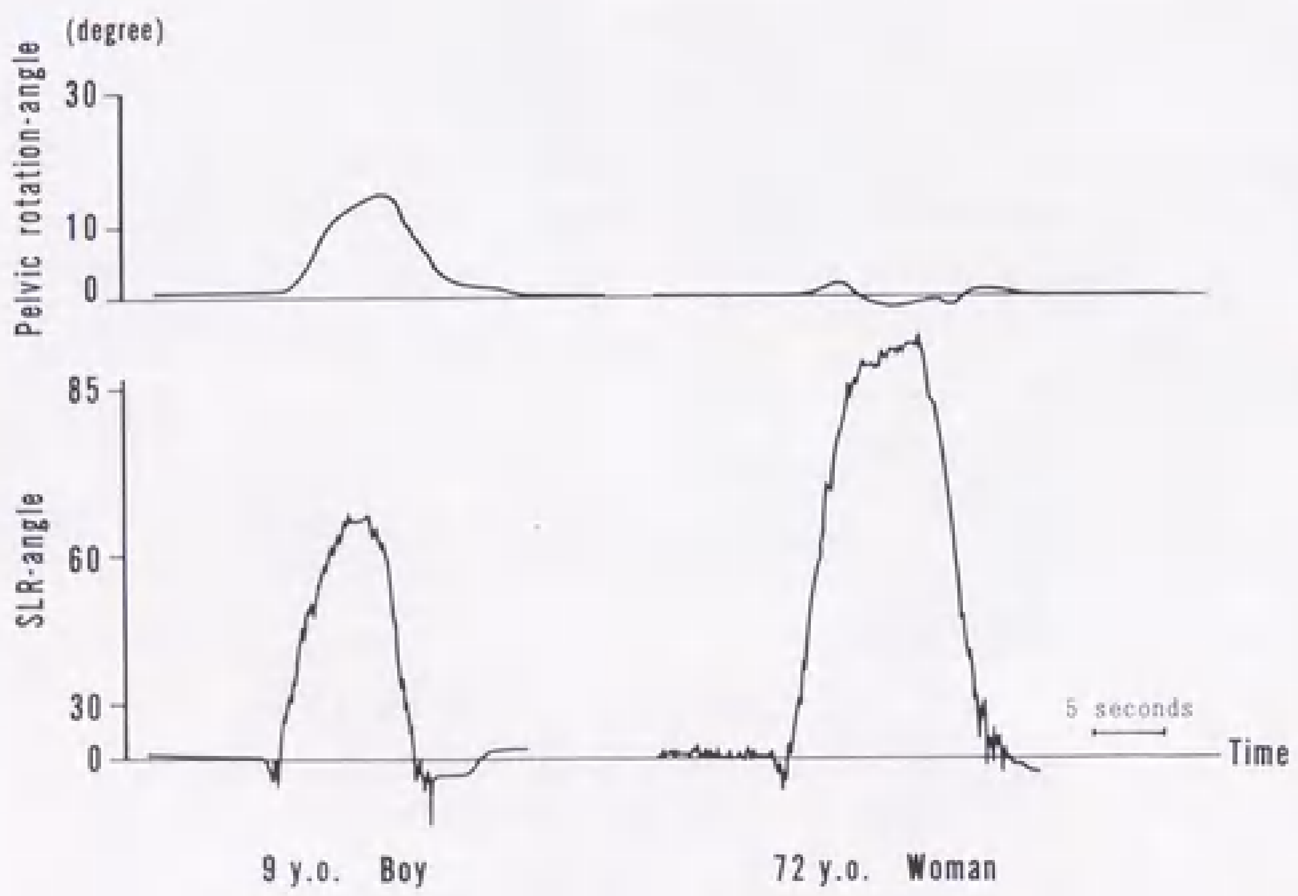


Fig. 5-a Degree of pelvic rotation during SLR-t comparing a 9-yr-old boy (left) and a 72-yr-old woman (right)

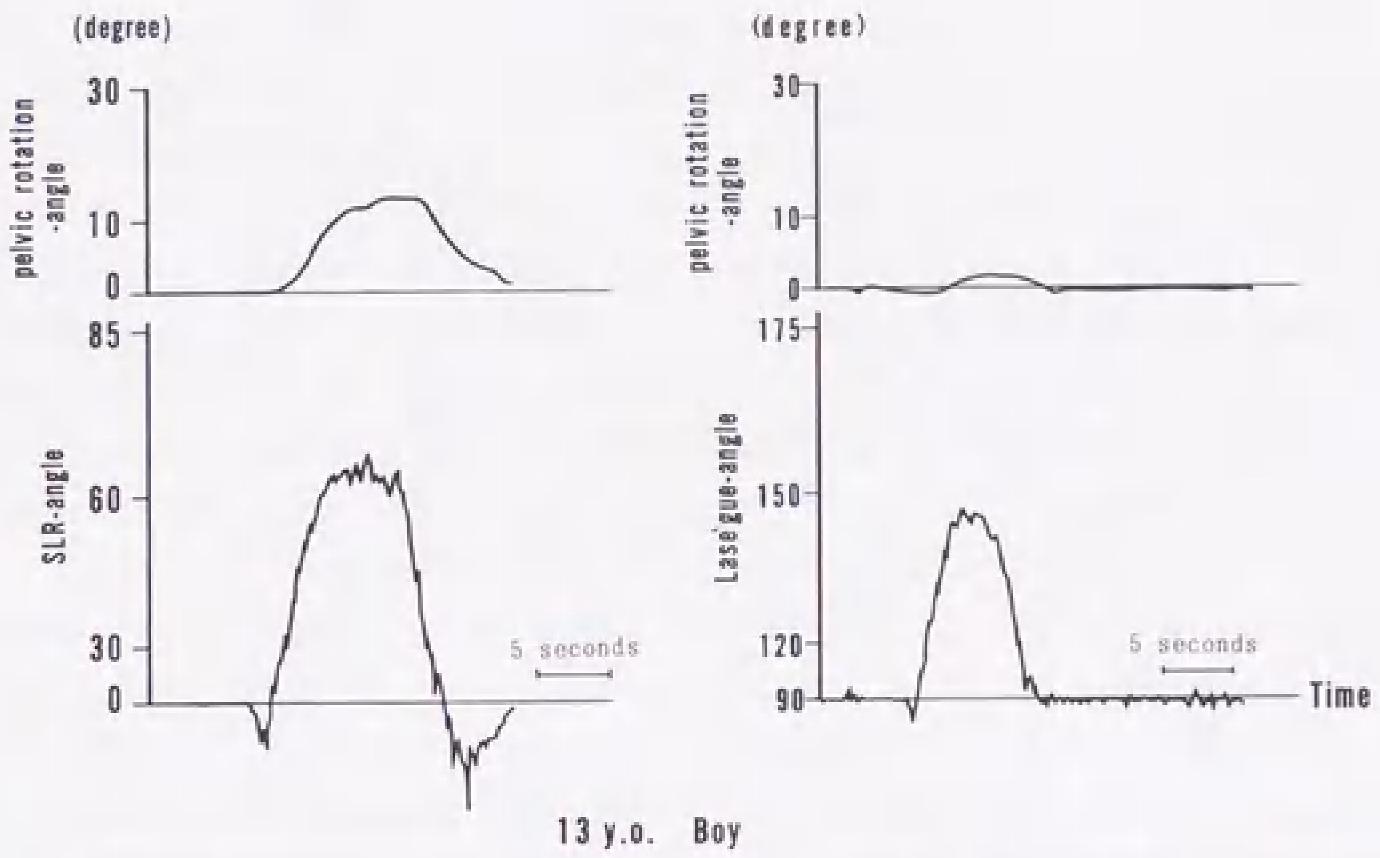


Fig. 5-b Degree of pelvic rotation during SLR-t and Lasègue-t (13-yr-old boy)

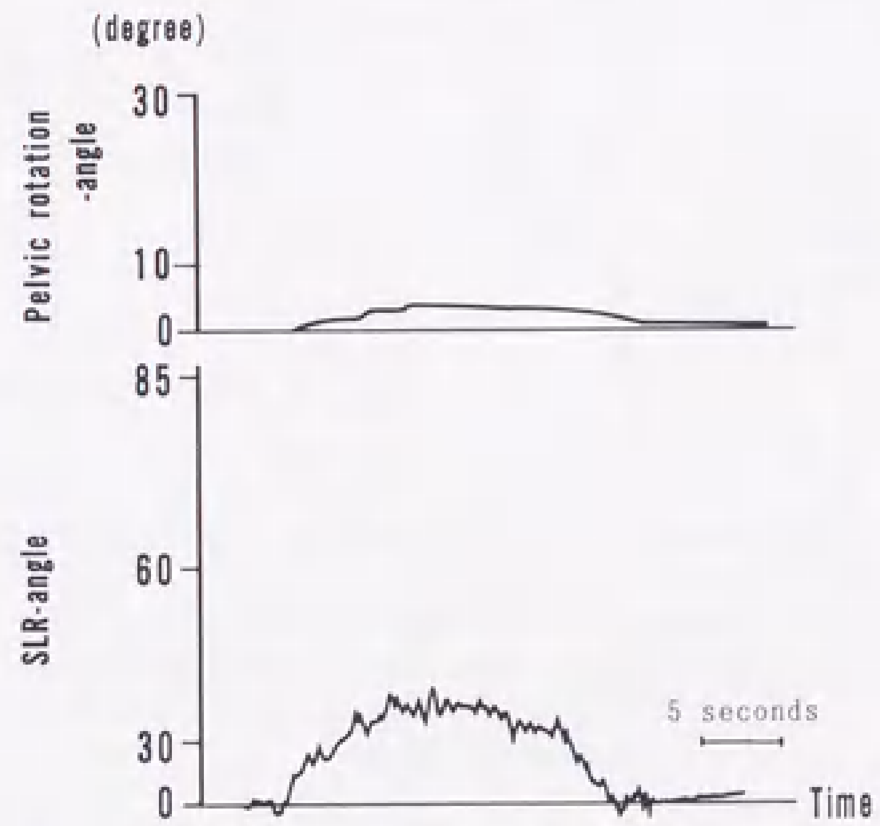


Fig. 5-c Degree of pelvic rotation during SLR-t in a patient with lumbar disk herniation (11-yr-old boy)

RESULTS

(1) Age and gender-dependent variations in SLR angle

Changes in the mean SLR angle according to age and gender followed this general pattern. The SLR angle diminished gradually after birth, and aside from a slight increase at about age 10, reached a minimum at 12-13 years in girls and at 14-15 years in boys (at the time of the maximum growth spurt). The angle increased gradually thereafter in both men and women, then began to decline again after age 65. Examination of gender-dependent differences in the SLR angle revealed that the SLR angle was larger in women than

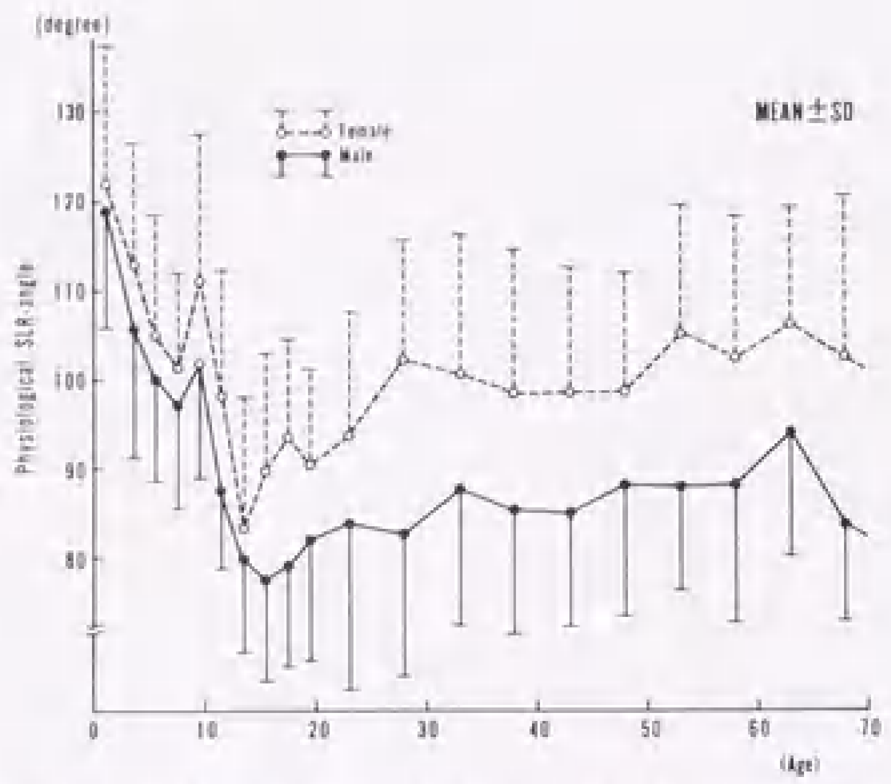


Fig. 6-a Physiologic changes in SLR angle according to age and gender (right leg)

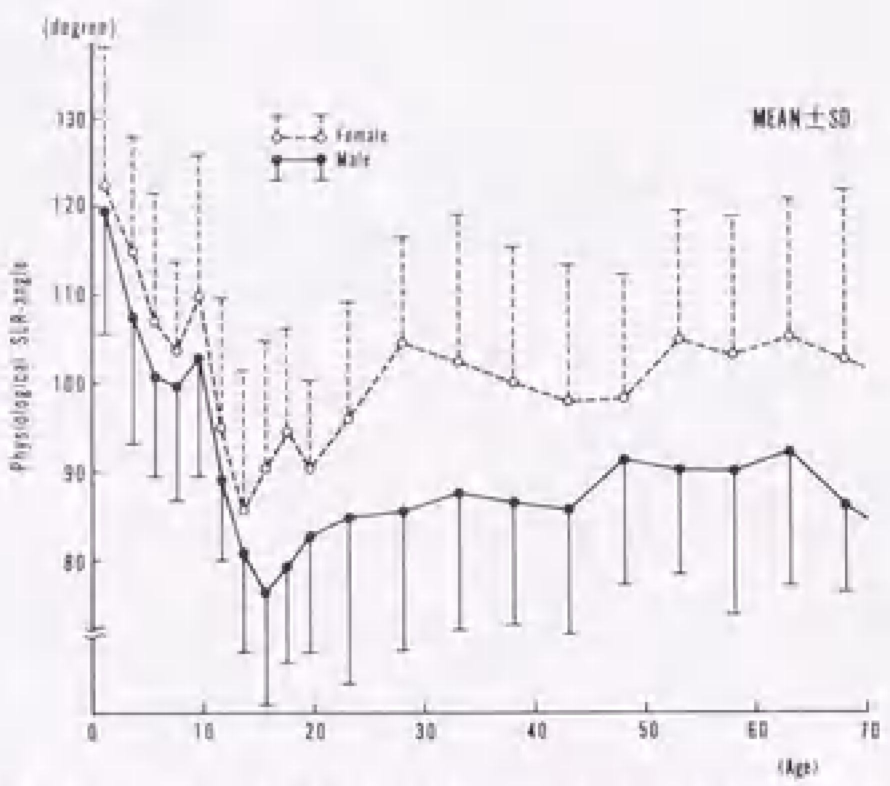


Fig. 6-b Physiologic changes in SLR angle according to age and gender (left leg)

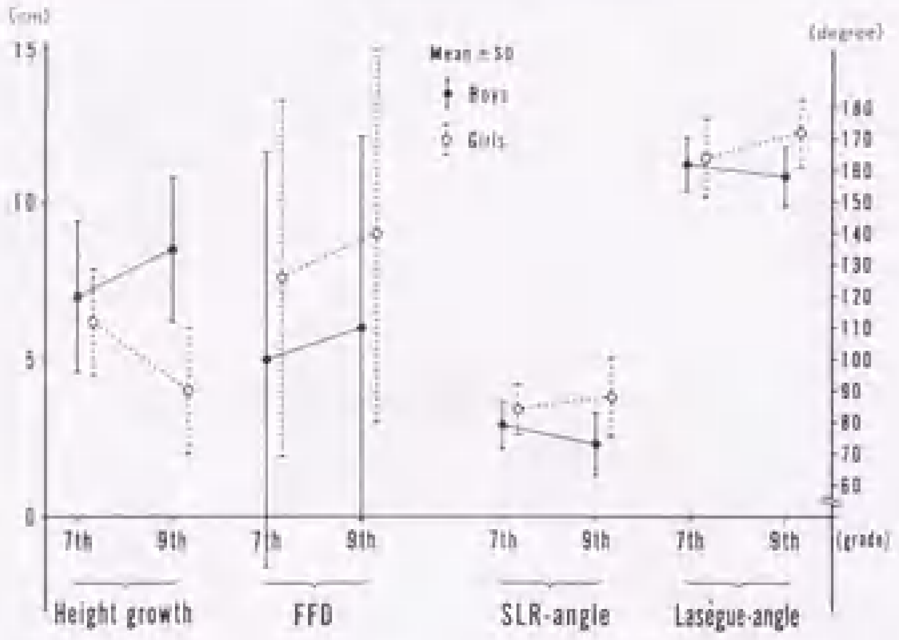


Fig. 7 Comparison of height growth, FFD, SLR angle and Lasègue angle between 7th and 9th graders in junior high school (solid lines, boys ; dotted lines, girls)

in men ($p<0.01$) at all stages of life. In the period from infancy through elementary school (ages 1-12) this difference was approximately 5°, while from junior high school to young adulthood (ages 13-25) it was about 10°, after which a difference of approximately 15° was seen between the sexes. There was no clear difference between the left and right legs in either sex (Fig. 6 a, b).

(2) Correlations among (A) increase in height during the growth years, (B) SLR angle, (C) Lasègue angle, and (D) FFD

Height increases for junior high school boys in the 7th grade averaged 7.0±2.4cm, and reached 8.4±2.3cm by the 9th grade. The SLR angle and Lasègue angle were 78.5°±7.7° and 162.6°±8.7° (respectively) in the 7th grade, but decreased to 72.9°±10.1° and 158.6°±9.9° in the 9th grade. In girls, the maximum increase in height was found at an earlier age, with growth slowing from 6.2±1.7cm in the 7th grade to 4.0±2.0cm in the 9th grade. Conversely, both the SLR angle and Lasègue angle increased in girls between the 7th and 9th grades, from 83.3°±8.0° and 164.6°±12.4° to 86.7°±12.6° and 171.4°±11.2°, respectively.

No significant difference in FFD was seen between the two age groups. For boys it increased from 5.0±6.6cm in the 7th grade to 6.0±6.1cm in the 9th grade, and for girls, from 7.6±5.7cm to 9.0±6.0cm (Fig. 7) in each of the two grades, respectively.

Correlation coefficients among growth rate (height in the previous year divided by present height), SLR angle, Lasègue angle and FFD are as follows: SLR angle/Lasègue angle =0.83, SLR angle/FFD=0.37, Lasègue angle/FFD=0.41, growth rate/SLR angle=−0.23, growth rate/Lasègue angle=−0.20, growth rate/FFD=−0.10.

(3) Degree of posterior pelvic rotation during the SLR-t and Lasègue-t

The correlation coefficient for SLR-t was −0.63 in males and −0.56 in females, for an overall negative correlation of −0.61 (Fig. 8). For the Lasègue-t, the correlation with posterior rotation of the pelvis was −0.04in males and −0.19 in females for an overall correlation of −0.19. Values remained at roughly this level regardless of age (Fig. 9). In short, the younger the subject the greater the degree of posterior rotation during the SLR-t, meaning that the SLR angle tends to appear greater than it actually is.

A comparison of 23 youths aged ≤20 years (both boys and girls aged 9 to 20 years) and 21 subjects of middle to advanced age (26 to 78 years) revealed no significant differences in the SLR angle between the two

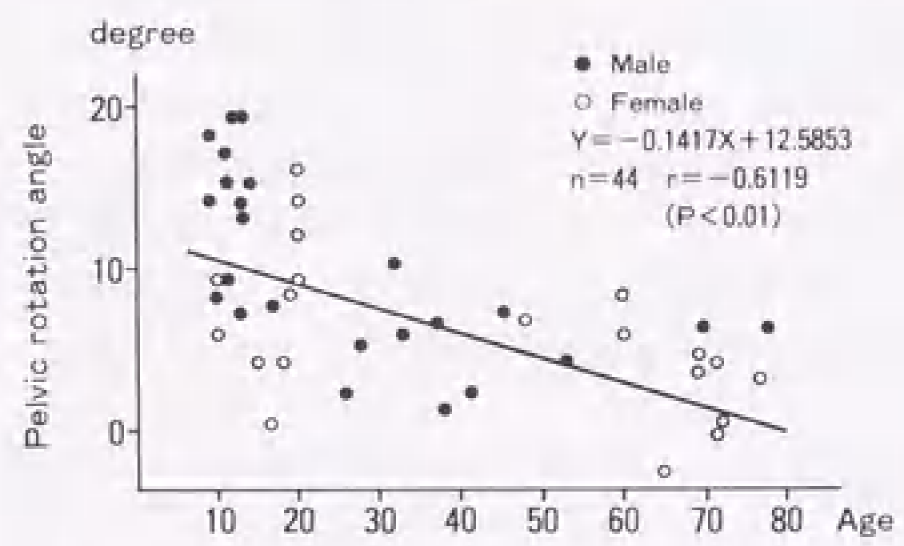


Fig. 8 Degree of pelvic rotation during SLR-t according to age (black circles, male ; white circles, female)

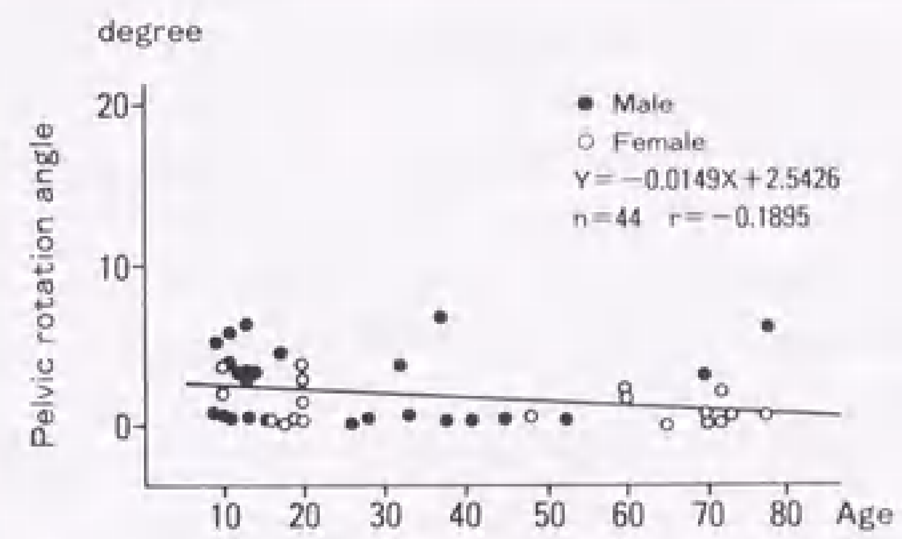


Fig. 9 Degree of pelvic rotation during Lasègue-t according to age (black circles, male ; white circles, female)

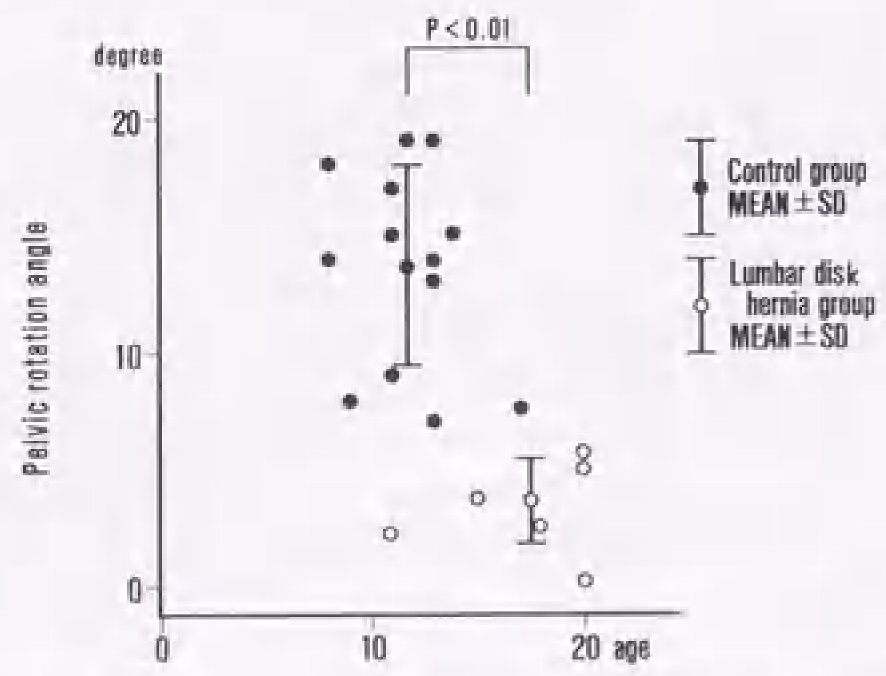


Fig. 10 Degree of pelvic rotation in men during SLR-t (black circles, control group ; white circles, lumbar disk herniated group) men≤20 years (mean±SD ; $p<0.01$)

groups, with values of 81.5°±9.8° and 87.3°±15.1° found in the former and latter, respectively. However, a comparison of the degree of posterior pelvic rotation demonstrated that in subjects aged ≤20 years the angle of rotation was 11.2°±5.2° during the SLR-t and 2.4°±1.9° during the Lasègue-t, while in subjects ≥21 years, values of 4.2°±3.0° and 1.7°±1.8° were found, respectively, showing a marked decrease ($p<0.01$) after the age of 21. In the group of men aged ≤20 years, the 6 subjects with lumbar disk herniation were compared with 13 healthy subjects. The results indicated that in both tests, movement was significantly ($p<0.01$) more restricted in the herniated group, with the SLR angle for this group averaging 47.0°±13.5° while the degree of pelvic rotation was 3.3°±1.9° during the SLR-t and 0.5°±0.8° during the Lasègue-t (Fig. 10).

DISCUSSION

(1) Study of age and gender-dependent variations in the SLR angle

It is believed that, regardless of age, gender-based differences in the SLR angle depend largely on individual differences in the suppleness of muscles and joints[6]. The fact that SLR angles are seen to abruptly decline during periods of intense growth in both sexes is attributed to the inability of soft tissue growth, namely that of muscles and tendons, to keep pace with bone growth, with tension induced in the pelvic muscles resulting in an imbalance in growth of the vertebral canal and spinal cord. The SLR angle, therefore, is smallest just after growth has stopped, and gradually begins to increase again with age. Provided that no disorders of the hip joint are present, gradual widening of the SLR angle is thought to result from consequences of the aging process such as reduced pelvic muscle tension and slackness in nerve roots and the sciatic nerve due to degeneration and shrinkage of intervertebral disks. After the age of 65, however, stiffness in the articular capsule and muscles overtakes this slack, and it again becomes more difficult to elevate the limb.

(2) Correlations among (A) increase in height during the growth period, (B) SLR angle, (C) Lasègue angle and (D) FFD

An inverse correlation exists between growth in height and changes in SLR and Lasègue angles. Boys experience sudden growth from the age of 12-13 years and continue growing until about the age of 14-15, at which point the SLR and Lasègue angles are the smallest of any age. In girls, the period of greatest growth (in height) is at 12-13 years of age, consistent with which the SLR and Lasègue angles are smallest at precisely this age. It appears that the imbalance in the growth of bones and muscles characteristic of this period of sudden growth induces a comparative tightening of the hamstrings. FFD, on the other hand, continues to increase with age in both sexes. The increase in FFD despite the reduction in SLR and Lasègue angles during the growth period is attributed to the fact that there is greater growth in the upper limbs and spine than in areas distal from the pelvis.

(3) Pelvic rotation during the SLR-t and Lasègue-t

There was significantly greater pelvic movement during the SLR-t than the Lasègue-t. In addition, a negative correlation was found between age and posterior rotation of the pelvis in the SLR-t, whereas almost no such correlation was found in the Lasègue-t. Consequently, it is thought that the Lasègue-t is a better method than the SLR-t to accurately evaluate tension signs because it is subject to less age-dependent variation and the degree of posterior rotation is smaller. Moreover, because there is a tendency for more posterior rotation in younger subjects during the SLR-t the increase in the apparent SLR angle over the true SLR angle must be taken into account. The reasons for the lesser degree of pelvic rotation with aging despite the persistence of a large SLR angle have already been discussed in Section (1) of the Discussion and are thought to include weakening of the pelvic muscles and age-related changes such as degeneration and

contraction of disks, and shrinkage of bones and cartilage, which lead to lack of tension in the nerve roots and increased slack in the sciatic nerve.

In patients with herniated lumbar disks, especially in those of young age, in addition to the age-dependent restrictions on SLR angle, movement is further restricted by symptoms of herniation, pain from tension in the lumbar spinal muscles and in the pelvic and lower leg muscles. Because of these factors, and the additional limitations on posterior rotation of the pelvis, such patients are particularly susceptible to so-called tight hamstrings.

CONCLUSION

1) This study established that range of movement in the SLR is limited during the period of maximum growth, with restrictions becoming most apparent at 14-15 years in boys and at 12-13 years in girls.

2) An investigation of possible correlations between the growth rate (height increase) and SLR-t, Lasègue-t, and FFD results suggested that growth in height was directly related to increased tension in the pelvic muscles.

3) SLR in youths (normal healthy subjects) was accompanied by rotation of the pelvis from the very beginning of the test. There was also a greater amount of pelvic movement in this age group than in persons of middle or advanced age.

4) Results from the Lasègue-t were subject to fewer age-dependent variations and were less influenced by pelvic motion.

5) Study of cases of lumbar disk herniation in young people revealed that in addition to a limited range of SLR movement there was also greater restriction of pelvic posterior rotation.

ACKNOWLEDGMENTS

The authors would like to thank Professor T. Miura, M. D., and K. Mimatsu, M. D., of the Department of Orthopaedic Surgery, Nagoya University School of Medicine, for their guidance and suggestions.

Part of this study was presented at the 62nd Meeting of the Japanese Orthopaedic Association in 1989.

REFERENCES

1) Berig, A.: Biomechanical considerations in the straight-leg-raising test. Spine, **4**: 242-250, 1979.
2) Chang-yu, H.: Straight-leg-raising test, Comparison of three instruments. Phys. Ther., **63**: 1429-1433, 1983.
3) Edit. Physical Education Bureau of Ministry of Education; Guidelines for Conducting Sports Tests (in Japanese).
4) Fisk, J. W.: The passive hamstring stretch test; clinical evaluation. New Zealand Medical Journal, **89**: 209-211, 1979.
5) Kikuchi, S.: Physical examination in spine. Orthop. Trauma Surg., **27**: 1297-1304, 1984 (in Japanese).
6) Okabe, T.: Age-and gender-dependent changes in the range of joint movement in healthy subjects. Rihabiriteshon igaku, **17**: 76, 1980 (in Japanese).
7) Okabe, T.: About extension of femur muscles and hamstrings in the healthy human subject. Rihabiriteshon igaku, **19**: 93-96, 1982 (in Japanese).
8) Oshina, T.: Angle of elevation and extension of the lower limb in adults. Rihabiriteshon igaku, **21**: 215-218, 1984 (in Japanese).
9) Richard, G.: Hamstring muscle tightness. Rhys. Ther., **63**: 1085-1089, 1983.
10) Richard, G.: Effects of ankle dorsiflexion on active and passive unilateral straight-leg-raising. Phys. Ther., **65**: 1478-1482, 1985.

11) Richard, W. B.: Cinematographic analysis of the passive straight-leg-raising test for hamstring muscle length. Phys. Ther., **62**: 1269-1274, 1982.
12) Spangfort, E.: Lasègue's sign in patients with lumbar disk herniation. Acta Orthop. Scand., **42**: 459, 1971.
13) Troup, J. D. G.: Straight-leg-raising and the qualifying tests for increased root tension. Spine, **6**: 526-527, 1981.
14) Toyoda Koki Co.: Technical sales literature, ATS-16S KK8-04281-04287 (in Japanese).
15) Yamada T.: Electromyographical study of the straight-leg-raising test on the lumbar disc herniation. J. Jpn. Orthop. Ass., **57**: 507-518, 1983 (in Japanese).
16) Yoshida, T.: How age and gender influence the straight-leg-raising test. J. Jpn. Orthop. Ass., **54**: 1164-1166, 1980 (in Japanese).

Straight-Leg-Raising test に関する研究

(名古屋大学整形外科学教室　主任：三浦隆行教授)

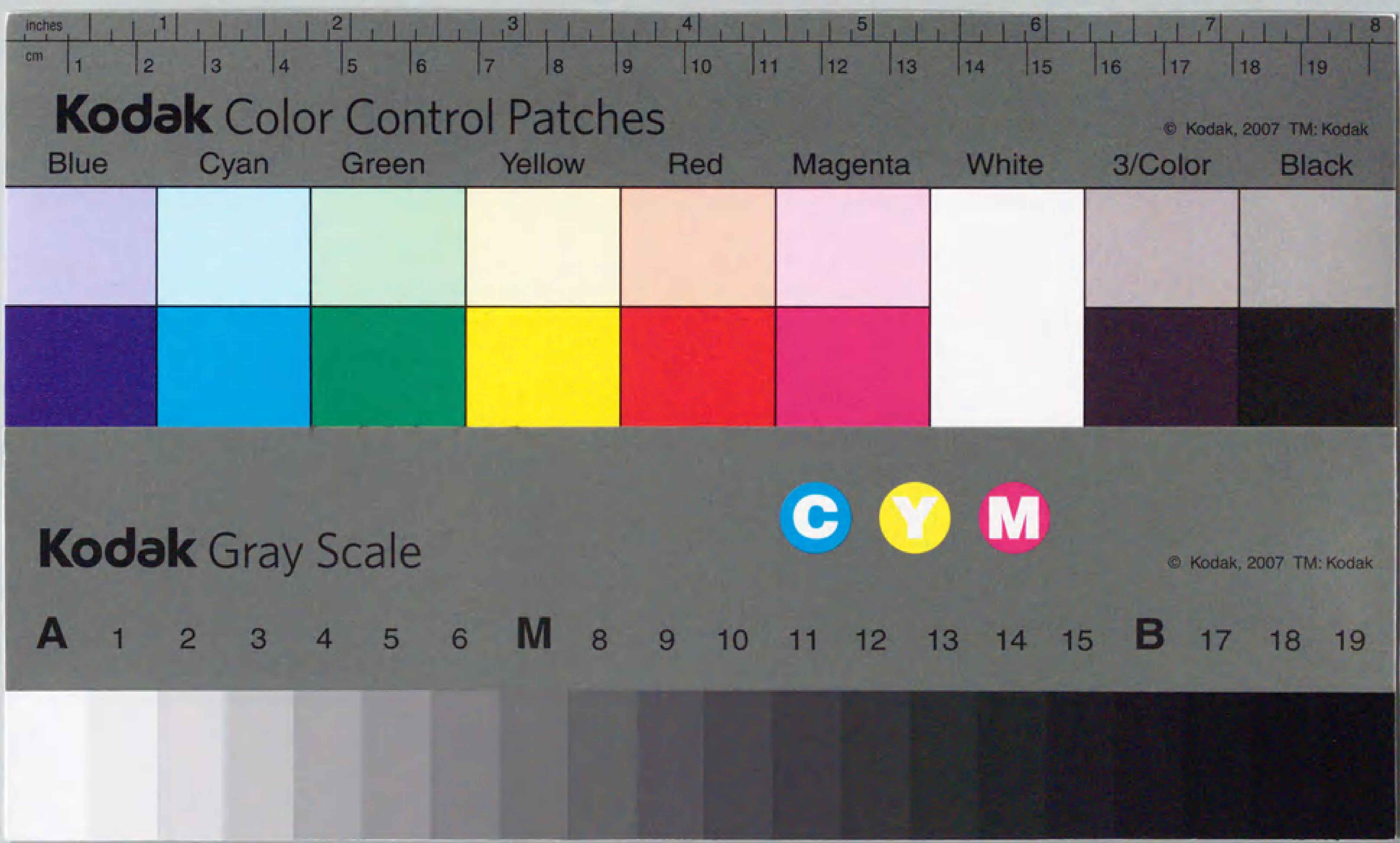
井 戸 田　仁

(吉田整形外科病院)

吉　田　徹

われわれが日常使用している nerve stretch test は，古くから行われひんぱんに日常診療に利用される一方，年齢，性別，股関節，脊椎，骨盤等の動きは考慮せずに評価されていることが多い．これに対し①健常者の膝伸展位での股関節屈曲可能角度(生理的 SLR 角度)の年齢差および性差，②成長期の tension sign の変化，③健常者，腰部椎間板ヘルニア患者例の SLR-test, Lasègue-test 施行時の骨盤の動きを加速度トランスデューサーを用いて調査した．その結果，男性では 14 歳から 15 歳，女性では 12 歳から 13 歳の成長期に SLR が制限されており，身長の伸びが骨盤下腿筋群の緊張に関与していることがわかった．また男性よりも女性のほうがいずれの時期においても生理的 SLR 角度が大きかった．健常若年者は中高年者より SLR-test 施行時の骨盤後方回旋度が大きく，SLR 角度を実際より大きく見せる可能性が示唆された．さらに SLR-test より Lasègue-test のほうが年齢による変化が少なく，かつ骨盤の回旋度も少ないためより正確な tension sign を表現しうることがわかった．若年者の腰部椎間板ヘルニア例では，年齢的な SLR 角度の制限に加えてヘルニア徴候による SLR 角度の制限も加わり，さらに疼痛による腰部脊柱筋，骨盤下腿筋群の緊張のため骨盤後方回旋度の低下も影響していわゆる tight hamstrings の状態を引き起こしやすいと考えられた．

4 901480 610917
CF-A4SNY MADE IN JAPAN


inches
cm
Kodak Color Control Patches
© Kodak, 2007 TM: Kodak
Blue Cyan Green Yellow Red Magenta White 3/Color Black
C Y M
Kodak Gray Scale
© Kodak, 2007 TM: Kodak
A 1 2 3 4 5 6 M 8 9 10 11 12 13 14 15 B 17 18 19