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Morphometric Study of lumbar vertebral pedicles using CT axial sections: pedicle width, chord length and inclination angle.

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Abstract: *The aim of this study is to determine the dimensions of lumbar pedicles, carried out to find an index for the Jazan population (KSA) inorder to deduce safety parameters for surgical procedures placements in lumbar region, the correlations between these parameters were according to age, gender and lumbar level.CT scan axial images were taken .200 patient images were analyzed, L1 - L5 (1000 vertebrae,2000 pedicles) with the mean age of the total patients was 40years old. Pedicle width, axial length, and transverse angle were determined in each axial image.*

The results suggested that the largest mean lumbar pedicle width was seen at vertebral level L5 in both males (12.99±1.29mm) and females (13.024±1.05mm) and the least was at vertebral level L1 in both males (5.56±.95mm) and females (5.39±.68mm). The lumbar pedicle width increased gradually from L1 to L5 in both males and females .The mean pedicle width in males was (8.39 ± 1.23mm) and in females was (8.47 ± 1.17 mm). The mean pedicle chord length in males was (49.89± 2.30 mm) and in females was (49.71 ± 2.06 mm). The largest mean lumbar chord length was seen at vertebral level L5 in both males (50.66±2.25mm) and females (50.80±2.26mm) and the least was at vertebral level L1 in both males (49.08±2.12mm) and females (48.83±1.83mm).Lumbar vertebrae increased gradually from L1 to L5 in both males and females pedicle chord length. There were gradually increase in the degree of angles from L1- L5,the maximum transverse pedicle angle found to be among female at L5=(30.70^o)and minimum transverse pedicle angle found in both males and females (13^o) at L3.The mean transverse pedicle angle of the pedicle in males was 21.18^o ± 2.40 and in females was 19.24^o ± 2.33. Significant differences were observed (P<0.05) when groups were compared. The current study established the dimensions of the pedicle for Jazan population (KSA).which might be of great value for successful pedicle screw fixation

Keywords - *pedicle, vertebra, morphometry, lumbar, transpedicular*

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I. INTRODUCTION

The morphometric dimensions of the vertebral pedicle determine the size and shape of pedicle screws [1]. There are no studies to date in the morphometric dimensions of the lumbar vertebral pedicle among Saudi Arabia Jazan population[2] even there are no existed reports about the vertebrae in Saudi population [3] Most patients with spinal fusion surgery prefer transpedicular fixation over other fusion methods since it has replaced many other techniques [4,5].It became the nineteenth most popular surgical procedure in 2003, and it increased from 22 to 51 procedures performed per 100,000 inhabitants [6].In order to examine lumbar vertebral morphometry, many studies were applied [7,8]as awareness, significance the precision of the lumbar spine anatomy which is crucial not only for finding the biomechanical and dynamic characteristics of the spine, but also for various interventions [9].Due to its dynamic nature, the lumbar region is particularly vulnerable to injuries arising from road traffic accidents, use of heavy mechanical devices and adventure sports besides surgical procedures as well as other different conditions[10].Screws are used to attach various devices to the spinal column for immobilization.[11].The use of implants requires an accurate screw path and a good quality of bone for screw reinsertion [12].Transpedicular screw insertion procedures have gained favor in recent years [13].The pedicles' particular architecture makes them an ideal location for screw implantation in reconstructive spine procedures to maintain and restore stability .[14]A mismatch in pedicle and screw size can result in screw loosening, pedicle fracture, and other damages [13-15].The screw path is determined by the transverse width and height of the pedicle. The CT scan has been established as the best method of evaluating pedicle radiographic morphology [15].However, according to many studies [13 -16-17]., there is no significant statistical difference between data collected from CT scan and direct cadaveric measurements. The morphological features of the

vertebrae, and especially the pedicle, determine the size of the implants in both width and length, as well as the ideal shape, direction and angle of the screw at the time of insertion [18].Due to inadequate placement or wrong screw orientation, the surgeon must be aware of these traits in order to avoid problems [19-20].The aim of this study is to determine the morphometric variability of the lumbar vertebral pedicle among Saudi Arabians(Jazan population) by using CT scan and hence provide morphometric data of crucial parameters useful for a precision designing and placement of lumber pedicle screw.

II. MATERIALS AND METHODS

This study performed an observational, cross-sectional, descriptive, and prospective study by analyzing 200patients, L1 to L5 (1000 vertebrae,2000 pedicles) The mean age of the total patients was 40.79 years (range between 19 and 75 years), with the mean age of 100 male being 41.6 years (range 21–75years) and the mean age of 100 female patients being 39.9 years (range 22–66 years).The 2000 vertebrae were analyzed with CT scans, patients were selective randomly according to their fulfilling the inclusion criteria [age above 18] and exclusion criteria [patients with a certain degree of skeletal pathology which was interpreted by their chronic back pain, back pain related to age factor, arthritis prior back surgery, pregnancy and degenerative conditions, spondylolisthesis, retrolithesis, and disk space collapse. The study was carried out between March 2016 and April 2019.The study was conducted at Jazan region [Saudi Arabia], cases collected from governmental hospitals CT scanner departments. The patients were informed of the exam subject and all information was used with confidentiality, no patient data were published also the data was kept in personal computer with personal password.

Measurement Method:

For all patient axial plane are obtained using slice thickness 3-10 mm for all planes, the study was executed using multi-detector computed tomography scanner MDCT[8-Slice scanner,16 slice,64 slice,128slice (0.625mm slices): 0.625mm collimation, table feed 10 mm/rotation, effective tube current 685 mAs at 120 kV. Pitch = 10/40 mm collimation = 0.25. Average scan time = 5 s, fan beam shape, CT monitor for controlling scanning and processing and PACS system, the images were measured on bone window settings, cases were diagnosed by a senior radiologist in Jazan university and the various morphometric software parameters were measured using DICOM viewer.[Radiant DICOM Viewer 4.6.9 (64-bit) reviewed April 14, 2019].We determined if significant differences existed between the mean values of the various parameters studied using a parametric correlation test (Student's t test), considering a P value < 0.05 as significant.

Measurements parameters [Figure1]

Measurement parameters were carried out using the following;

[1] Pedicle width(PDW)in (mm) were measured bilaterally, It is the distance between medial and lateral surfaces of pedicle at its midpoint, measured at right angles to the long axis of the pedicle also known as (isthmus), transverse or axial width, as proposed by (Zindrick et al.1987)[12].

[2] The pedicle axis length (PDAL) in (mm) also known as; (Chord length) or (screw path length) It is the distance from the most posterior aspect of the junction of the superior facet and the transverse process to the anterior cortex of the vertebral body along the pedicle axis on the axial plane, as described or reported by (Olszewskiet al. 1990) [18].

[3] Transverse Pedicle angle (TPA) (in degree) also known as; Chord angle is determined the transverse pedicle angle. It is the angle between a line passing through the pedicle axis and a line parallel to the vertebral midline in the transverse plane.

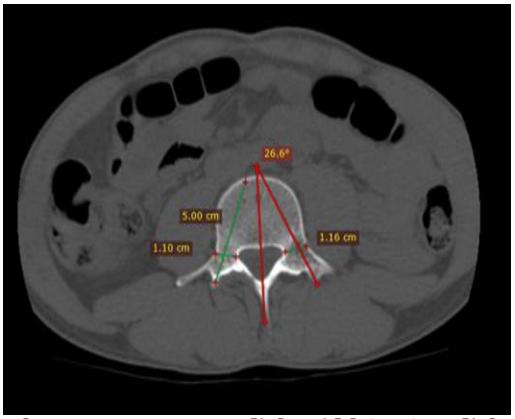

Figure1: demonstrated the three parameters: Pedicle width(PW),Pedicle axial length(PDAL) in (mm) and Transverse pedicle angle(TPA) in degree at Lumbar level four

III. RESULTS

Pedicle width (PDW):

The range (in mm) for the right pedicles width of the lumbar vertebrae [L1, L2, L3, L4 and L5] were (4.00 -9.23,4.80-9.06,5.00-9.80,8.00-12.90 and 10.00-15.70) and(4.00-9.87,4.90-9.06,5.00-9.70,8.00-12.90 and9.00-15.50) for the Left pedicles width respectively. The mean pedicle width of the pedicle on the left side was (8.43 ± 0.95439 mm) and on the right side was (8.42 ± 0.95683mm). The mean±SD (in mm)for the males were(5.56±.95),(5.98±.653),(7.67±.75),(9.74±.900)and(12.99±1.29)and(5.39±.68),(6.04±.83),(7.89±.65),(9.99± 1.17) and 13.02±1.05) for the females respectively.

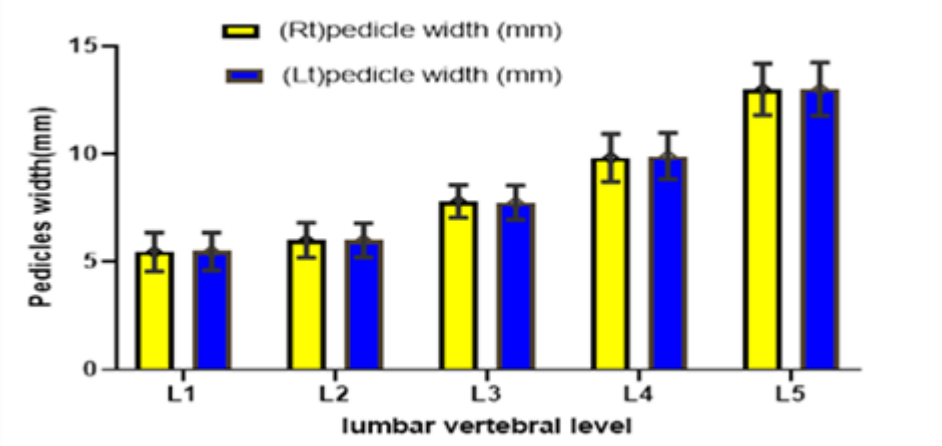

Figure 2: Bar chart demonstrated comparison of the mean values and SD between the right and left pedicles width at each lumbar vertebral level.

The pooled data of gender are listed in(Table 1).The results suggest that the average pedicle width L3 is less for male (M = 7.67±0.74) than for female (M = 7.89±0.65), t(198) = -2.156, p =0.032(P<0.05),whereas the results for other levels suggest no significant difference (P>0.05) between males and females t(198) = (L1=1.498, P =0.13), (L2= -.622, P= 0.535),(L4= -1.760,P=.080)and(L5= -.188,P=.851) respectively. The largest mean lumbar pedicle width was seen at vertebral level L5 in both males (12.99±1.29) and females (13.024±1.047) and the least was at vertebral level L1 in both males (5.56±.948) and females (5.3901±.68104) .The minimum (5.39mm) and maximum (13.023mm) readings for both male and female pedicles width were noted both at (female L1) and (female L5) respectively. In all the vertebral levels, the mean pedicle width was slightly larger in females than in males and the difference was statistically insignificant (p >0.05) except at vertebral level L1 .The result in (Table 1) demonstrated that lumbar vertebrae increased gradually from L1 to L5 in both males and females, the largest PDW was located at female L5 (13.024 mm) and the smallest PDW was located at female L1 (5.39 mm). The mean (PDW) of the pedicle in males was (8.39 ± 1.23) mm and in females was 8.47 ± 1.17 mm.

Table 1: Demonstrated comparison of (PDW) of lumbar vertebrae (L1 -L5) between gender using independent sample t-test ,the results are expressed in mm.

		Male	Female	T-values	Significance
L1	Mean	5.56	5.39	1.498	0.138
	SD	.95	.68		
	Maximum	9.44	9.07		
	Minimum	4.34	4.25		
L2	Mean	5.98	6.04	-.622	0.535
	SD	.65	.83		
	Maximum	8.00	9.03		
	Minimum	4.85	5.00		
L3	Mean	7.67	7.89	-2.156	**.032***
	SD	.74	.65		
	Maximum	9.35	9.50		
	Minimum	5.17	6.05		
L4	Mean	9.73	9.99	-1.760	0.080
	SD	0.900	1.17		
	Maximum	11.85	8.15		
	Minimum	8.25	12.90		
L5	Mean	12.99	13.02	-0.188	0.851
	SD	1.29	1.05		
	Maximum	15.60	15.25		
	Minimum	9.50	10.95		

First lumbar vertebra (L1)second lumbar vertebra (L2)third lumbar vertebra (L3)fourth lumbar vertebra (L4) fifth lumbar vertebra (L5) ,SD=standard deviation**,.* p<0.05** between female and male at each lumbar level. The post-hoc ,Bonferroni-corrected pair wise analysis demonstrated that the mean pedicle width at vertebral levels L5 in the lumbar spine was significantly larger in older age categories (more than 55) than in younger age category(26-35) ($p \leq 0.05$) (Table 2). No significant differences were found between the mean pedicle width and both categories in all the other lumbar vertebral levels.

Table 2: Pair wise (post hoc Bonferroni) comparison of the mean pedicle width between younger and older categories. *Statistically significant value

Vertebral Levels	26-35years Vs> 55years (p-value)
L1	.160
L2	.075
L3	1.000
L4	1.000
L5	0.000*

This study has established an equation to predict the correlation coefficient between the pedicle width and age for Saudi –Jazan region population of a known age with correlation significant at ($p \leq 0.05$) ,**R^2 =.122. Pedicle width(PDW) =8.58+0.015*age.(Table 3).**Our study also convinced that there was positive linear relationship between thepedicle width and age among participants according to the scatter plot diagram (Figure.3)

Table 3: Demonstrated correlation coefficient between the Pedicle width and age:

	Unstandardized Coefficients		Standardized Coefficients		
Age (Constant)	B	Std. Error	Beta	T	Sig
	.015 8.576	.003 .118	.349	5.240 72.456	.000 .000

Established equation to predict the pedicles width for Saudi –Jazan region population of known age. Correlation is significant at ($p \leq 0.05$) ,**R^2 =.122. Pedicle width(PDW) =8.58+0.015*age.**

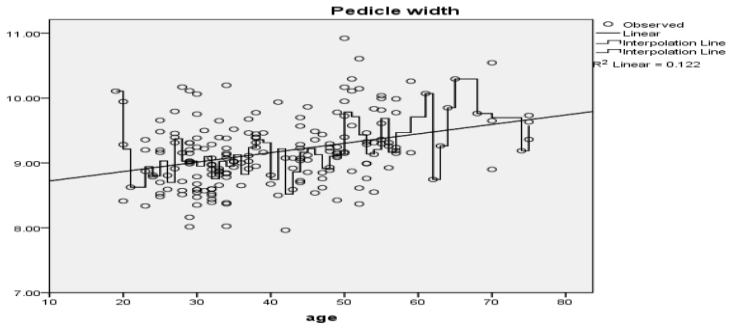

***Figure 3: A scatter plot diagram demonstrated the positive linear relationship between the pedicle width and age among Jazan population*.**

The overall results of the mean values, SD and range of pedicles width (PDW) of lumbar vertebrae (L1-L5),for the total participants Jazan population were (L1=5.48±.828, L2 6.012±.74, L37.78±.71, L49.87±1.049 and L513.008±1.176) respectively(Figure 4) and the (Mean value for the PDWs (L1 to L5) =(8.43 mm ± 1.432805). The result depicted gradually increase of the mean values from L1 to L5. This finding was supported by most of pedicles width measurement in different populations with slight differences such as; Amonoo Kuofi (1995 in Saudi Arabians),Kim et al (1994 in Koreans) .

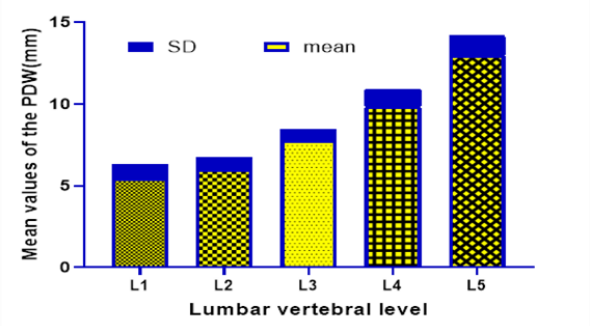

Figure 4: Bar chart demonstrated the mean values (mm) and SD of the (PDW) at each lumbar vertebral level among participants

The results of pedicle width in our study when compared with different populations demonstrated these studies depicted corresponding with our study in gradually increase in pedicle width from L1 to L5, (Olmos,Tomé,2002[20]; Urrutia Vega, et al.,2009[28]; Lien,2007[29]; Li,B et al, 2004 [30];Nojiri,et al.,2005 [31] ;Acharya, et al,2010[26] ; Kang,et al.,2011[32] ; Amonoo-Kuofi,1995[33] ; Singel,et al 2004[34] ; Olsewski, et al.,1990[18] ;Wolf,et al., 2001[35] and Maaly, et al 2010 [36]).There was a great variation between our results with some other races and ethnicities at each vertebral level in the mean values, although some populations showed close or slightly close corresponding with our results such as; Turkish (Kadioglu, et.al 2003 [37]), Israelis (Wolf, et al.2001[34]), Indians (Acharya,et al2010[26]), Chinese (Li Jiang, et al.(2004)[30], Mexicans (UrrutiaVega, et.al 2009)[28] and Japanese(Nojiri, et al.2005)[31].

Pedicle axis length (PDAL): (Chord length) or (screw path length):

Screws or chord length appeared to be safe at all lumbar levels when minimum mean chord length was determined previously[19].

The comparison between gender in relation to pedicle axis length (PDAL)or chord length or screw pathway showed there were significant between males (49.08±2.13,49.97±2.57,50.07±2.78,49.70±1.52 and 50.66±2.25) and females (48.84±1.84,49.45±2.25,49.91±2.63,49.56±1.35 and 50.80±2.26) respectively. The pooled data of males and females are listed in(Table 4). The mean pedicle axial length was slightly larger in males in L1-L4 (in L5 the mean of females were larger than in males)than in females and the difference was statistically insignificant (p >0.05) (Table 4.).The mean (PDAL) of the pedicle in males was 49.89± 2.30 mm and in females was 49.71 ± 2.06 mm. The largest mean lumbar chord length was seen at vertebral level L5 in both males (50.66±2.25) and females (50.80±2.26) and the least was at vertebral level L1 in both males (49.08±2.12) and females (48.83±1.83). The minimum (48.83 mm) and maximum (50.80mm) readings for both male and female pedicle axis length were noted at (females L1) and (females L5) respectively. The result in (Table 4) demonstrated that the lumbar vertebrae increased gradually from L1 to L5 in both males and females

(PDAL) ,the largest (PDAL) was located at female L5 (50.80 mm) and the smallest (PDAL) was located at female L1 (13.19 mm).

Table 4:Demonstrated the mean values of the (PDAL) or chord length of (L1 -L5) between gender using independent sample t-test ,the results are expressed in (mm).

		Male	Female	T-values	Significance
L1	Mean	49.08	48.83	879	.380
	SD	2.12	1.83		
	Maximum	54.40	54.40		
	Minimum	46	46		
L2	Mean	49.96	49.44	1.523	.129
	SD	2.56	2.25		
	Maximum	59	59		
	Minimum	46	46		
L3	Mean	50.08	49.91	.435	.664
	SD	2.80	2.62		
	Maximum	57.70	57.70		
	Minimum	46.80	46		
L4	Mean	49.69	49.56	.654	.514
	SD	1.52	1.35		
	Maximum	55.80	55.90		
	Minimum	47	47.40		
L5	Mean	50.66	50.80	-.442	.659
	SD	2.25	2.26		
	Maximum	56	56.20		
	Minimum	47.10	47.80		

First lumbar vertebra (L1)Second lumbar vertebra (L2)Third lumbar vertebra (L3)Fourth lumbar vertebra (L4) Fifth lumbar vertebra (L5) ,SD=standard deviation,. P>0.05 statistically not significant between female and male at the lumbar level. Post-hoc,Bonferroni-corrected pairwise analysis demonstrated that the mean pedicle chord length at vertebral levels L1,L2 and L3 in the lumbar spine was significantly larger in younger age categories (26 -35 years) than in older age category(>55years) ($p \leq 0.05$) (Table 5). No significant differences were found between the mean pedicle chord length and both categories in L4 and L5 lumbar vertebral levels.

Table 5: Depicted Pair wise (post hoc Bonferroni) comparison of the mean Chord length of younger and older categories of Jazan population. *Statistically significant values (P<0.05)

Vertebral Levels	26-35years **Vs**> 55years p-value
L1	.002*
L2	.000*
L3	.000*
L4	1.000
L5	0.202

Our study has established an equation to predict the correlation coefficient between the Pedicle Chord length(PDAL) and age for Jazan region population of a known age with Correlation significant at($p \leq 0.05$),R2=.138.**Chord length (PDAL) =51.611+(-.044)*age.**(Table 6).Correlation Coefficient between the (PDAL) and age was also depicted in a scatter plot diagram which showed the negative linear relationship between the pedicle chord length (PDAL) and age(Figure. 5).

Table 6: Demonstrated Correlation Coefficient between the Pedicle Chord length(PDAL) and age

	Unstandardized Coefficients		Standardized Coefficients		
Age (Constant)	B	Std. Error	Beta	T	Sig
	-.044 51.611	.008 .336	-.371	-5.629 153.707	.000 .000

stablished equation to predict the Pedicle Chord length(PDAL) for Saudi –Jazan region population of known age. Correlation is significant at($p \leq 0.05$),R^2=.138 .**Chord length (PDAL) =51.611+(-.044)*age.**

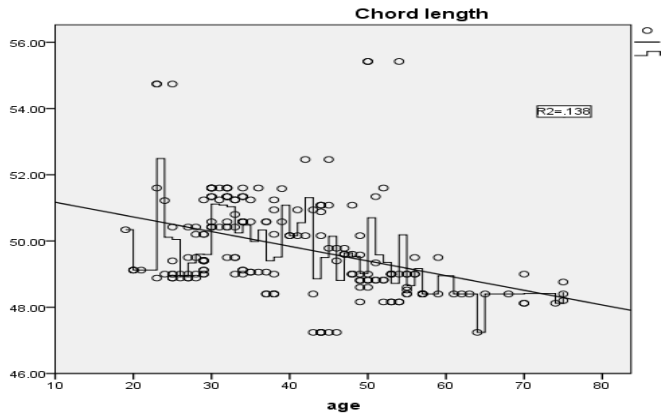

Figure 5:Ascatter plot diagram demonstrated the negative linear relationship between the pedicle chord length (PDAL) and age

The overall result of measurements of the (chord length) (PDAL) of the lumbar vertebral among the 200 participants showed, L1(48.96), increased gradually to L2 (49.71), L3(49.99), then reduced suddenly in L4 (49.63),then increment again in L5 (50.73).,our measurements in (PDAL) were in line with that of other studies. (Figure.6).

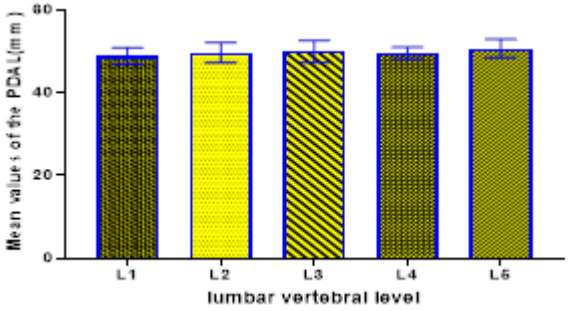

Figure 6: Demonstrated Bar chart showing dimension of (PDAL) mean values (mm) and SD in sample at each lumbar vertebral level between participants.

The results of(PDAL)showed that there were not a greater variation in the mean values of vertebra levels of our study (49.80mm) and others some populations such as; (Ebraheim et al[19] 48.87mm,USA) and India (Acharya et al[26] 47.68mm,India), whereas the greater variation shown between our study and population of (Tan et al[27]41.78mm,Singapore) ((Figure.7).

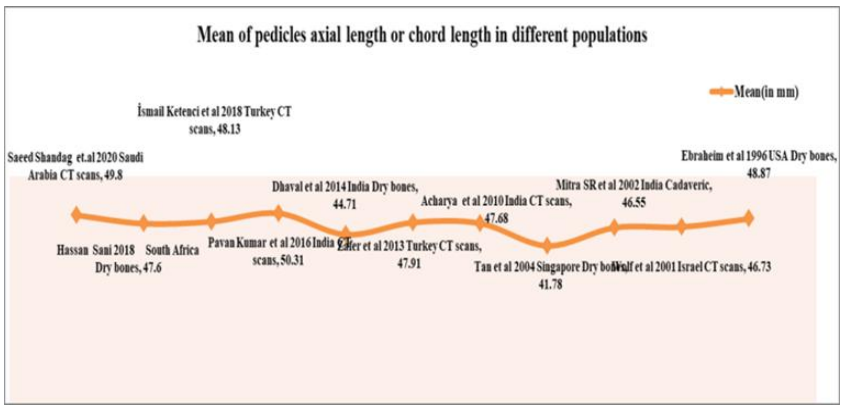

Figure 7: Chord length of lumbar vertebral pedicles obtained in studies performed in different populations.

Transverse pedicle angle (TPA):

Knowledge of transverse pedicle angle is important while placing screws because any inadvertent medial perforation due to wrong placement of the pedicle screw can put the spinal cord at risk or cause vascular injury [21] it's the angle of screw path inclination. The results of the comparison of the mean values of(TPA)at L1to L5 between males and females suggested that no significant difference between males (L118.71^{o} ±1.97,L219.21^{o} ±1.92,L319.94^{o} ±1.76,L4 22.32^{o}±2.28 and L5 25.71^{o} ±3.19) and females (L118.49^{o} ± 2.01,L2 19.20 ^{o} ±1.78,L3 19.90 ^{o} ±1.80,L4 22.44 ^{o} ±2.22 and L526.16^{o}±2.76)respectively. L1 (0.76,p=0.45),L2(0.04,P=0.96),L3(0.19,P=0.85),L4(-0.40,P=0.68)andL5(-1.07,P=0.29) respectively. The pooled data of males and females are listed in (Table 7). The results of the TPA showed gradually increase in the degrees of angles from L1 to L5,the maximum TPA found to be among female at L5=(30.70 $^{o)}$ and minimum (TPA) found in both males and females (13 ^{o}) at L3.The mean (TPA) was slightly larger in males in than in females and the difference was statistically insignificant (p >0.05) (Table 7).The mean (TPA) of the pedicle in males was 21.18^{o} ± 2.40 and in females was 19.24^{o} ± 2.33. The largest mean lumbar transverse pedicle angle was seen at vertebral level L5 in both males (25.71^{o} ±3.19) and females (26.16 ^{o} ±2.76) and the least was at vertebral level L1 in both males (18.71^{o}±1.97) and females (18.49^{o}±2.01).The largest (TPA) was located at female L5 ((30.70^{o}) and the smallest (TPA) was located at female L1 (18.49^{o}).

Table7: Demonstrated comparison of (TPA)of (L1-L5) between gender using independent sample t-test ,the results are expressed in (degree).

		Male	Female	T-values	Significance
L1	Mean	18.71	18.49	0.76	0.45
	SD	1.97	2.01		
	Maximum	22.90	22.90		
	Minimum	14.70	14.70		
L2	Mean	19.21	19.20	0.04	0.96
	SD	1.92	1.78		
	Maximum	23.50	22.40		
	Minimum	14.70	14.70		
L3	Mean	19.94	19.90	0.19	0.85
	SD	1.76	1.80		
	Maximum	23.70	23.70		
	Minimum	13	13		
L4	Mean	22.32	22.44	-0.40	0.68
	SD	2.28	2.22		
	Maximum	26.60	26.60		
	Minimum	18	18.50		
L5	Mean	25.71	26.16	-1.07	0.29
	SD	3.19	2.76		
	Maximum	30	30.70		
	Minimum	14	14		

First lumbar vertebra (L1)Second lumbar vertebra (L2)Third lumbar vertebra (L3)Fourth lumbar vertebra (L4) Fifth lumbar vertebra (L5) ,SD=standard deviation,. P>0.05 statistically insignificant between female and male at the lumbar level. The results of the post-hoc, Bonferroni-corrected pairwise analysis convinced that the mean (TPA) at all vertebral levels L1-L5 in the lumbar spine was significantly larger in older age categories(> 55) than in younger age category(26-35) (p≤ 0.05) (Table.8)

Table 8: Pair wise (post hoc Bonferroni) comparison of the mean transverse pedicle angle of younger and older categories of Jazan population. *P<0.05 statistically significant differences

Vertebral Levels	26-35years Vs> 55years p- value
L1	.002*
L2	.000*
L3	.000*
L4	.006*
L5	.000*

Our study has established an equation to predict the correlation coefficient between the Transverse pedicle angle(TPA) and age for Jazan region population of a known age with Correlation significant at($p \leq 0.05$),R^2=.002**. Transverse pedicle angle(TPA)=19.249+.005*age.** (Table 9).Correlation Coefficient between the (PDAL) and age was also convinced in a scatter plot diagram which depicted the positive linear relationship between the transverse pedicle angle (TPA) and age.(Figure.9).

Table 9: Correlation Coefficient between the Transverse pedicle angle(TPA) and age

	Unstandardized Coefficients		Standardized Coefficients		
Age (Constant)	B	Std. Error	Beta	T	Sig
	.005 19.249	.009 .369	.042	.591 52.226	.555 .000

Established equation to predict the transverse pedicle angle (TPA) for Saudi –Jazan region population of known age. Correlation is significant at($p \leq 0.05$),R^2=.002**.transverse pedicle angle(TPA)=19.249+.005*age.**

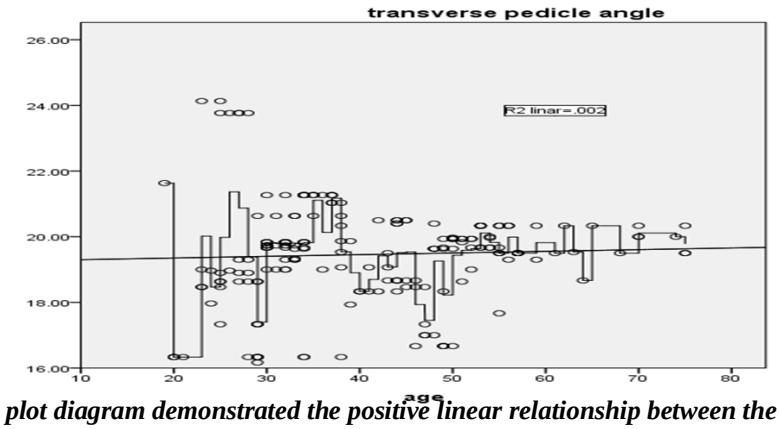

Figure 8: Ascatter plot diagram demonstrated the positive linear relationship between the transverse pedicle angle (TPA) and age.

The overall result of the mean values of the (TPA) of the lumbar vertebrae among the 200 participants showed gradually increase from ,L1(18.59^o), L2 (19.20^o), L3(19.92^o),L4 (22.38^o) and L5 (25.93^o). (Figure.9)

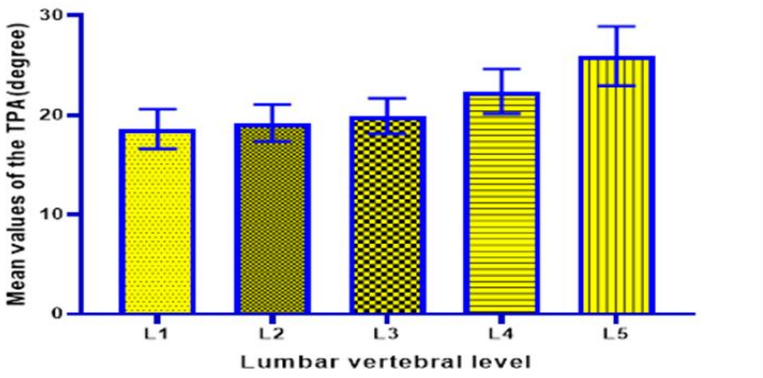

Figure 9: Bar chart showing dimension of (TPA) mean values in (degrees) and SD in sample at each lumbar vertebral level between participants

When the result of our study mean values for the (TPA) in(degrees) compared with other populations in the world the results depicted that the mean value of our study of the (TPA) (21.21^o) was totally different with some populations such as; USA(28.82 ^{o}),Israel(12.42 ^{o}),India(11.24 ^{o}),Taiwan(13.73 ^{o}) ,Pakistan(16.6 ^{o}) whereas there was no greater variation shown between our study and some populations of Burkina Faso (21.58 ^{o}) and Black South Africans (24.18^o)(Figure.10).

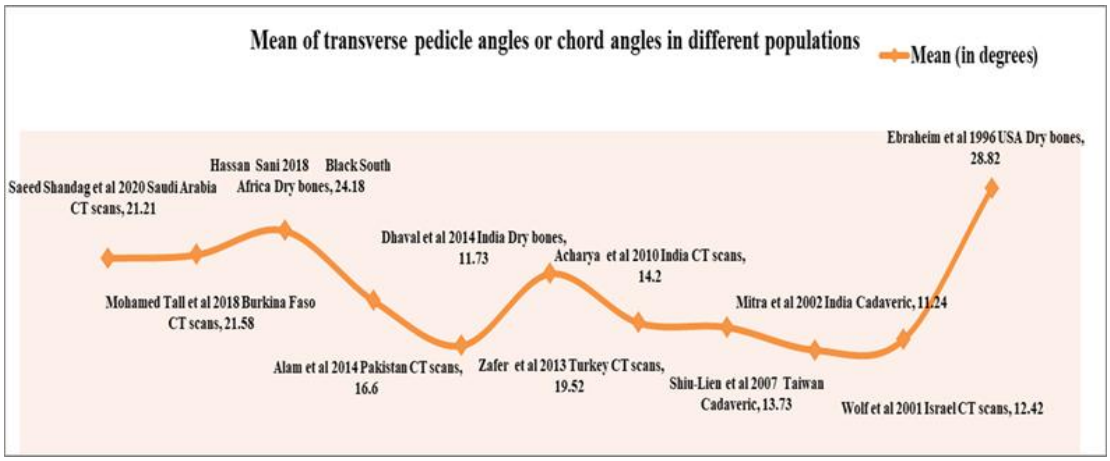

Figure 10. Demonstrated transverse pedicles angle of lumbar vertebral pedicles obtained from studies performed in different populations.

IV. DISCUSSION

The pedicle width range for typical lumbar vertebrae has been mentioned previously [23] as 4- 17 mm, and as 5 - 17 mm[17], and as 4.5- 20 mm[24], compared to (4.25mm -15.60mm) in the current study. The average diameter of our study pedicle width is 8.43mm; hence 5.5 to 7.5 mm screw would be safiest with the Jazan population. A lumbar pedicle with a width of 8.43 mm will easily accommodate a 7.5 mm screw, especially if the pediculation is done under fluoroscopy or computed tomography scan guidance.

The total number of participants' average for (PDAL) in our study is (49.80mm). One previous study [17] had found that the range of (PDAL) chord length for typical lumbar vertebrae among the USA population was (38 - 58 mm) as opposed to (48.83 -50.80mm) in our study.

Screws ranging in length from 41 to 42 mm look to be safe at all lumbar vertebral levels, as the minimum mean chord length was 48.83 mm. Important study[19] convinced that the transverse pedicle angle ranged between (20 - 40^o) for typical lumbar vertebrae, whereas the current study found (13-30.70^o).

The differences in the current study's results and those of previous studies in terms of some of the parameters are primarily due to differences in race, ethnicity, environmental factors, and study methods.

As a conclusion the current study accurately found the morphometric diameters of the lumbar vertebral pedicle among Jazan population, so according to the our results, it can be mentioned that the lumbar transpedicular screw that , use of a 5.5 to 7.5 mm screw width and of 41 to 42 mm length appeared to be suitable and safety for use with our participants at all lumbar levels.

V. CONCLUSION

As a conclusion the our study with high degree of precision had determined the morphometric diameters of the lumbar vertebral pedicle among the Jazan population, it can be Sayed that the lumbar transpedicular screw with a screw width of 5.5 to 7.5 mm and a length of 41 to 42 mm look to be suitable and safest for use with our participants at all lumbar levels.

However, because this is a one-of-a-kind study among the Jazan population, more anatomical imaging studies with a large number of samples are needed to analyze the morphometric diameters of the lumbar vertebral pedicle and other anatomical structures.

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