

Changes in the Superior Zygapophyseal Joints in the Lower Thoracic and Upper Lumbar Vertebrae in Babylon Population

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الخلاصة:

ان التغيرات المفصليّة للعمود الفقري تلعب دورا في سراية الوزن بالاضافة الى تأمين مجال واتجاه الحركة بين فقرتين. ان نمط التغيرات في اتجاه هذه التغيرات المفصليّة من الشكل الصدري الى الشكل القطني نادرا ما ذكر في كتب التشريح.

الغرض من الدراسة:

دراسة نمط التغيرات في النَّائِيَّ الْقَارِيَّ الْمُفْصِلِيَّ في مواطني محافظة بابل، العراق.

طريقة العمل:

140 شخص (80 اناث و60 ذكور) تتراوح اعمارهم من 20 - 66 سنة (معدل 46.84 ± 14.438) من مراجعي قسم الاشعة في مستشفى مرجان التعليمي، بابل، العراق، شاركوا في هذه الدراسة. تم التأكد من خلوهم من التشوهات الولادية والمرضية. باستخدام تصوّر مَقْطَعِيّ مُحَوَّسَب (المفراس) ومقاطع محورية، تم دراسة الفقرات الصدرية الاربع السفلية والفقرات القطنية العليا. النَّائِيَّ الْقَارِيَّ الْمُفْصِلِيَّ لوحظ بدقة لمعرفة مكان التغيرات من صدرية الشكل الى قطنية الشكل.

النتائج:

اظهرت الدراسة الحالية ان هنالك نوعان من التغيرات في النَّائِيَّ الْقَارِيَّ الْمُفْصِلِيَّ؛ تدريجي ومفاجئ. 21.42% من الاشخاص اظهروا التغيرات التدريجية في النَّائِيَّ الْقَارِيَّ الْمُفْصِلِيَّ من الشكل الصدري الى الشكل القطني، مع ملاحظة ارتفاع النسبة لدى الاناث عنها في الذكور. كانت التحولات تبدأ عند ص 11-ق2 غالبا، بعض الاشخاص اظهروا تحولات عند ص12-ق2. في حين ان 78.58% من الاشخاص اظهروا التغيرات المفاجئة؛ معظمها عند ص12-ق1 وبشكل اقل عند ص11-ص12.

الاستنتاجات:

في مجموعة الاشخاص التي تم دراستها، من الواضح ان التغيرات في النَّائِيَّ الْقَارِيَّ الْمُفْصِلِيَّ من الشكل المسطح المتجه الى الجهة الخلفية الوحشية والتي هي الشكل الصدري الى الشكل المنحني المتجه الى الجهة الخلفية الانسية والتي هي الشكل القطني، هي غالبية الحدوث بالشكل المفاجئ أكثر مما هي عليه بالشكل التدريجي والاخيرة لوحظت في خمس عدد السكان.

Abstract:

Background: The articular processes of the vertebral column play a role in weight transmission as well as in governing the range and direction of movement between two vertebrae. The pattern of changes of orientation of these particular processes from thoracic to lumbar type was seldom mentioned in anatomical textbooks.

Objective: to study the pattern of changes of zygapophyseal joints in local citizen in Babylon Province.

Methodology: 140 persons (80 female and 60 male) aged 20-66 years (mean 46.84 ± 14.438) attending to radiology department in Marjan Teaching Hospital, Babylon, Iraq, were participated in this study, they were investigated to be free from any congenital anomaly or pathological change. Using computed tomography with axial

sections, the lower four thoracic and upper lumbar vertebrae. The zygapophyseal joints were carefully observed to detect the site of changes in orientation from thoracic to lumbar type.

Results:

The present study revealed that there were two types of change in the orientation of zygapophyseal joint were observed; gradual and sudden.

21.42% of subjects showed gradual changes in orientation of zygapophyseal from thoracic type to lumbar type, with female ratio higher than male. The transition started mainly at T11-L2, some subjects showed transition at T12-L2.

While 78.58% of subjects showed sudden changes; mainly at T12-L1, and to a lesser extent at T11-T12.

Conclusions:

In the group of people who were studied it was clear that the change of the superior zygapophyseal joint from flat, posterolaterally oriented which is thoracic type to curved, posteromedially oriented which is lumbar type is more likely to occur as sudden change rather than the gradual change which observed in about one-fifth of the population.

Introduction:

Until the eighties of last century, it was thought that the weight is transmitted through the vertebral column via the vertebral bodies and the intervertebral discs, with no contribution to the role of articular processes in weight bearing function, the articular processes are considered to determine the range and direction of movement between any two vertebrae. Many textbooks of anatomy and great deal of published investigations^{1,2,3,4}, indicate that the vertebral bodies and intervertebral discs sustain all the vertebral compression force, the magnitude of which increases from the axis vertebra to the lumbosacral joint⁵.

Later on, it has been proved that the neural arch component of a vertebra, beside its contribution to the formation of the vertebral canal and the role of its articular processes in governing the range and direction of movement between two vertebrae, is also involved in weight bearing^{6, 7}. Pal & Routal, on the basis of measurements of the

vertebral column and mathematical calculations, have provided strong evidence for the role of the neural arch in the weight transmission through the cervical and upper thoracic region of the vertebral column.

It was shown that in the cervical part of the vertebral column, an almost equal amount of weight is borne by the body and the neural arch. In fact in the cervical region weight is transmitted through three columns, *i.e.* an anterior column formed by bodies and intervertebral discs and two posterior columns formed by articulations of articular processes⁵.

Few textbooks of anatomy mention that the change in the orientation of the articular process from thoracic to lumbar type usually occurs at the 11th thoracic vertebra (T11), but rarely at T12 or T10. There is no reveal to the pattern of change of orientation in these two regions^{8,9}.

It is clear that the superior articular surfaces of the thoracic vertebrae are flat and face posterolaterally, whereas in the

lumbar region they are curved and face posteromedially¹⁰.

As the thoracic column is concave anteriorly and the line of gravity passes anterior to the vertebral bodies, there is tendency for accentuation of load on the vertebral bodies. Hence the weight acting at the zygapophyseal joints is also transmitted towards the vertebral body (figure 1). This is supported by the fact that the superior articular surface faces posterolaterally and thus would transmit the weight anteromedially to the body through its pedicles. In the lumbar region the line of gravity passes posterior to the vertebral bodies; there is

therefore a tendency for weight to be accentuated on the zygapophyseal joints. The posteromedially facing curved articular surface of the lumbar vertebrae is expected to receive the load from the inferior articular process of the upper vertebra and transmit it anterolaterally to its strong wall¹⁰ (figure 2).

The present study was done to explore the mode of change of zygapophyseal joint in the thoracolumbar junction in Iraqi citizen using a computed tomography.

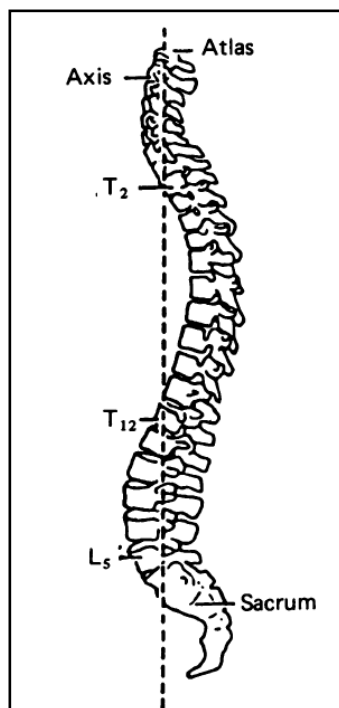


Figure 1: Line of gravity (vertical dashed line) in relation to the vertebral column curvature.

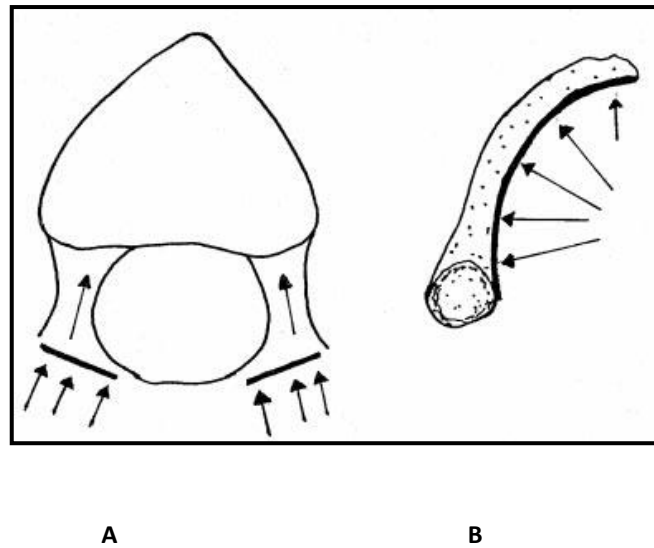


Figure 2: (A) Diagrammatic representation of a typical thoracic vertebra seen from above. From the lateral part of the articular surface forces are transmitted to the pedicle, whereas from the medial part forces are transmitted below to the lamina.

(B) Diagrammatic representation of a transverse section passing through a typical lumbar superior articular process. Forces act at a right angle to the articular surface. The articular surface facing dorsally transmits the load to the pedicle, and a large surface facing medially transmits the forces laterally to the articular process/

Materials and Methods:

140 persons (80 female and 60 male) aged 20-66 years (mean 46.84 ± 14.438) attending to radiology department in Marjan Teaching Hospital, Hilla, Iraq, were participated in this study, they were investigated to be free from any congenital anomaly or pathological change. Using computed tomography type (Philips CT, Brilliance 16 slice) 3 mm thickness, axial sections. A serial cut at the lower thoracic and upper lumbar regions was done; the superior articular processes were carefully noticed of each lower four thoracic and upper lumbar vertebrae to observe the change in orientation of the zygapophyseal joint. The inferior articular processes were not included as they were reciprocally related to the superior articular processes of the vertebra below.

Results:

There were two pattern of change in the orientation of zygapophyseal joint were observed; gradual and sudden.

In general, a vertebra in which both the superior articular surfaces were flat and facing posterolaterally and in which the inferior articular surfaces were flat and facing anteromedially was classified as a thoracic vertebra. Similarly, a vertebra in which both superior articular surfaces were curved and facing posteromedially and in which the inferior articular surfaces were curved and facing anterolaterally was classified as a lumbar vertebra. Any vertebra showing articular surfaces oriented in a different plane (other than just described) were considered to be a transitional vertebra.

In 21.42% of total subjects they show gradual change in orientation of zygapophyseal from thoracic type to lumbar type. The transition started mainly at T11 – L2.

In females, 25% of cases were found to have gradual changes in the orientation of zygapophyseal joint from thoracic type to lumbar type, half of them i.e. 12.5% show gradual changes at T11-L2 and 12.5% were at level of T12-L2. The rest of female (75%) were found to have sudden changes from thoracic to lumbar type; they were divided into two groups: the first one which showed sudden

changes at level of T11-T12 this observed in 37.5%, while in the second one (the remaining 37.5%) the changes were at level of T12-L1 (figure 3).

In male, 16.66% were had gradual changes at level of T11-L1.

The rest of male (83.34%) showed a sudden change at level of T12-L1 (figure 4).

It is observed that the superior articular joints of T11 were thoracic type in all of case studied, and no lumbar type was seen at T11. While at L2, the superior articular joints were all lumbar type, and no thoracic type was seen at L2.

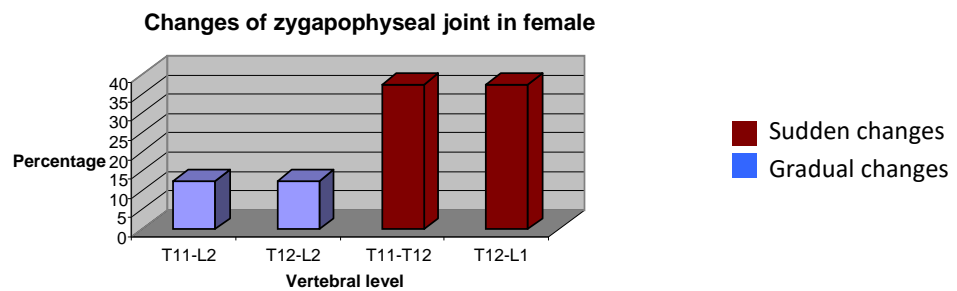


Figure 3: Vertebral levels and percentage of changes of zygapophyseal joint in female.

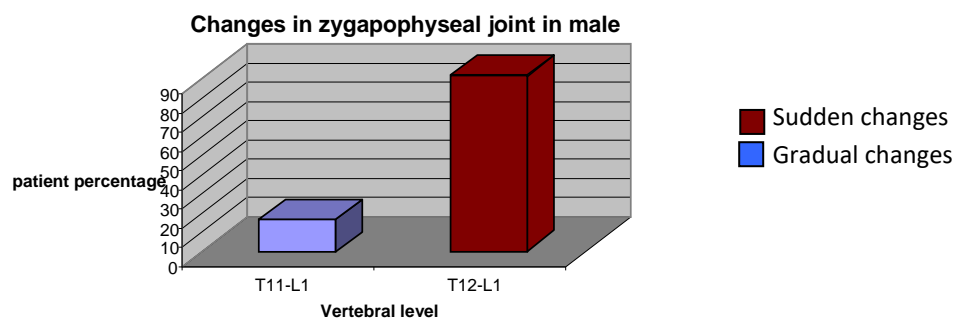


Figure 4: Vertebral level and percentage of changes of zygapophyseal joint in male.

Discussion:

There is general agreement that the primary function of the articulations between the vertebral bodies is load-bearing, while that of the articulations between the articular processes is the limitation of the direction and extent of trunk movement. Undeniably, however, the articular processes also play a load-bearing role, even though such a role complements that of the vertebral bodies.

Many previous studies focused on the pattern of change in the orientation of zygapophyseal joints in thoracolumbar junction and study its clinical relevance.

Davis, Shinohara, and Pal & Routal^{11,12,10}, studied dried vertebral column, while Singer *et al.*, used computed tomography based study to observe the change in zygapophyseal joints¹³.

Davis observed the change as abrupt¹¹, and Singer *et al.*¹³ found that the sudden and gradual changes were in equal proportion. Shinohara reported that in 66% of cases of dried vertebral column collected in Japan, the changes of zygapophyseal joint were sudden; 44% at level of T12-L1 and 22% at T11-T12. In the remaining of cases (34%) the change was gradual. Also he found that age and sex did not showed preferential pattern¹². The present study observed that the gradual change occur in 21.42% of total cases with sexual preference of female (20 cases out of 80) more than in male (10 cases out of 60). According to Williams *et al.* the change in orientation of the articular process from the thoracic type to the lumbar type usually occurs at the 11th thoracic vertebra, but sometimes at the 12th or 10th thoracic vertebra⁹. In the current study we found that the abrupt changes were mainly occurred at level of T12-L1 in male, and in equal incidence at levels of T11-T12 and T12-L1 in female. These findings do

not confirm the previous description of Williams *et al.*

As the thoracic column is concave anteriorly and the line of gravity passes anterior to the vertebral bodies, there is tendency for accentuation of load on the vertebral bodies. Hence the weight acting at the zygapophyseal joints is also transmitted towards the vertebral body. This is supported by the fact that the superior articular surface faces posterolaterally and thus would transmit the weight anteromedially to the body through its pedicles. In the lumbar region the line of gravity passes posterior to the vertebral bodies; there is therefore a tendency for weight to be accentuated on the zygapophyseal joints. The posteromedially facing curved articular surface of the lumbar vertebrae is expected to receive the load from the inferior articular process of the upper vertebra and transmit it anterolaterally to its strong wall. From the superior articular process this load is expected to be transmitted inferiorly to the lamina. The superior articular processes in the lumbar region are curved because they have to embrace the inferior articular processes intimately to receive the load and then to transmit it below to the lamina¹⁰.

We found, in the present study, that the changes in orientation of zygapophyseal joint did not follow a preferential pattern concerning the age of the subject, since the gradual and sudden changes were observed in different age groups, this finding are consistent with that of Shinohara regarding the age but differ with him regarding the sexual preference (as mentioned above).

The orientation of the superior articular joints was adapted to participate in carrying part of the weight in addition to vertebral bodies and

intervertebral discs. Cihak stated that the zygapophyseal joints of lumbar vertebrae, at birth, are all oriented in the coronal plane, similar to the joints of the thoracic vertebrae. However, during postnatal growth their orientation starts to change from the coronal to the sagittal plane. The process of sagittalisation begins at the 6th postnatal month and is completed by the age of 18 months. During this period the articular surface gradually rotates from coronal to sagittal, becoming curved at the same time. It may be said that the period of sagittalisation corresponds to the development of the lumbar curvature which is associated with the child learning to stand erect and walk. Thus the process of 'sagittalisation' of the articular processes in the lumbar region is associated with loading of the zygapophyseal joints. The sagittally oriented curved articular processes are well adapted to bear the load acting at the lumbar zygapophyseal joints¹⁴.

Pal and Routal declared that the change in the orientation of the articular processes is associated with a change in the direction of weight transmission at the thoracolumbar junction. As the line of gravity crosses the T11 and T12 vertebrae, these levels are the most common sites to show transition from the thoracic to the lumbar type of articular process¹⁰. These findings are consistent with our observations in that the sudden changes were mostly at T12-L1. They also reported that, the gradual sagittalisation of articular processes is confined between T10 and L1 vertebral levels. In addition, they observed that the sagittalisation of the articular surface, in the transitional zone always increased with successive vertebrae (craniocaudally). This pattern itself indicates that there is a gradual shift of load from the anterior to posterior components of vertebrae (from bodies to

neural arches). This is also supported by the fact that none of the vertebral columns showed the reverse orientation once sagittalisation is established, i.e. a posteromedial facing or slightly concave surface was never followed by a coronally oriented or posterolateral facing articular surface in the lower vertebrae. Our findings, regarding the gradual changes, they tend to occur at T11-L2 mainly, and to lesser extent at T12-L2. However, as the lumbar vertebrae followed downward, it was observed that the sagittalisation of superior zygapophyseal joint become less in most of cases. These supports the hypotheses of weight transmission through zygapophyseal joints as the lumbar lordosis reach its end and the line of weight transmission tends to shifted anteriorly.

The flat, posterolateral oriented of zygapophyseal joints in thoracic type vertebrae allow the rotational movement of the vertebral column. This movement is restricted by the change of these joints to curved, posteromedial direction which observed in lumbar type vertebrae.

Pal and Routal stated that the gradual transition may help to protect the spine from fracture at the thoracolumbar junction resulting from sudden vertical impact, i.e. a fall from a height. This is because, due to the gradual change, the forces are expected to be transmitted gradually between the anterior and posterior components of vertebrae at the junction of the two spinal curves¹⁰. However, where the change is sudden, the single transitional vertebra has to bear the impact of forces, thus making it more liable to fracture. Similarly, a vertebra showing sudden transition is also more susceptible to torsional injuries. As the torsional stress is resisted by the sagittally oriented facet joint, a vertebra showing sudden transition would bear the maximum

impact of torsional stress. These joints may be the site of origin of low back pain because of their vertical orientation which may lead to the stretching of the joint capsule.

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