

The Midpedicular and Interpedicular Distance of Thoracolumbar Vertebrae

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Abstract

Objectives : 1. To introduce the measurement of the midpedicular distance (MPD) as an alternative to the interpedicular distance (IPD).

2. To measure the IPD and MPD of T_{11} , T_{12} , L_1 and L_2 vertebrae on antero-posterior (AP) plain film of the normal spine.

3. To study the relationship of the IPD and MPD of T_{11} to L_2 of the normal spine.

Study design : Thoracolumbar AP plain film of 89 subjects (39 males, 50 females) with an average age of 47.6 years (range 21-78 years) from the roentgenographic files were included. Both the IPD and MPD of T_{11} , T_{12} , L_1 and L_2 were measured by two observers. The mean difference of IPD and MPD at these four levels were compared by using a one-way ANOVA. The relationship of the IPD and MPD measured from the T_{11} to L_2 levels were evaluated using the simple linear regression model.

Results : The mean IPD was progressively wider ($p = 0.000$) from the T_{11} to L_1 level, but no significant difference ($p = 0.308$) was found between the mean IPDs of L_1 and L_2 .

The mean MPD of each level was significantly different from the others ($p = 0.000$) except the mean MPDs of T_{12} and L_1 ($p = 1.000$).

Both the IPD and MPD had a statistically significant linear relationship with the level of the vertebrae from T_{11} to L_2 ($p = 0.000$) with the coefficients of determination (R^2) of 0.39 and 0.28, respectively.

Conclusion : More care should be taken in clinical practice when measuring the IPD of a fractured vertebra relative to those of adjacent lower levels in order to determine whether or not widening has occurred, especially IPD L_1 vis-à-vis IPD L_2 . MPD measurement has no advantage over the IPD measurement but is a useful alternative when a comparison of the pedicular distance of L_1 and L_2 is needed.

Key word : Midpedicular Distance, Interpedicular Distance, Thoracolumbar Spine

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The interpedicular distance (IPD) is the distance between the innermost edges of the pedicle contours of a given vertebra seen on the anteroposterior (AP) plain film of the spine (Fig. 1)(1,2). Since the first report of a widened IPD following trauma in 1975(3), the IPD has become an important feature in the detection of spinal injuries on AP plain film of the vertebral column, especially burst fractures(4-7). The thoracolumbar junctional region (i.e. T₁₁, T₁₂, L₁ and L₂) is a common site for burst fractures. The IPD measured on the fractured level is usually compared with the IPD of the adjacent (upper or lower) levels to detect widening.

In clinical practice, the author (SS) observed that the morphology of the pedicle contour seen on the AP plain film of the normal spine varied from level to level (Fig. 2). This variation could affect the IPD measurement and lead to misinterpretation of widening when the spine was fractured.

The author then proposed a new method of measurement, midpedicular distance (MPD) (Fig. 3), which was measured between the midpedicular point, the intersection point of the lines drawn mid way, vertically and horizontally, of the pedicle contour of the vertebra. The authors hypothesized that the MPD would better reflect the pedicular distance than the IPD.



Fig. 1. The interpedicular distance (IPD) measurement.

The purpose of this study was to measure the IPD and MPD of T₁₁, T₁₂, L₁ and L₂ vertebrae on AP plain film of normal (non-fractured) spine and analyse the relationship of both IPD and MPD at these four levels.

MATERIAL AND METHOD

The roentgenographic files at the Radiology Department, Srinagarind Hospital were systematically searched for anteroposterior thoracolumbar spine plain films. Films of the spine with abnormalities such as spinal deformity and bone destruction were excluded as were films not truly AP or overexposed ones. Finally, thoracolumbar AP plain films of 89 subjects (39 males, 50 females) with an average age of 47.6 years (range, 21 to 78) were included.

Measurements were made with a vernier scaled caliper. The IPD of T₁₁, T₁₂, L₁ and L₂ of each film were measured then the MPD measurements were made in a different sequence at a different time.

Intra and interobserver reliability

The IPD and MPD measurements were performed by two observers and each observer measured each film twice for both IPD and MPD on different occasions.



Fig. 2. The variation of the morphology of the pedicle contour seen on the AP plain film of the normal spine.

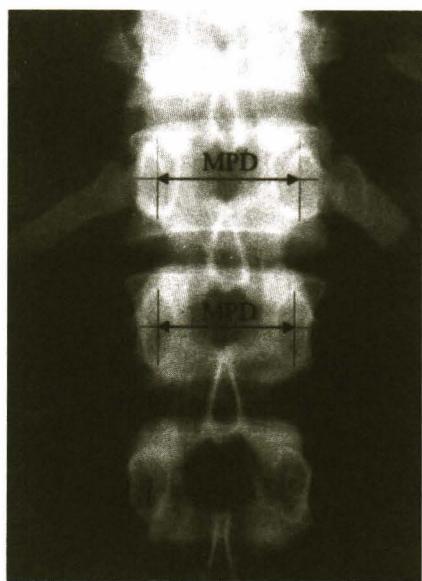


Fig. 3. The midpedicular distance (MPD) measurement.

Statistical analysis

Data were analysed using a statistical software program, SPSS 10.0 for windows (SPSS Inc.,

Chicago, IL). The mean difference of the IPD or MPD of T₁₁, T₁₂ L₁ and L₂ were compared using a one-way ANOVA. A post hoc test (Bonferroni) was used for the correction of multiple comparisons. Statistical significance was set at $p < 0.05$ for each comparison as determined by two-tailed analysis.

To evaluate the relationship of the IPDs or MPDs measured from the T₁₁ to L₂ levels, simple linear regression models were used and the coefficient of determination (R^2) calculated to establish the magnitude of association.

The intraclass correlation coefficients were used to estimate the intra and interobserver reliability.

RESULTS

Mean comparison of IPD

The means and 95 per cent confidence intervals of the IPD of T₁₁, T₁₂, L₁ and L₂ are shown in Fig. 4. The IPD of each level became progressively wider from T₁₁ to L₁ ($p = 0.000$), but a comparison between the IPD of L₁ and L₂ revealed no significant difference ($p = 0.308$).

Mean comparison of MPD

The means and 95 per cent confidence intervals of the MPD of T₁₁, T₁₂, L₁ and L₂ are

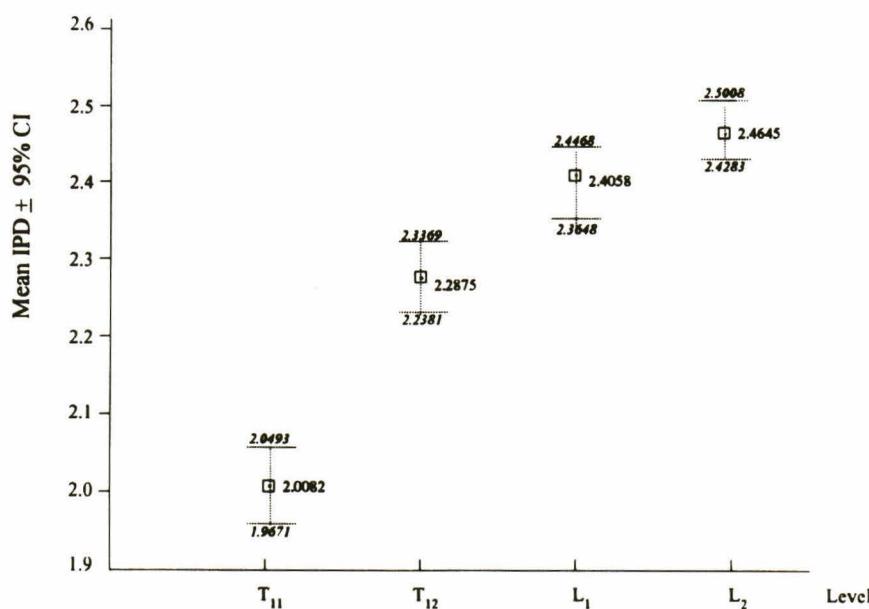


Fig. 4. The means and 95 per cent confidence intervals of the IPD of T₁₁, T₁₂, L₁ and L₂.

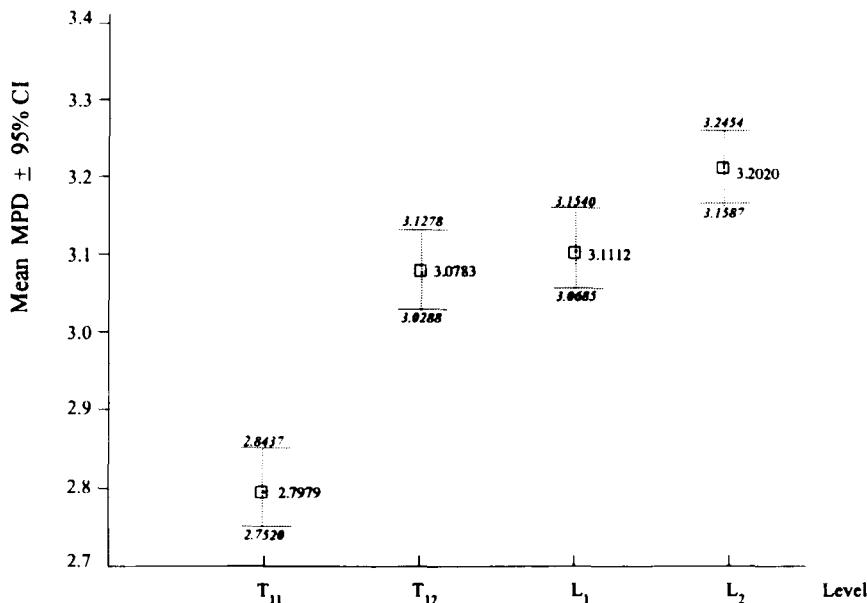


Fig. 5. The means and 95 per cent confidence intervals of the MPD of T₁₁, T₁₂, L₁ and L₂.

presented in Fig. 5. The MPD of each level was significantly different from the others ($p = 0.000$) except T₁₂ and L₁ ($p = 1.000$).

Linear regression

The linear regression model indicated that both IPD and MPD had a statistically significant linear relationship with respect to the level of the vertebrae (i.e. from T₁₁ to L₂) ($p = 0.000$). However, the coefficients of determination (R^2 , IPD = 0.39 : MPD = 0.28) were low, only 39 per cent of the variations among the observed values of the IPD and 28 per cent of the MPD were explained by its linear relationship with the level of the vertebrae.

Reliability

Intra and interobserver reliability for each observer were excellent when comparing each of the IPD and MPD measurements. The intraclass correlation coefficients were very consistent for both methods of measurement ($\rho = 0.97-0.99$); the paired comparisons between observers were similar.

DISCUSSION

The widening of the interpedicular distance has been considered to be one of the characteristic features of a burst fracture of the spine for more than

twenty-five years⁽³⁾. However, to the best of our knowledge, no document or agreement on the definition of "widening" could be found in the literature. Therefore, a variety of definitions were presented in many reports, for example : a focal increase of 4 mm⁽⁴⁾, an increase of 1 mm or more compared with the level above or below⁽⁷⁾, an IPD 2 or 3 mm greater than that at the adjacent levels⁽⁸⁾. The reason for many investigators as well as many clinicians in clinical practice to compare the IPD of the fractured vertebra with the adjacent level below is based on the understanding that the IPD of the normal thoracolumbar vertebra increases gradually from the proximal to the distal levels⁽⁹⁾.

The present study demonstrated that the mean IPD gets progressively and significantly wider from level T₁₁ to L₁, but the mean IPD at L₁ and L₂ are not significantly different. Since T₁₂ and L₁ vertebrae are the most common sites of burst fractures, the clinical relevance of this finding is clear. When a burst fracture occurs at T₁₂, and the IPD of T₁₂ is greater than that of L₁, one can conclude that widening of the IPD T₁₂ has occurred, regardless of how much greater it is. By contrast, for L₁ fractures, it is difficult to compare the IPD L₁ and IPD L₂ and know whether the widening of IPD L₁ has occurred.

The proposed measurement of MPD was not an improvement over the IPD measurement as a comparison of the mean MPD revealed no significant difference between the mean MPD of T₁₂ and L₁. However, a MPD measurement may be helpful when fractures occur at the L₁ level. Since the mean IPD of L₁ did not yield a significant difference from that of L₂, the MPD of L₁ can be used to compare the MPD of L₂ instead to reflect the widening of the pedicular distance.

Hinck⁽¹⁾ in 1966 reported a study on the range of normal IPD, particularly with regard to the variability of their value in any given age group at various spinal levels, but there was no statistical analysis

to demonstrate the comparative relationship of these distances. Although the simple linear regression analysis of both the IPD and MPD of T₁₁ to L₂ vertebrae in the present study showed a statistically significant linear relationship with the level of the vertebrae, the low coefficient of determination indicates that there is much variation in pedicular morphology contour seen on the AP plain film of a normal thoracolumbar spine.

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ระยะจุดกึ่งกลางและระยะระหว่างเพดิคิลของกระดูกสันหลังช่วงอกเอว

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วัตถุประสงค์ : 1. เพื่อแนะนำการวัดระยะกึ่งกลางเพดิคิล (MPD) ให้เป็นทางเลือกในการวัดระยะเพดิคิล
 2. เพื่อวัดระยะระหว่างเพดิคิล (IPD) และระยะจุดกึ่งกลางเพดิคิล (MPD) ของกระดูกสันหลังระดับ T_{11} , T_{12} , L_1 และ L_2 บน แผ่นพิล์มธรรมชาติ ถ่ายทำหน้าหลังของกระดูกสันหลังปกติ
 3. เพื่อศึกษาความสัมพันธ์ของ IPD และ MPD ของกระดูกสันหลังปกติระดับ T_{11} ถึง L_2

รูปแบบการวิจัย : ศึกษาโดยวัด IPD และ MPD บนแผ่นพิล์มธรรมชาติช่วงอกเอว ถ่ายทำหน้าหลัง จากแผ่นภาพ-เอกสารของคนปกติ จำนวน 89 ราย (ชาย 39, หญิง 50) ช่วง อายุเฉลี่ย 47.6 ปี (พิลัย 21-78) การวัดกระทำโดยผู้ศึกษา จำนวน 2 คน ผลการวัดที่ได้ทั้ง IPD และ MPD ของแต่ละระดับ ถูกนำมาเปรียบเทียบและวิเคราะห์โดยใช้ one way ANOVA, สำหรับการศึกษาความสัมพันธ์ของ IPD และ MPD ที่วัดจากระดับ T_{11} ถึง L_2 วิเคราะห์โดยใช้ simple linear regression models

ผลการศึกษา : ค่าเฉลี่ย IPD จะกว้างขึ้นอย่างมีนัยสำคัญทางสถิติ จากระดับ T_{11} จนถึง L_1 ($p = 0.000$) แต่ค่าเฉลี่ย IPD ของ L_1 และ L_2 ไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p = 0.308$)

ค่าเฉลี่ย MPD ของแต่ละระดับมีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p = 0.000$) ยกเว้นค่าเฉลี่ย MPD ของ ระดับ T_{12} และ L_1 ($p = 1.000$)

ทั้งค่า IPD และ MPD ที่วัดได้ในแต่ละระดับตั้งแต่ T_{11} จนถึง L_2 ต่างมีความสัมพันธ์ โดยมีค่าเพิ่มขึ้นตามระดับ เป็นแนวตรง อย่างมีนัยสำคัญทางสถิติ ($p = 0.000$) โดยมี coefficient of determination (R^2) เท่ากับ 0.39 และ 0.28 ตามลำดับ

สรุป : ในเรขาปฏิบัติ การวัดค่า IPD ของกระดูกสันหลังระดับที่มีการหัก เพื่อเปรียบเทียบกับระดับที่อยู่ติดกัน และ ตัดสินว่า มีการกว้างขึ้นนั้น ควรจะกระทำด้วยความระมัดระวัง โดยเฉพาะ การเปรียบเทียบค่า IPD L_1 กับ IPD L_2 การวัด MPD ไม่ได้มีข้อเด่นเหนือกว่าการวัด IPD แต่น่าจะเป็นทางเลือกที่มีประโยชน์ โดยเฉพาะอย่างยิ่งเมื่อมีความจำเป็นต้องเปรียบ-เทียบระยะเพดิคิลของกระดูกสันหลังระดับ L_1 กับ L_2

คำสำคัญ : ระยะจุดกึ่งกลางเพดิคิล, ระยะระหว่างเพดิคิล, กระดูกสันหลังช่วงอกเอว

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