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## Magnetic resonance imaging based lumbar interspinous distance measurements in Thai subjects

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**Background** : *There is no previous report regarding normal lumbar interspinous distance in Thai subjects. The measurement of the lumbar interspinous distance is made based on the magnetic resonance imaging images.*

**Objective** : *To measure the distance of the lumbar interspinous process in Thai subjects and compare with the size of the currently available interspinous device in Thai market.*

**Methods** : *Sixty healthy subjects (30 males and 30 females) age 20 - 55 years were enrolled into this study. All of the subjects were underwent the lumbar spine magnetic resonance imaging (MRI). The interspinous distance was measured at the most midline cut in T2 weighted MRI image by marking the mid portion of each spinous process from L1 to L5 then the interspinous distance was measured from lower border of proximal spinous process to upper border of adjacent distal spinous process. The measurement was performed at L1-2, L2-3, L3-4 and L4-5 level, respectively then the results were compared with a size of the interspinous device currently available in Thailand.*

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- Results** : *The mean age of subjects is 36.3 years. Total mean distance from all samples at L1-2 level is  $11.8 \pm 2.3$  (10.0 - 14.1) mm, L2-3 level is  $10.9 \pm 2.4$  (8.4 - 14.1) mm, L3-4 level is  $10.4 \pm 2.3$  (9.0 - 14.1) mm and L4-5 level is  $9.9 \pm 2.2$  (8.0 - 13.0) mm. Mean distance in female at L1-2 level is  $11.1 \pm 2.4$  (10.0-12.2) mm, L2-3 level is  $10.1 \pm 1.5$  (9.2-11.6) mm, L3-4 level is  $9.9 \pm 1.1$  (9.1-10.7) mm and L4-5 level is  $9.2 \pm 2.1$  (8.0-10.1) mm. Mean distance in male at L1-2 level is  $12.5 \pm 2.1$  (10.2 - 14.1) mm, L2-3 level is  $11.8 \pm 3.2$  (8.4 - 14.1) mm, L3-4 level is  $10.9 \pm 3.5$  (9.0 - 14.1) mm and L4-5 level is  $10.6 \pm 2.2$  (8.4 - 13.0) mm. The maximum and the minimum distance from all samples are 14.1 mm and 8 mm respectively which was covered by the range of interspinous device sizes available in Thailand market (range 8 -16 mm) .*
- Conclusions** : *This study demonstrated the interspinous distance in Thai subjects. The results provided the important information regarding the proper size of the interspinous device used in Thai individual for surgeon who get involved with interspinous device about a proper range of device size to matching the interspinous distance in Thai population.*
- Keywords** : *Interspinous distance, lumbar interspinous device, magnetic resonance imaging.*

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**เหตุผลของการทำวิจัย** : ในปัจจุบันมีการใช้อุปกรณ์ชนิดสอดที่ interspinous space ของกระดูกสันหลังส่วนเอวเพื่อเพิ่มความมั่นคงแก่กระดูกสันหลังส่วนเอวในประเทศไทยเพิ่มขึ้นอย่างมาก อย่างไรก็ตามทางคณะผู้วิจัยพบว่ายังไม่มีข้อมูลเกี่ยวกับ interspinous distance ของกระดูกสันหลังส่วนเอวในคนไทย คณะผู้วิจัยจึงทำการศึกษาโดยการวัดระยะดังกล่าวจากภาพถ่ายคลื่นรังสีสะท้อนในสนามแม่เหล็กในประชากรศึกษาชาวไทย

**วัตถุประสงค์** : การศึกษานี้ทำเพื่อให้ได้ข้อมูลของ interspinous distance ของกระดูกสันหลังส่วนเอวในประชากรศึกษาชาวไทยและเพื่อนำข้อมูลดังกล่าวมาเปรียบเทียบกับขนาดของอุปกรณ์ชนิดสอดที่ interspinous space ส่วนเอว เพื่อเพิ่มความมั่นคงแก่กระดูกสันหลังส่วนเอวที่มีอยู่ในประเทศไทยว่ามีขนาดที่เหมาะสมครอบคลุม interspinous distance ของกระดูกสันหลังส่วนเอวในประชากรศึกษาชาวไทยหรือไม่

**รูปแบบการวิจัย** : การศึกษาแบบพรรณนา

**สถานที่ทำการศึกษา** : ภาควิชาออร์โธปิดิกส์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

**ตัวอย่าง** : ผู้เข้าร่วมวิจัยที่สุขภาพดีเป็นปกติ อายุตั้งแต่ 20 ปีถึง 55 ปีได้รับการถ่ายภาพภาพคลื่นรังสีสะท้อนในสนามแม่เหล็กของกระดูกสันหลังส่วนเอวระหว่างเดือนมกราคม 2552 ถึง เดือนธันวาคม 2552 จำนวน 60 ราย

**วิธีการศึกษา** : วัดขนาดของ interspinous distance ของกระดูกสันหลังส่วนเอวในประชากรศึกษาชาวไทยโดยการนำภาพคลื่นรังสีสะท้อนในสนามแม่เหล็กของกระดูกสันหลังส่วนเอวในท่า sagittal วิธีวัดเริ่มต้นโดยทำการวัดความยาวของสันกระดูกสันหลังระดับที่ L1 - L5 แล้วหาจุดแบ่งครึ่งลากเส้นเชื่อมแต่ละจุดเข้าด้วยกัน ทำการวัด interspinous distance ของกระดูกสันหลังส่วนเอวบนเส้นดังกล่าว โดยเลือกระยะตั้งแต่ขอบล่างของ spinous process ขึ้นบนลงมาถึงขอบบนของ spinous process ขึ้นถัดลงไป โดยการวัดดังกล่าวจะทำที่ระดับ L1-2, L2-3, L3-4 และ L4-5 เมื่อได้ผลลัพธ์แล้วจึงนำไปเปรียบเทียบกับขนาดของ Lumbar interspinous device ที่มีในประเทศไทยต่อไป

- ผลการศึกษา** : อายุเฉลี่ยของประชากรศึกษาทั้งหมดคือ 36.6 ปี ค่าเฉลี่ยของ lumbar interspinous distance ในเพศหญิงที่ระดับ L1-2 เท่ากับ  $11.1 \pm 2.4$  (10.0 - 12.2) mm, L2-3 เท่ากับ  $10.1 \pm 1.5$  (9.2 - 11.6) mm, L3-4 เท่ากับ  $9.9 \pm 1.1$  (9.1 - 10.7) mm and L4-5 เท่ากับ  $9.2 \pm 2.1$  (8.0 - 10.1) mm ค่าเฉลี่ยของ lumbar interspinous distance ในเพศชายที่ระดับ L1-2 เท่ากับ  $12.5 \pm 2.1$  (10.2 - 11.4) mm, L2-3 เท่ากับ  $11.8 \pm 3.2$  (8.4-14.1) mm, L3-4 เท่ากับ  $10.9 \pm 3.5$  (9.0 -14.1) mm และ L4-5 เท่ากับ  $10.6 \pm 2.2$  (8.4 - 13.0) mm ระยะกว้างที่สุดที่พบในกลุ่มประชากรศึกษาคือ 14.1 mm และระยะที่แคบที่สุดคือ 8 mm โดย lumbar interspinous distance ในประชากรศึกษาดังกล่าวอยู่ในความครอบคลุมของขนาดของ Lumbar interspinous device เพื่อเพิ่มความมั่นคงแก่กระดูกสันหลังส่วนเอวที่มีในประเทศไทย 4 ชนิด
- สรุป** : การศึกษานี้ให้ข้อมูลของ lumbar interspinous distance ในประชากรไทย โดยผลลัพธ์ที่ได้นี้ทำให้ศัลยแพทย์ผู้ผ่าตัดทราบถึงความครอบคลุมของขนาดของอุปกรณ์ interspinous device ที่มีใช้ในประเทศไทยต่อ lumbar interspinous distance ในประชากรศึกษาชาวไทย
- คำสำคัญ** : Interspinous distance, กระดูกสันหลังส่วนเอว, คลื่นรังสีสะท้อนในสนามแม่เหล็ก.

Neurogenic intermittent claudication (NIC) secondary to lumbar spinal stenosis is a posture dependent condition in which symptoms such as lower limb tingling, pain and numbness are typically exacerbated in extension and relieved in flexion.<sup>(1, 2)</sup> Interspinous device is function mainly by limits extension of the motion segment or keeps it slightly flexion. Flexion of the spinal motion segment leads to increasing of the spinal canal space.<sup>(3)</sup> Feng et al. found the spinal canal diameter was increased relative to segmental motion segment flexion by 0.009 mm/degree in L1-2, 0.120 mm/degree in L2-3, 0.071 mm/degree in L3-4, 0.126 mm/degree in L4-5, and 0.091 mm/degree in L5-S1. Many previous research studies reported the good results for interspinous devices.<sup>(4-8)</sup> To achieve a satisfactory outcome, matching between the device size and interspinous space of the patient is needed. The proper size of device can maximize the improvement of symptoms and decrease the risk of over distraction or dislodgement. However, all of these devices are designed based on anatomic size of the Western population. Due to the fact that most morphological data between Western and Asian population are different, the interspinous distance may also be different. In Thailand which is one of the Asian countries, all devices are imported from Western countries which the size may not match to Thai population. To the best of our knowledge, there is no data about interspinous distance for Thai subjects. As a result, this study aims to examine the interspinous distance in Thai subjects.

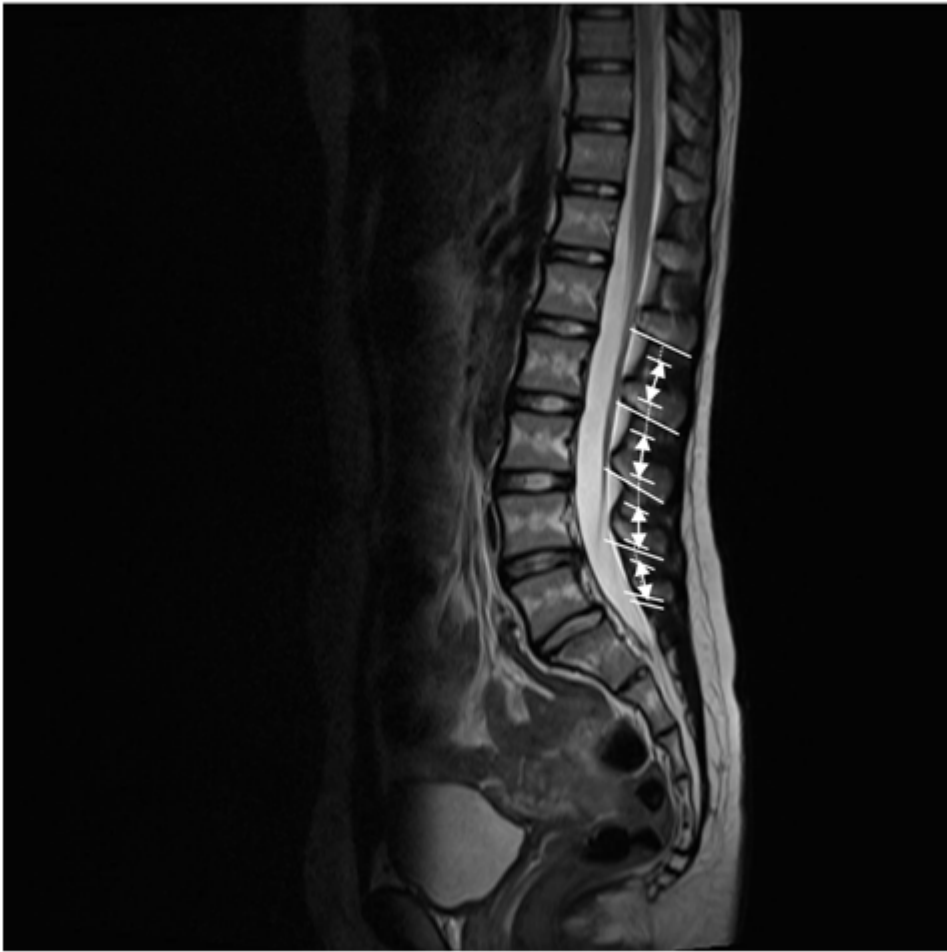
#### Materials and Methods

Between January 2009 and December 2009,

60 consecutive lumbar spine magnetic resonance imaging (MRI) studies were performed in healthy Thai subjects. We retrospectively reviewed L-S spine MRI data which was performed for any reason such as low back pain, yearly check up, etc. We selected only MRI result that was already evaluated by radiologist and considered normal. In addition, the selection criteria included age between 20 to 55 years old, no congenital deformity, no scoliosis, no traumatic injury to spine and no previous spine surgery. Finally, we included lumbar spine MRI of 30 males and 30 females to perform this study.

MRI was performed using a 1.5 Tesla whole body MR imaging system (Siemens 1.5 Tesla, Avanto, Germany) with an extremity coil. Pulse sequences were T2-weighted images. Before performing the study, the MRI was precalibrated to provide a 0% of magnification with the use of cadaveric specimen. All images were reconstructed at 2-mm intervals. The position of all subjects was supine position.

This study was measured interspinous process with eFilm version 2.0 (Merge, CA, USA). We chose the most midline cut of each subject to make a measurement. The longitudinal length of each spinous process between L1 to L5 was measured and its mid portion was marked then the connecting line was drawn between each point represent the mid part of the L1-L5 spinous process. The interspinous distance was measured from the point at the lower border of proximal spinous process to upper border of adjacent distal spinous process along the connecting line (Fig. 1). All measurements were done one time by orthopaedic fellow (S.T.).



**Figure 1.** Double head arrows show the interspinous distance measurement.

Descriptive statistic was used for demographics data and interspinous distance measurements. The GraphPad Prism 5.01.336 software (La Jolla, CA, USA) was used for statistical analysis.

### Results

Thirty patients were males and 30 were females. The demographic data are shown in table 1.

The measurement results are shown in table 2. Overall maximum and minimum interspinous distance were 14.1 mm and 8 mm respectively. We compared the maximum range of interspinous distance in this study (8.0 - 14.1 mm) with available device size in Thailand (all devices have size from 8 -16 mm) (Table 3). We found that all 4 devices have good size coverage to the interspinous distance of Thai subjects.

**Table 1.** The demographic data of the subjects.

Sex (no.)	Age (year)	Height (cm)	Weight (Kg.)
	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)
Female (30)	36.9 $\pm$ 8.2 (20 - 52)	156.7 $\pm$ 5.9 (150 - 170)	58.3 $\pm$ 9.8 (37.7 - 80)
Male (30)	36.6 $\pm$ 8.6 (20 - 51)	166.8 $\pm$ 9.1 (152 - 176)	70.4 $\pm$ 12.2 (46 - 104)
Total (60)	36.3 $\pm$ 8.4 (20 - 52)	161.78 $\pm$ 7.5 (150 - 176)	64.4 $\pm$ 11 (37.7 - 104)

**Table 2.** Average interspinous distance.

Subjects (no.)	Mean interspinous distance $\pm$ SD (range) mm.			
	L1-2	L2-3	L3-4	L4-5
Female (30)	11.1 $\pm$ 2.4 (10.0 - 12.2)	10.1 $\pm$ 1.5 (9.2 - 11.6)	9.9 $\pm$ 1.1 (9.1 - 10.7)	9.2 $\pm$ 2.1 (8.0 - 10.1)
Male (30)	12.5 $\pm$ 2.1 (10.2 - 14.1)	11.8 $\pm$ 3.2 (8.4 - 14.1)	10.9 $\pm$ 3.5 (9.0 - 14.1)	10.6 $\pm$ 2.2 (8.4 - 13.0)

**Table 3.** Interspinous devices and its sizes that available in Thailand.

Device name	Size available in Thailand (mm)
X Stop (Kyphon Inc, California, US)	8, 10, 12, 14, 16
Diam (Medtronic Sofamor Danek, Tennessee, US)	8, 10, 12, 14, 16
In space (Synthes spine, Umkirch, Germany)	8, 10, 12, 14, 16
Coflex (Paradigm spine, Newyork, US)	8, 10, 12, 14, 16

## Discussion

Proper size of interspinous device is one of the important factors for the success of the procedure. Improper device sizing increase the risk of implant dislodgment (in case of too small) or over distraction and spinous process fracture (in case of too large).<sup>(10)</sup> Agarval et al. suggested the method that their used to determine the device size is to find the “elastic limit” of the interspinous space (the point at which the force needed to distract the interval

further begins to dramatically increase) via manual distractive force exerted by the sizing device then choose device that is 2 mm smaller.<sup>(11)</sup> The interspinous distance value from this study can not apply to use with this measurement method due to lack of distraction force before distance measurements.

Regarding the measurement of interspinous distance, there are some previous studies available.<sup>(12, 13)</sup> However, the methodologies of



measurements, racial of the subjects were difference from this study then their values are not comparable with our results. For example, Sobottke et al.<sup>(13)</sup> measured the interspinous space in abdominal CT scan (recumbent position) of 565 non pathologic spine Western subjects and found that the average measured interspinous space was  $9.1 \pm 2.5$ mm (range 3.5 - 33.5 mm). In current study, the overall range of interspinous distance in supine position without distraction force is 8.0 - 14.1 mm which is quite different from Sobottke's results. This may be explained by difference in race, measurement technique and instrument. In our study, we chose to perform measurement in MRI because of comparable accuracy of distance measurement between CT and MRI.<sup>(14)</sup> Furthermore, MRI has benefit about no radiation exposure to patients.

We separate male and female measurement because of male and female are generally had different body size and anthropometric data. In our opinion, range of distance for each gender is clinically important when the surgeon has to prepare proper instrument size for patient in different gender.

There is a limitation of this radiologic study; the posture of subjects in this study was supine position. The results of distance may different from the prone position that the patient has to be set up before the interspinous instrument insertion procedure begins. As the interspinous distances vary with patient positioning, our measurements are valid only for the supine position of patients undergoing MRI.

In conclusion, the result of the present study can provide detail information to allow a better anatomic understanding of interspinous distance in Thai individual. We strongly recommend preparing

the device size 6 mm in case of the operation will be performed in Thai population. However, all of the results were obtained from healthy subjects. Extrapolation from these data to the patient with neurogenic intermittent claudication should be done with caution.

Finally, the data from this study can be used as basic anatomical information for further development or manufacture of interspinous device in Thai population.

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