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THE COMPARISION OF RADIOLOGICAL DISTANCE DIFFERENCE BETWEEN THE PARS INTER-ARTICULARIS AND PEDICLE, AS A REPRODUCIBLE AND CONSISTENT GUIDE FOR PEDICULAR SCREW FIXATION TECHNIQUE, IN SPINAL LUMBAR SURGERIES.

Orthopaedics

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ABSTRACT

The Inter-Pedicular and Inter-Pars distance was measured in a plain AP radiography (X-Ray) of 150 and 75 CT images normal patients between 18-47 years of age. The aim of the study is to measure the normal Inter-Pedicular and Inter-Pars distance. We found that by studying the anatomical relationship between the inner or medial Pedicular border and the Pars outer or lateral border, gives the Orthopaedic Surgeon a reproducible and consistent guide towards exacting a pedicular screw placing. We found that both X-Ray and CT images shows steady increase in the Ipr and Ipd from L1 to L5, there is a minimal difference from L1-L2 and marked difference seen from L3 to L5, and showing the differences in distances are more in the males, compared to females. The Means of all the groups compared also proves that there is steady raise in the diameter of the IPR and IPD from L1 to L5, where there is dramatical and significant change in the upward direction, noted from L3 to L5. The mean difference is almost constant from L1to L2. So this study, did essentially to help, establish that, the inner medial border of pedicle, is in near relationship to, the outer lateral border of the Pars-Interarticularis, which helps in establishing the latero-medial entry point for the pedicular screw insertion in the lumbar spine.

KEYWORDS

Inter-Pars distance, Inter-Pedicular distance, Pedicle Screw Fixation

INTRODUCTION:

"Lumbar" is derived from the Latin word called as "lumbus," it means lion and is purpose is for both stability and flexibility of the spine. Pars Inter-articularis [fig: 1a&b] (Latin-bridge between two joints) or Pars in short considered as small segment of bone that contacts the superior and inferior facet joints in the vertebral column, in the transverse plane and in axial view the pars, lies between the Lamina and the Pedicle, it forms the bony mass that lies between the superior and inferior facet joints. Anatomically Pars forms the narrowest part of the posterior bony arch, and Bio mechanically Pars is subjected to high stresses during adjacent segment movements in the vertebral column, and has its own important clinical implications.

Krenz et al; studied the normal anatomy of the pars of 4th and 5th Lumbar vertebra in seven cadaver specimens and described that the pars is made up of two dense cortical layers Antero-Lateral and Postero-Medial; the Antero-Lateral being the thickest part (1). The role of Pars Inter-Articularis, in maintaining the structural integrity of the vertebral column is shown in various studies. Ranu et al; analyzed the amount of stress on the pars on the intact and post laminectomised vertebra and found that the Pars is subjected to high stress and also shown to increase when the Posterior Elements are further removed.(2) The concept of Pedicle and Facet screw fixation was first reported in 1940's by King D(3), and later by Boucher et al; (4) used in 1959 and more extensively used by Roy-Camille et.al.,(5) Since then pedicle screw instrumentation is gaining its popularity as its use increased fusion rates, enhanced rigidity, can be used in short and long segment fusion and above all pedicle screw does not require an intact Posterior Elements. The pedicle is considered as the strongest part of the vertebral body where the Posterior Elements of the spine converge to form a bony mass, which attaches to the Anterior Portion, of the vertebral body. It is described as "Force Nucleus" of the vertebra (6).

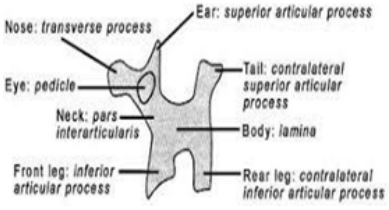

Fig : 1a

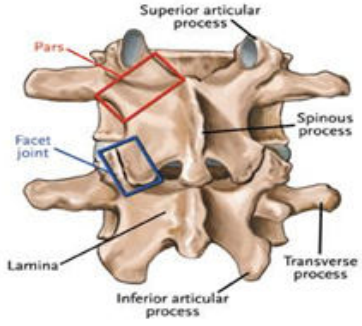

Fig :1b

There are significant number of anatomical and morphological studies mostly focused on the Vertebral body, Pedicles, Spinal Canal, and the

relationship of the Pedicles to Spinal Canal. Till date, there is limited data available regarding the Pars Inter-articularis and its relationship to the surrounding structures, in the south Indian population of the Indian subcontinent.

AIMS AND OBJECTIVES:

To study the relationship between Pars Inter-Articularis with the Pedicle in the lumbar vertebra and to use that relationship as a "Consistent Landmark" for Pedicle Screw insertion, between L1 and L5 vertebra.

To demonstrate that the lateral border of the Pars Inter-Articularis and the medial border of pedicle can be used as a consistent and reproducible anatomical Landmark between L1 to L5 vertebra, to guide pedicle screw placement in a "Free Hand Technique".

MATERIALS AND METHODS:

The study was done by taking normal 150 X-rays and 75 CT's of both the sex, The Inter-Pedicle and Intra-Pars distances of X-ray and CT images of normal patient where then subjected to Computer Based Measurement all patients screened were those admitted in Chettinad Hospital And Research Institute Kelambakkam, Chengalpattu District of Tamil Nadu. Written consent was taken from all patients participating in the study to have their Clinico-Radiographic data published, without compromising on their privacy details.

METHODOLOGY:

A total of 150 normal radio-graphs and 75 normal CT scans were collected from the hospital database of the patients who underwent imaging for routine diagnostic purposes. Computer Based Measurements were taken for both X-ray and CT images and values tabulated.

INCLUSSION CRITERIA:

1. Normal radiography (X-ray) images of Lumbar Spine AP supine of the skeletally mature patients age (18 to 47 years)
2. Normal CT images skeletally matured patients age (18 to 47 years)

EXCLUSION CRITERIA:

1. Radiographs and CT scans with fractures.
2. Radiographs with degenerative conditions.
3. Radiographs with pathological disease conditions.
4. Radiographs with congenital anomaly and the those suffering from metabolic disorders.

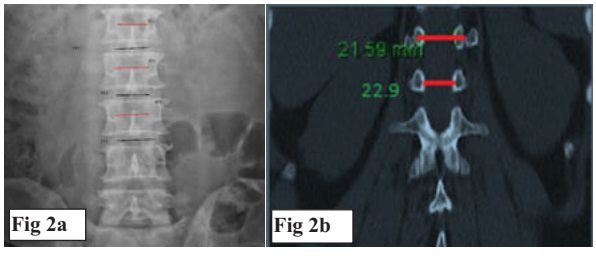

Figure 2a and 2b shows Inter-Pedicle and Inter-Pars distance measurements both in X-ray and CT images of a clinically normal patient.

RESULTS:

TABLE 1 X-RAY [MALE]:

LEVEL	INTER-PARS DISTANCE (Ipr) in mm MEAN distances calculated	INTER-PEDICULAR DISTANCE (Ipd) in mm MEAN distances calculated	Ipr-Ipd/2 in mm MEAN distances calculated
L1	25.5	21.5	2.20
L2	26.5	22.5	2.30
L3	29.5	24.0	2.75
L4	32.0	25.5	3.25
L5	33.6	27.8	3.45

TABLE 2 X-RAY[FEMALE]:

LEVEL	INTER-PARS DISTANCE (Ipr) in mm Mean distances calculated	INTER-PEDICULAR DISTANCE (Ipd) in mm Mean distances calculated	Ipr-Ipd/2 in mm Mean distances calculated
L1	25.0	21.5	1.75
L2	26.0	23.3	1.85
L3	29.0	24.5	2.30
L4	30.2	25.0	2.60
L5	33.0	27.2	2.90

Table 1 and 2 shows te x-ray difference between pars inter-articularis and pedicle in lumbar spine shows, there is increase in the mean diameter from L1 to L5 fo both the sex, where the mean male radiological images shows L1-2.20, L2-2.30, L3-2.75, L4-3.25 ,L5-3.45 and female radiological images shows L1-1.75, L2-1.85, L3-2.30, L4-2.60, L5-2.90. This shows that there is minimal difference in the mean of both the sex from L1-L3 and there is dramatical increase in the diameter from L4-L5 vertebral levels. Male radiographic images shows higher diameter variance than females.

TABLE 3 CT [MALE]:

LEVEL	INTER-PARS DISTANCE (Ipr) in mm Mean distances calculated	INTER-PEDICULAR DISTANCE (Ipd) in mm Mean distances calculated	Ipr-Ipd/2 in mm Mean distances calculated
L1	22.5	19.2	1.65
L2	23.5	20.0	1.75
L3	24.7	20.3	2.20
L4	26.9	21.5	2.72
L5	31.0	25.2	3.60

TABLE 4 CT [FEMALE]:

LEVEL	INTER-PARS DISTANCE (Ipr) in mean Mean distances calculated	INTER-PEDICULAR DISTANCE (Ipd) in mm Mean distances calculated	Ipr-Ipd/2 in mm Mean distances calculated
L1	22.5	19.0	1.75
L2	23.3	19.5	1.90
L3	24.5	20.0	2.25
L4	26.5	22.5	2.66
L5	30.0	24.9	3.15

The table 3 and 4 shows that the CT difference between Pars Inter-Articularis and Pedicle distance in the lumbar spine shows that, there is increase in the mean diameter from L1-L5 for both the sex, where the mean male CT images shows L1-1.65 ,L2-1.75 ,L3-2.20, L4-2.72 ,L5-3.60 and female radiological images shows the diameter from L1-L5 is L1-1.75, L2-1.90, L3-2.25, L4-2.66, L5-3.15. This CT image difference shows that, there is minimal difference in the mean of both the sex from L1to L2 and there is sudden increase in the diameter from L3 to L5 vertebral levels. Males tend to have higher difference than their female to counterparts.

TABLE 5 COMPARISION OF MEAN Ipr-Ipd/2 in all groups, X-ray vs CT imaging.

GROUP	L1	L2	L3	L4	L5
XRAY EVALUATION					
MALE	2.20	2.30	2.75	3.25	3.45
FEMALE	1.75	1.85	2.30	2.60	2.90
CT EVALUATION					
MALE	1.65	1.75	2.20	2.72	3.60
FEMALE	1.75	1.90	2.25	2.66	3.15

In table 5 the means of all the groups compared also proves that there is steady raise in the diameter of of the Ipr and Ipd from L1-L5, where there is significant change noted from L3 to L5. The mean difference is almost insignificant from L1 to L2.

DISCUSSION:

A vast majority of back pains, though not accurately localised, have a limited distribution pattern and arise from a limited part of the spine Kellgren et al; (11). Because most of the complex spinal structures are inaccessible to detailed physical examination, it is necessary to develop ancillary methods of examining them. Pedicles produce visible landmarks on plain Antero-Posterior Radiographs and therefore Inter-Pedicular distances can be measured accurately. Mean Inter-Pedicular distance vary among different age groups, and between the two sexes Hinck et al; (9).Normally, these distances increase steadily from LI to L5, but it has been reported by Weir and Abrahams et al; (10) that the distances can actually decrease from above

downwards in congenital anomalies like, mongolism (Trisomy 21).
The pedicle is considered as the strongest part of the vertebral body, where the posterior elements of the spine converge, to form a bony mass which attaches to the anterior portion of the vertebral body. It is described as "Force Nucleus" of the vertebra (14). Being the strongest portion, pedicle is considered as an ideal point force for pedicle screw placement. When properly placed screw is used along with a screw-rod or screw-plate configuration, the ability to apply compression, distraction and rotational force across the spinal segments have been greatly enhanced, in order to address various deformities and other pathological clinical conditions .

In the present study of both Male and Female radiological imaging, shows there is an increase in the Inter-Pedicular [Ipd] and Inter-Pars [Ipr] distances from L1 ot L5. From L1 to L2 there is slight co-relation between both the sex, but there is a sudden upward variation in distance from L3 to L5. E. Yee et al; (7) in their cadaveric study measured the average width of the Pars from L1 to L5 vertebra from the medial edges of the Pedicle on the ipsilateral side, following a serial laminectomy from mid-line to the medial border of the pedicle. Hinck et al. (8), in which inter-pedicular distances increased with age, and were higher in males, it seems reasonable to suggest that growth of the vertebral column and definitive build of the individual play important roles in determining the width of the lumbar spinal canal.

There were studies documented on the Inter Pars Distance at lumbar level by Austin peters et al(11) analyzed 265 vertebra and demonstrated that there is gradual increase in the Inter Pars distances from L1 to L4 and the Inter-Pars distance increased dramatically from L4 to L5 and also found that the trend was similar in both the males and females. In the present study the comparison of both X-Ray and CT images [table 1-4], shows steady increase in the Ipr and Ipd from L1 to L5, there is a minimal difference from L1-L2 and marked difference seen from L3 to L5, and showing the differences in distances are more in males compared to female. Tarek Aly et al(12) measured the Inter-Pedicular Distance along with other parameters in 300 normal Egyptian population using CT scan from L1 to S1and demonstrated that the inter-pedicular distance showed a steady increase from L1 to L5.

In table 5 the Means of all the groups compared also proves that there is steady raise in the diameter of of the IPR and IPD from L1 to L5, where there is dramatical and significant change in the upward direction, noted from L3 to L5. The mean difference is almost constant from L1to L2.

CONCLUSION:

There is a Cranio-Caudal increase of transverse diameter of Ipd and Ipr from L1to L5 vertebrae. Dimensions of the male populations are significantly higher in comparison to the female population.The present study confirms that there is a racial variation in the size of the lumbar vertebral canal. The sizebale sample of the study, provides a fair idea to the Orthopaedic surgeon, about the ranges of Ipr and Ipd and , it also helps the surgeon to determine the free hand technique for the pedicle screw insertion as the pars lateral border and pedicle medial border lies close to each other. However, since there is no room for complacency in this regard, nowadays imaging is always done, intra-operatively by Image Intensifier images, in both views. By studying the anatomical relationship between the inner or medial Pedicular border and the Pars outer or lateral border, gives the Orthopaedic Surgeon, a reproducible and consistent guide towards exacting a pedicular screw placing. The study, further establishes that the inner medial border of pedicle is in near relationship to, the outer lateral border of the Pars-Interarticularis, which helps in establishing the latero-medial entry point for the pedicular screw insertion in lumbar spine.

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