MORPHOLOGIC EVALUATION OF THE LOWER CERVICAL VERTEBRAE AND ITS SURGICAL APPLICATIONS AMONG EGYPTIANS

By

George W Boghdady, MD* and Raouf F Bedir, MD**

From

**Department of Orthopaedic Surgery, Faculty of Medicine, Mansoura University, Mansoura, Egypt.*

***Department of Anatomy, Faculty of Medicine, Mansoura University, Mansoura, Egypt.*

ABSTRACT

Lower cervical spine stabilization necessitates precise knowledge of different osseous morphometric measures of the cervical vertebrae for accurate and safe application of fixation devices. Human cadaveric studies revealed significant variability worldwide raising the issue of possible differences among races. This study was conducted on 28 osseous cadaveric models to obtain morphometric measurements among Egyptians. For posterior measures, 1.6 mm Kirschner wires were inserted in the cervical pedicles and lateral masses bilaterally to assess different linear and angular measurements. Linear measurements of the vertebral body were also assessed and presented. All results were correlated with their surgical importance for both posterior and anterior lower cervical spine surgery. The results of this study revealed morphometric differences between Egyptians and other races. Although most of these differences are not statistically significant, yet it raises the necessity of extreme accuracy that should be considered in insertion of posterior cervical pedicle and lateral mass screws concerning, the point of insertion, length, diameter, sagittal and transverse angles and offsets. For anterior surgery, the transverse, sagittal and vertical measurements of the vertebral body should be precisely assessed for safe and

adequate decompression as well as defining the ideal lengths of screws for anterior plating of the lower cervical spine.

INTRODUCTION

Surgical stabilization of the unstable cervical spine can be achieved by a variety of methods including spinous process wiring, triple wire technique, sublaminar wiring, posterolateral mass plating, anterior vertebral body plating, and the newly emerging posterior pedicular screw-plate / rod fixation. The technique used basically depends on the main pathological findings and the extent of surgeon's experience. All plating techniques are proven to provide superior fixation than wiring techniques especially in multilevel instabilities (Ugur, Attar et al. 2000) . A detailed knowledge of the osseous anatomy is essential for all methods of fixations (kwon, Song et al. 2004). However, morphometric measurements in the human cadaveric studies have revealed significant variability (Rumi, Kowalski et al. 2001), raising legitimate concern about the safety and feasibility of different morphometric measurements to be applied on all races. The aim of this work is to provide different important morphometric measurements of the lower cervical spine vertebrae in Egyptian cadavers and their surgical applications for both anterior and posterior cervical spine plating techniques.

MATERIALS AND METHODS

Twenty eight osseous cadaveric models obtained from the Anatomy Department, Faculty of Medicine, Mansoura University, Egypt, were used for the current study to analyze different morphometric data of the third to the seventh cervical vertebrae (Fig. 1). According to the surgical application, the current study was conducted in two parts.

In the first part, morphometric data of the middle and posterior columns of the vertebrae were obtained. Kirschner wires measuring 1.6 mm in diameter were placed coaxially in each pedicle of C3-C7 using Abumi et al technique (Abumi and Kaneda 1997) where the point of entry was slightly lateral to the center of the lateral mass and close to the inferior articular process of the cranially adjacent vertebra. Coaxial alignment could be verified by direct visualization of all four pedicle walls around the Kirschner wire. Any cortical breach by the K-wire was considered noncoaxial alignment. In this fashion, the Kirschner wires represented the orientation of ideally placed transpedicular screws in the cervical spine (Fig. 2). K wires were also placed in the lateral masses of each vertebra using An et al., technique (An, Gordin et al. 1991) where the point of entry was 1 mm medial to the midportion of the lateral mass and proceeded along a course of 15° cranially and 20-30° laterally. This was done to measure the ideal length of the screw placed in the lateral mass without any cortical breach of either the vertebral foramen or the far cortex of the lateral mass which might endanger the nerve root (Fig. 3).

The measurements included 1) the cord length (CL) of the pedicle measured from the posterior cortical entry point of the pedicle to the anterior vertebral cortex in line with the axis of the pedicle, 2) the pedicle length (PL) measured from the posterior cortex of the pedicle to the level of the posterior cortex of the vertebral body along the axis of the pedicle, 3) the transverse diameter (TD) (the medial-lateral outer cortical width of the pedicle) measured at the isthmus, 4) the sagittal diameter (SD) (the superior-inferior outer cortical width of the pedicle) measured at the isthmus, 5) the transverse width (TW) of the lateral mass measured from the laminofacet junction to the lateral border of the lateral mass at the midpoint of the lateral mass, 6) the sagittal height (SH) of the lateral mass measured from one facet joint line to the next caudad facet joint line at the midpoint of the lateral mass, 7) the transverse offset (TO) of the pedicle measured from the laminofacet junction to the coaxial K-wire placed in the pedicle, 8) the sagittal offset (SO) of the pedicle measured from the cephalad facet joint line to the coaxial K-wire placed in the pedicle, 9) the transverse angle of pedicle insertion (TA) measured from the midline to the coaxial K-wire placed within the pedicle in the transverse plane, 10) the sagittal angle of pedicle insertion (SA) measured from a line perpendicular to the sagittal axis of the lateral mass to the coaxial K-wire placed within the pedicle in the sagittal plane. These measures were done according to Ludwig et al., measurements (Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000). Finally, 11) the length of the K wire drilled in the lateral mass from the posterior cortex of the lateral mass to its far cortex in the predetermined direction (Fig. 4)

All dimensions were measured with a caliper at a precision of 1 mm, and all angular measurements were recorded with a goniometer that was precise to within 1!. All measurements were made directly from the specimens by two independent observers.

Results were statistically analyzed and correlated using a computer program (SPSS for windows, release 10) using T test and paired sample T test.

RESULTS

In the first part of the study, 280 cervical subaxial pedicles as well as lateral masses (C3-C7) were instrumented with K wires, and linear, angular, and offset measurements were made.

Linear measurements :

Combined means for observers, standard deviations, and ranges for pedicle diameters and length are shown in table 1. Graphic representation for each variable by cervical level is portrayed in figures 6 and 7.

The pedicle of the seventh cervical vertebra had the largest sagittal and transverse diameters in the study (7.89 mm & 6.32 mm) respectively, while C3 had the smallest sagittal and transverse diameters (7.04 mm & 5.46 mm respectively). It was also observed that both sagittal and transverse diameters increased as we proceed caudally from C3 to C7.

Angular measurements :

The results of mean, standard deviation, and ranges of angular measurements in the sagittal and transverse planes are shown in table 2. Graphic representation for each angular variable by cervical level is portrayed in figure 8.

Both C3 and C4 had positive sagittal angles suggesting the existence of superiorly oriented pedicles. C7 showed slightly positive angle suggesting a less superiorly oriented pedicle. Both C5 and C6 had negative sagittal angles suggesting the existence of inferiorly directed pedicles.

The greatest transverse angle was observed at C4 (42 degrees). The angle decreased as we proceed downwards to reach the smallest angle at C7 (37.25 degrees). C3 showed the third greatest transverse angle.

Offset measurements :

Ratios representing sagittal (SO) and transverse (TO) offsets of an ideal pedicle screw entry point on the lateral mass were calculated. The transverse offset ratio determines the pedicle starting point in the medial-lateral plane, referenced from the medial aspect of the lateral mass (Fig. 4). The transverse offset ratio was calculated by dividing the distance in millimeters from the laminofacet junction (medial aspect of the lateral mass) to the coaxially placed K wire by the distance from the laminofacet junction to the lateral border of the lateral mass. The sagittal offset ratio determines the pedicle entry site in the sagittal plane as referenced from the inferior border of a cephalad facet to the superior border of the next caudal facet (Fig. 4). The sagittal offset ratio was calculated by dividing the distance in millimeters from the inferior border of the superior facet to the coaxially placed K wire by the distance from the inferior border of a cephalad facet to the superior border of the next caudal facet. All ratios were expressed as a percentage because it was thought that percentage values might account more accurately for interspecimen variability than specific linear measurements.

The mean ratios of both transverse offset and sagittal offset of the pedicle are shown in table 3. Graphic representation for each offset variable by cervical level is portrayed in figure 9.

Combining and analyzing the average offset points and average angular measurements at each cervical level from the third to the seventh cervical vertebra resulted in the following guidelines for coaxial screw placement at each cervical level as shown in table 4.

Kirschner wire measurements :

The lengths of the Kirschner wires placed in the lateral mass of each cervical level using An et al., technique were measured from the posterior cortex of the lateral mass to its anterior cortex. The K wire was introduced from the predetermined point of entry until its tip appears from the anterior cortex of the lateral mass. The depth of the k wire in the lateral mass was calculated by subtracting the remaining length from the known full length of the K wire. The mean, range, and standard deviation of the length of K wires at each cervical level are shown in table 5 and portrayed in figure 10.

In the second part of the study, morphometric measures of the anterior column of 140 cervical vertebrae were made.

Transverse diameter of the body :

The 7th cervical vertebra showed the widest transverse diameter (17.96 mm) of all cervical vertebrae with the diameter decreasing gradually as we proceed cephalad to reach the smallest diameter at C3 (15.71 mm). The mean, range and standard deviation of the transverse diameter of cervical vertebrae at each level are shown in table 6 and portrayed in figure 11.

Anteroposterior midsagittal diameter of the body :

The 7th cervical vertebra showed the largest anteroposterior midsagittal diameter measured at the inferior end plate (16.96 mm) of all cervical vertebrae. The diameter decreases gradually as we proceed cephalad to reach the smallest diameter at C3 (15.75 mm). The mean, range and standard deviation at each level are shown in table 7 and portrayed in figure 12.

Anterior vertebral body height :

The mean anterior height of the vertebral bodies from C3 to C7 increases gradually as we proceed caudally from 14.04 mm to 14.96 mm. The mean, range and standard deviation of the anterior height of cervical vertebral bodies at each level are shown in table 8 and portrayed in figure 13.

Posterior vertebral body height :

The mean posterior height of the vertebral bodies from C3 to C7 increases gradually as we proceed caudally from 14.21 mm to 15.11 mm. The mean, range and standard deviation of the anterior height of cervical vertebral bodies at each level are shown in table 9 and portrayed in figure 14.

Table (1): Linear Morphometric Measurements

Level	Diameter (mm) Sagittal	Diameter (mm) Transverse	Length (mm) Pedicle	Length (mm) Cord
C3				
Mean	7.04	5.46	16.07	35.10
SD	0.78	0.92	2.39	2.85
Range	6-9	4-7	12-20	30-39
C4				
Mean	7.14	5.68	15.32	36.86
SD	0.93	0.98	2.99	3.21
Range	5-9	4-7	11-20	31-42
C5				
Mean	7.32	5.96	15.29	37.68
SD	0.90	1.07	2.43	3.12
Range	5-10	4-8	11-19	32-42
C6				
Mean	7.68	6.29	15.57	38.46
SD	0.82	1.15	2.08	3.20
Range	5-9	4-8	12-20	33-43
C7				
Mean	7.89	6.32	14.86	37.82
SD	0.83	1.12	1.86	2.91
Range	5-9	4-8	11-17	30-42

Table 2: Angular Morphometric Measurements

Level	Angulation (Degrees) Sagittal	Angulation (Degrees) Transverse
C3		
Mean	8.40	41.25
SD	5.56	5.75
Range	N3-20	30-51
C4		
Mean	5.57	42.00
SD	4.03	4.79
Range	N3-14	32-50
C5		
Mean	-1.61	41.71
SD	6.43	5.17
Range	N11-13	29-49
C6		
Mean	-2.04	39.11
SD	8.63	5.78
Range	N16-21	26-50
C7		
Mean	0.68	37.25
SD	11.30	5.92
Range	N16-25	25-50

Table 3: Entry Point Offset

	Entry Point offset (%)	
Level	**Sagittal**	**Transverse**
C3		
Mean	14	61
SD	15.00	13.63
Range	N10-50	29-80
C4		
Mean	18	65
SD	10.83	15.07
Range	0-38	30-90
C5		
Mean	21	62
SD	13.84	19.42
Range	2-52	24-90
C6		
Mean	18	62
SD	7.69	12.31
Range	3-34	38-80
C7		
Mean	19	50
SD	8.14	8.31
Range	3-39	26-58

Table 4: Guidelines for pedicle screw placement

	Angular (degrees)		Offset (%)	
Level	**Sagittal**	**Transverse**	**Sagittal**	**Transverse**
C3	8.40	41.25	14	61
C4	5.57	42.00	18	65
C5	-1.61	41.71	21	62
C6	-2.04	39.11	18	62
C7	0.68	37.25	19	50

Table 5: Lengths of K wires placed in the lateral mass of each cervical level

Level	Mean	Range	Std. Deviation
C3	16.07	15-17	0.6042
C4	16.57	16-18	0.5727
C5	16.57	16-18	0.5727
C6	16.68	16-18	0.6118
C7	16.46	16-17	0.5079

Table 6: Transverse diameter of the body of each cervical level

Level	Mean	Range	Std. Deviation
C3	15.71	15-17	0.7629
C4	16.11	15-17	0.7373
C5	16.61	15-18	0.9165
C6	17.57	16-19	1.0338
C7	17.96	16-20	1.1049

Table 7: Anteroposterior diameter of the body of each cervical level

Level	Mean	Range	Std. Deviation
C3	15.75	15-16	0.4410
C4	16.04	15-17	0.3313
C5	16.75	16-17	0.4410
C6	16.89	16-18	0.4973
C7	16.96	16-18	0.5079

Table 8: Anterior height of the body of each cervical level

Level	Mean	Range	Std. Deviation
C3	14.04	13-15	0.7927
C4	14.21	13-15	0.6862
C5	14.43	13-16	0.8789
C6	14.79	14-16	0.7382
C7	14.96	14-16	0.7927

Table 9: Posterior height of the body of each cervical level

Level	Mean	Range	Std. Deviation
C3	14.21	13-15	0.6862
C4	14.39	13-15	0.6289
C5	14.39	14-16	0.5670
C6	14.79	14-16	0.7382
C7	15.11	14-17	0.9560

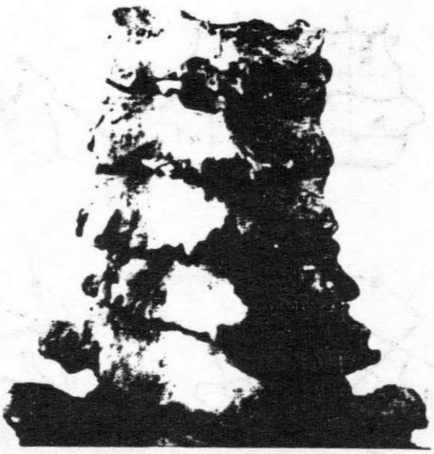

Fig. 1: A photograph showing one of the specimens used in the current study with anatomical arrangement of cervical vertebrae (C3-C7)

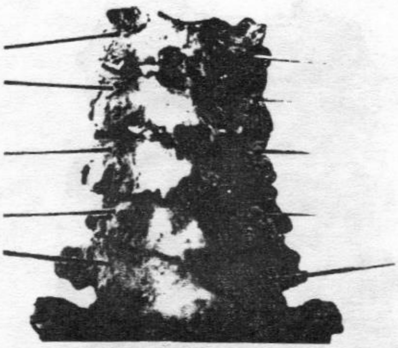

Fig. 2: A photograph showing K wires inserted in the pedicles of C3-C7

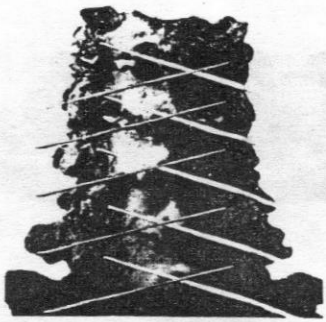

Fig. 3: A photograph showing K wires inserted in the lateral masses of C3-C7

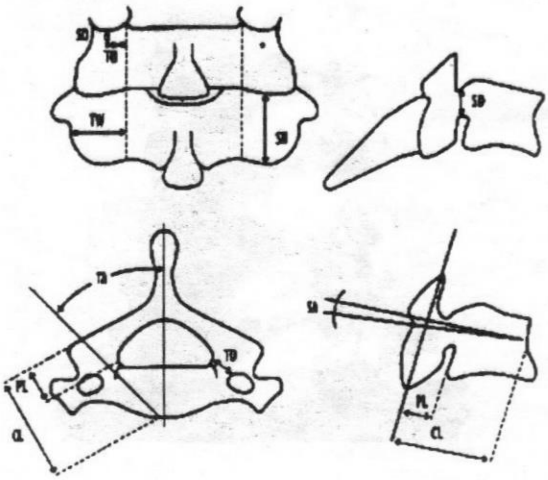

Fig. 4: Schematic drawing of the measured pedicle

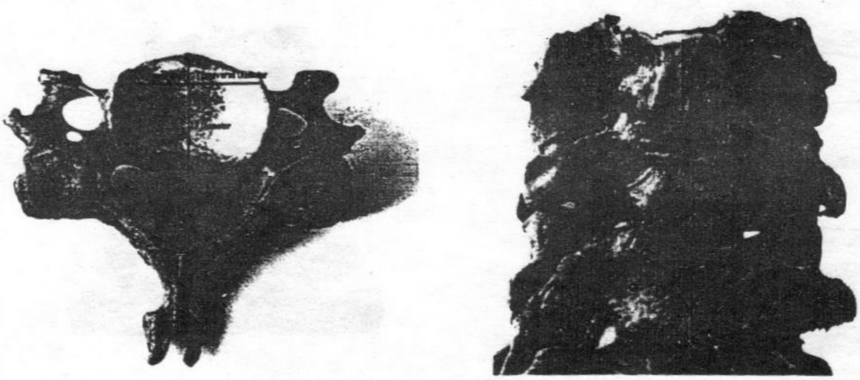

Fig. 5: A photograph showing measurements of the anterior column

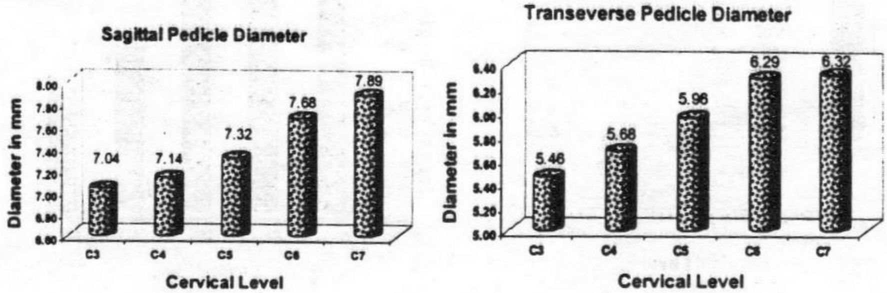

Fig. 6: Graphic representation showing linear morphometric measurements of the subaxial cervical pedicles: sagittal pedicle diameter and transeverse pedicle diameter

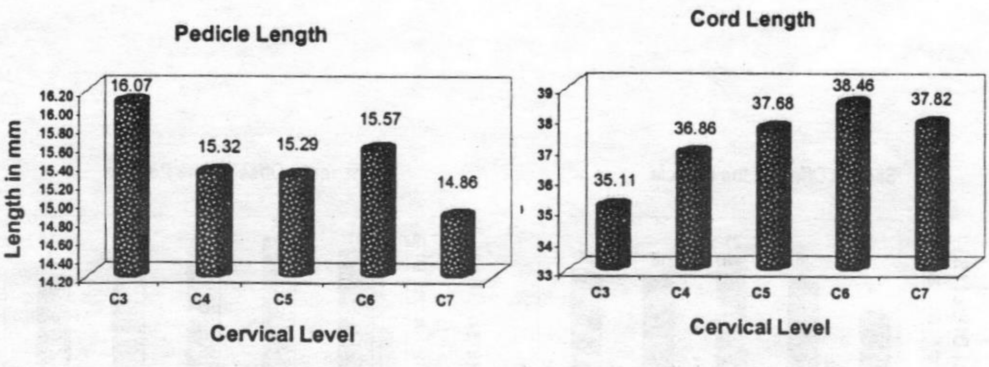

Fig. 7: Graphic representation showing linear morphometric measurements of the subaxial cervical pedicles: peddicle length and cord length

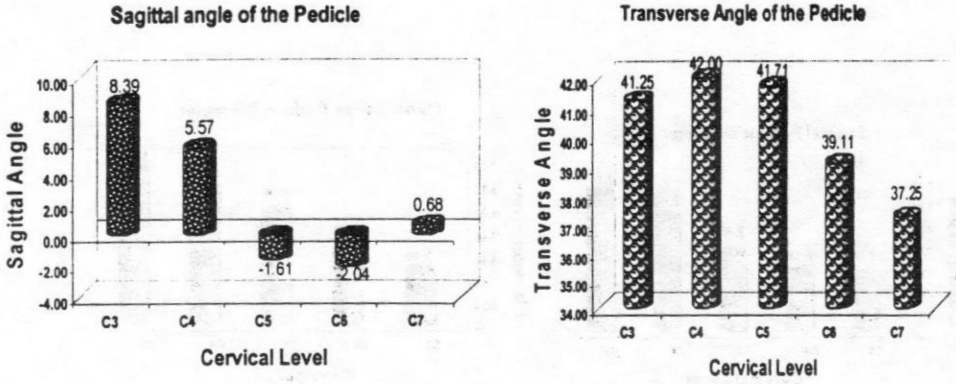

Fig. 8: Graphic representation showing angular morphometric measurements of the subaxial cervical pedicles

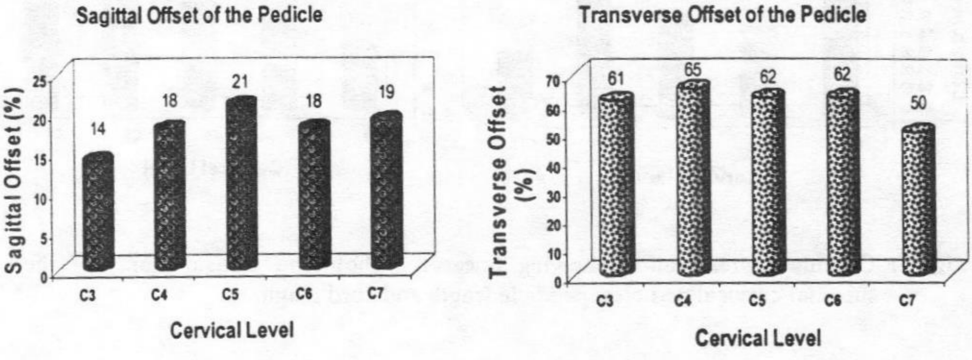

Fig. 9: Graphic representation showing offset morphometric measurements of the subaxial cervical pedicles

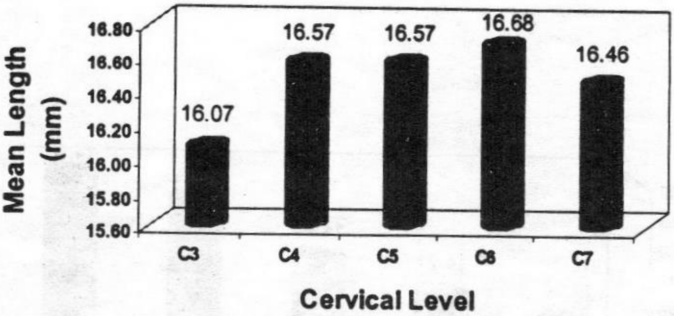

Fig. 10: Graphic representation showing the mean lengths of K wires placed in the lateral mass of each cervical level

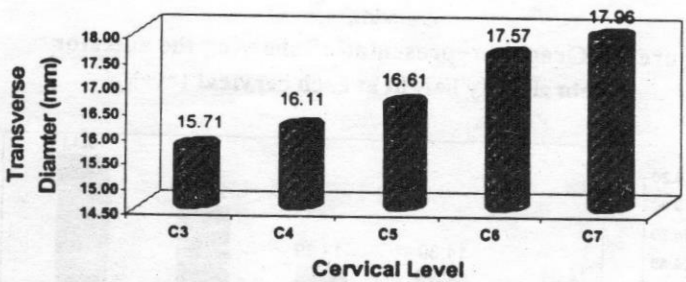

Figure 11: Graphic representation showing the transverse diameter of the body at each cervical level

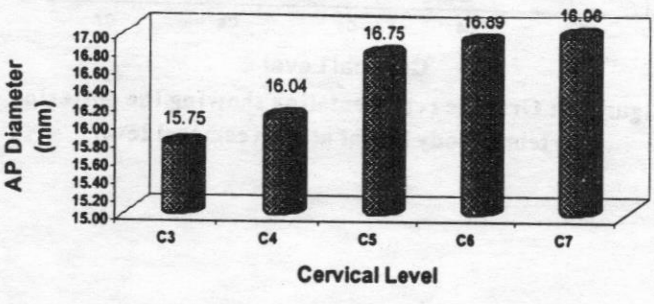

Figure 12: Graphic representation showing the anteroposterior diameter of the body at each cervical level

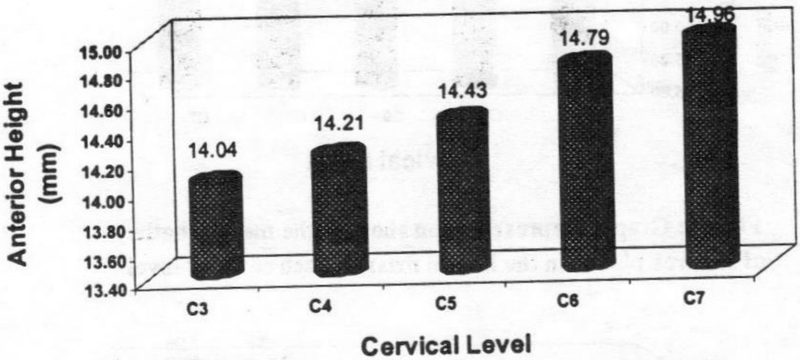

Figure 13: Graphic representation showing the anterior vertebral body height at each cervical level

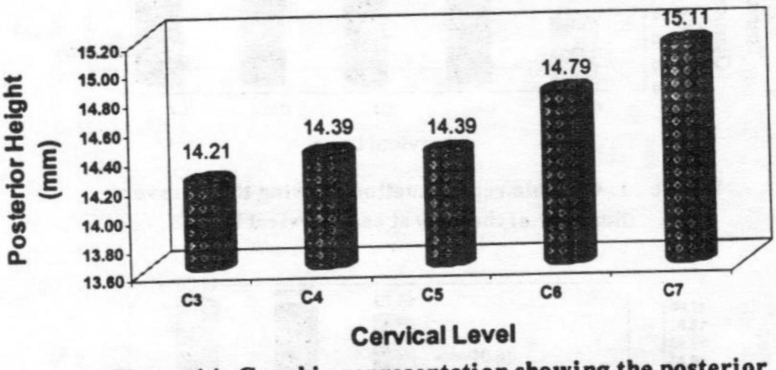

Figure 14: Graphic representation showing the posterior vertebral body height at each cervical level

DISCUSSION

An understanding concerning the morphometry of the cervical vertebrae is paramount in applying instrumentation, either posterior or anterior, to this region of the spine, where vital vascular and neurologic structures are intimately associated with its complex bony anatomy.

Regarding lower cervical spine posterior instrumentation, there is an increasing trend in the last decade, towards insertion of pedicular screws in this region to substitute lateral mass insertion of the screws, in both traumatic and non-traumatic conditions. With precise knowledge of the local anatomy and precise surgical technique, cervical pedicle screws are considered to be a safe method of fixation that provides stronger anchor points than lateral mass screws (Abumi 1997; Abumi and Kaneda 1997; Ladd, G et al. 1997; Albert, Klein et al. 1998; karaikovic, Yingsakmongkol et al. 2001; Rumi, Kowalski et al. 2001; Richter, Cakir et al. 2005).

Different studies have been published on the three dimensional anatomy of the lower cervical spine. (Ugur, Attar et al. 2000), performed a cadaver study for the surgical anatomic evaluation of the cervical pedicle and adjacent neural structures. At C3-C7, the mean pedicle height ranged from 5.2 to 8.5 mm and the mean pedicle width ranged from 3.7 to 6.5 mm. The mean angle of the pedicle ranged from 38 to 48 degrees.

(An, Gordin et al. 1991), performed a cadaver study to investigate the variability of certain morphometric parameters important in the application of lateral mass plate screw constructs. Morphology of C7 and T1 pedicles also was described, where the transverse and sagittal pedicle diameters at C7 measured 6.9 mm and 7.5 mm respectively with medial angulation of 34°.

(Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000), performed two investigations on the morphometric measurements of C3-C7 pedicles and their applications in transpedicular screw fixation in cadavers. They analyzed the average offset ratios and angular measurements at each level from C3-C7 and established specific guidelines for coaxial pedicle screw placement at each cervical level.

In the present study, morphometric data considering both pedicle screw insertion and lateral mass screw insertion in Egyptian cadavers were presented.

Linear measurements data indicated a slight increase in both transverse pedicle diameter (5.46-6.32 mm) and sagittal pedicle diameter (7.04-7.89 mm) as investigation proceeded caudally along the spine. The increase of the transverse pedicle diameter is consistent with those published in the aforementioned studies, but the increase in the sagittal pedicle diameter observed in the present study is not consistent with those of Ludwig et al., (Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000) as they observed a decrease in the sagittal diameter from cephalad to caudad. Comparing the mean values of sagittal diameters observed in the present study with those of Ludwig et al., there was no statistically significant difference except at C7 (7.89 mm : 7.27mm) (P value: 0.038). Pedicle length was greatest at C3 and least at C7 but with no constant decrease as we proceed caudally and the differences between each level were not statistically significant. Cord length was greatest at C6 and C7 and decrease gradually as we proceed cranially, also with no statistical significant differences. The results of both pedicle length and cord length are not consistent with those of Ludwig et al., as they observed fairly constant pedicle length and cord length greatest at C5 & C6. Comparing the mean values of the present study measures with those of Ludwig et al., there were no statistical significant differences.

The greatest mean transverse angle was observed at C4 (42^{o}) and least at C7 (37.25^{o}) with an average transverse angle of 40.26^{o} that is consistent with values published in other studies (An, Gordin et al. 1991; Abumi and Kaneda 1997; Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000). The values of sagittal angle measurements indicated a superiorly angled pedicle at C3, C4, and C7; and an inferiorly angled pedicle at both C5 and C6. These results are not consistent with other studies (An, Gordin et al. 1991; Abumi and Kaneda 1997; Ladd, G et al. 1997; Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000) but with no statistical significant differences.

The transverse offset as referenced from the medial laminofacet junction was least at C7 (50%) then increased cranially to reach its greatest value at C4 (65%) then decrease to 61% at C3. Although the percentage of the transverse offset at each cervical level in the present study differ from those of Ludwig et al., (Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000) the average transverse offset is identical (60%). The sagittal offset as referenced inferiorly from the superior facet was more variable through the subaxial spine with the greatest percentage at C5 (21%). These values are also consistent with other different studies (Ladd, G et al. 1997; Ludwig, Kramer et al. 1999; Ludwig, Kramer et al. 2000).

The mean length of the Kirschner wires introduced in the lateral mass to resemble lateral mass plate fixation ranged from 16.07 mm at C3 to 16.68 mm at C6 and slightly decreased to 16.46 mm at C7. The average length is 16.47 mm which is not consistent with those of Jenneret et al., (Jenneret, Magerl et al. 1991) or An et al., (An, Gordin et al. 1991) who used screws of 20 mm approximately in their technique.

Regarding lower cervical spine anterior instrumentation, the mean transverse diameter of the body increased gradually from C3 (15.71 mm) to reach it widest value at C7 (17.96 mm) with an average of 16.79 mm. Our results are not consistent with those of (Seong-Hoon, Perin et al. 1996; kwon, Song et al. 2004) whose average transverse diameter of the lower cervical spine bodies was 24.6 mm and 17.84 mm respectively. The difference between the results of the present study and those of the other two studies was statistically significant (P value: 0.021).

The mean anteroposterior midsagittal diameter of the body measured at the inferior end plate increased gradually from C3 (15.75mm) to reach its largest diameter at C7 (16.96 mm) with an average of 16.48 mm. Our results are not consistent with those of (Seong-Hoon, Perin et al. 1996; kwon, Song et al. 2004) whose average anteroposterior diameter of the body measured at the inferior endplate were 18.02 mm and 20.80 mm respectively. The differences between the results of the present study and the results of the aforementioned two studies were statistically significant only with those of (Seong-Hoon, Perin et al. 1996) (P value: 0.036).

The mean of the anterior height of the lower cervical vertebral bodies slightly increased from 14.04 mm at C3 to 14.96 mm at C7 with an average of 14.49 mm. The results of this study are consistent with those of (Seong-Hoon, Perin et al. 1996) whose average anterior vertebral body height was 14.12 mm.

The mean of the posterior height of the lower cervical vertebral bodies slightly increased from 14.21 mm at C3 to 15.11 mm at C7 with an average of 14.57 mm. The results of this study are consistent with those of (Seong-Hoon, Perin et al. 1996) whose average anterior vertebral body height was 14.49 mm.

Applying the aforementioned results obtained from Egyptian cadavers, it is obvious that for the lower cervical spine posterior instrumentation, slight differences exist between Egyptians and other races. Although these differences are mostly statistically insignificant, extreme care should be taken in insertion of posterior pedicular screws as well as strict verification of the screw with intraoperative images to avoid neurological or vascular complications. Further anatomic studies combined with radiological verification with computed tomography are needed to reach a more accurate and precise guidelines for insertion of screws in lower cervical spine pedicles.

For lateral mass plating it is obvious that the maximum screw length that can be used in Egyptians should not exceed 18 mm (average 16.47 mm without the thickness of the plate). It is well known that the point of entry determines the length of the screw used. With Roy-Camille technique (Weinder 1994) a screw of 14 - 16 mm can be used while a screw of 16 -18 mm can be used with Anderson et al., technique (Anderson, Henley et al. 1991). In our hands, the technique of An et al., (An, Gordin et al. 1991) is easier and more applicable so, the length of the inserted screw in lateral mass plating should be carefully verified with image intensifier intraoperatively to avoid too long screws that might endanger the nerve root or the vertebral artery.

For anterior instrumentation during discectomy / corpecctomy, it is obvious that the allowable distance of transverse decompression should not exceed 14 mm at C3 and C4, 15 mm at C5, and 16 mm at C6 and C7. Should decompression extend more laterally, the injury of the vertebral artery and the sympathetic chain is more possible. Also the length of the screws used for anterior plating should not exceed 16 mm in length to avoid posterior cortical breaching and the possibility of impinging on the neural sac. Further anatomic studies combined with radiological verification with computed tomography are also needed to reach a more accurate and precise guidelines for decompression and anterior instrumentation of the lower cervical spine in Egyptians.

REFERENCES

1. **Abumi, K. (1997) :** "Point of View: Morphometric Evaluation of Lower Cervical Pedicle and its Projection." Spine 22(1): 5,6.

2. **Abumi, K. and K. Kaneda (1997) :** "Pedicle Screw Fixation for Nontraumatic Lesions of the Cervical Spine." Spine 22 (16): 1853-1863.

3. **Albert, T. J., G. R. Klein, et al. (1998) :** "Use of Cervicothoracic Junction Pedicle Screws for Reconstruction of Complex Cervical Spine Pathology." Spine 23(14): 1596-1599.

4. **An, H. S., R. Gordin, et al. (1991) :** "Anatomic Considerations for Plate-Screw Fixation of the Cervical Spine." Spine 16: S548-551.

5. **Anderson, P. A., M. B. Henley, et al. (1991) :** "Posterior Cervical Arthrodesis with AO Reconstruction Plates

and Bone Graft." Spine 16: S72-79.

6. **Jenneret, B., F. Magerl, et al. (1991)** : "Posterior Satbilization of the Cervical Spine with Hook Plates." Spine 16: S56-63.

7. **karaikovic, E. E., W. Yingsakmongkol, et al. (2001)** : "Accuracy of Cervical Pedicle Screw Placement Using the Funnel Technique." Spine 26(22): 2456-2462.

8. **kwon, B. K., F. Song, et al. (2004)** : "Morphologic Evaluation of Cervical Spine Anatomy with Computed Tomography. Anterior Cervical Plate Fixation Consideration." J Spinal Disord Tech 17(2): 102-107.

9. **Ladd, J. E., H. J. G, et al. (1997)** : "Cervical Pedicle Screws Versus Lateral Mass Screws: Anatomic Feasibility and Biomechanical Comparison." Spine 22(9): 977-982.

10. **Ludwig, S. C., D. L. Kramer, et al. (2000)** : "Placement of Pedicle Screws in the Human Cadaveric Cervical Spine." Spine 25(13): 1655-1667.

11. **Ludwig, S. C., D. L. Kramer, et al. (1999)** : "Transpedicular Screw Fixation of the Cervical Spine." Clinical Orthopaedic and Related Research 359: 77-88.

12. **Richter, M., B. Cakir, et al. (2005)** : "Cervical Pedicle Screws: Conventional versus Computer-Assisted Placement of Cannulated Screws." Spine 30(20): 2280-2287.

13. **Rumi, M. N., J. M. Kowalski, et al. (2001)** : "Rationale for Cervical Pedicle Screw Placement in the Subaxial Spine." Current Opinion in Orthopaedics 12: 265-273.

14. **Seong-Hoon, O., N. I. Perin, et al. (1996)** : "Quantitative Three-dimensional Anato-

my of the Subaxial Cervical Spine: Implication for Anterior Spine Surgery." Neurusurgery 38: 1139-1144.

15. **Ugur, H. C., A. Attar, et al. (2000) :** "Surgical Anatomic Evaluation of the Cervical Pedicle and Adjacent Neural Structure." Neurusurgery 47(5): 1162-1169.

16. **Weinder, A. (1994) :** Posterior Plating. The Cervical Spine: An Atlas of Surgical Procedures H. H. Sherk. Philadelphia, JP Lippincot Company: 163-175.

تقييم مورفولوجى للفقرات العنقية السفلى و تطبيقاتها الجراحية بين المصريين

الهدف من الدراسة :

يتطلب تثبيت الفقرات العنقية السفلى معرفه دقيقه بمختلف القياسات العظمية المورفومترية للفقرات و ذلك للإستخدام الدقيق و الآمن لمختلف اجهزة التثبيت. و قد اظهرت الدراسات بمختلف دول العالم علي الجثث الآدمية إختلافات واضحه مما يثير التساؤل حول وجود هذه الإحتلافات بين الأجناس المختلفة.

خطوات البحث :

أجرى هذا البحث على ٢٨ نموذج عظمى للحصول على قياسات مورفومترية بين المصريين. فبالنسبة الى القياسات الخلفية ، تم وضع سلوك كيرشنر (٦ر١ مم) فى سويقات الفقرات العنقية و كذلك فى الكتل الجانبية للفقرات فى الجهتين اليمنى و اليسرى للحصول على القياسات الخطية و الزوايا. و بالنسبة للقياسات الأمامية تم تحديد و تمثيل القياسات الخطية لأجسام الفقرات. و تم ربط نتائج القياسات مع اهميتها الجراحية لكل من الجراحات الخلفية و الأمامية للفقرات العنقية السفلى.

نتائج البحث :

أظهرت نتائج هذه الدراسة وجود اختلافات مورفومترية بين كل من المصريين و الأجناس الأخرى. و بالرغم من ان معظم هذه الإختلافات غير مؤثرة احصائياً ، الا انها تظهر اهمية الدقة الشديدة التى يجب اتباعها عند تركيب المسامير الجراحية فى السويقات او الكتل الجانبية للفقرات العنقية بما يخص نقطة الدخول و الطول و القطر و الزوايا و الإزاحة السهمية و العرضية ، و كذلك لابد ان يتم تحديد القياسات العرضية و السهمية و الراسية لأجسام الفقرات و ذلك من اجل ازالة الضغط الدقيق و الكافى و كذلك تحديد الأطوال المثالية للمسامير الجراحية

المستخدمة فى الجراحات الأمامية للفقرات العنقية السفلى.

خلاصة البحث :

قدمت هذه الدراسه مختلف القياسات المورفومترية الأمامية و الخلفية للفقرات العنقية السفلى للمصريين مع مقارنتها بالقياسات المختلفة المنشورة فى الأبحاث الخري و كذلك تطبيق هذه القياسات على الجراحات الأمامية و الخلفية للفقرات العنقية السفلى.