ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Spine

Editor
Nancy E. Epstein, MD
Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook

SNI
Open Access

Technical Notes

Pedicle morphometry of the C7 and T1 vertebrae in an argentine population

Pablo Raul Devoto[1], Federico Eduardo Minghinelli[1], Juan José Mezzadri[1], Derek Orlando Pipolo[2], Matias Facundo Lacsi[3], Pablo Gustavo Jalon[1]

[1]Department of Neurosurgery, Hospital de Clínicas José de San Martín, Facultad de Medicina, Universidad de Buenos Aires, Buenos Aires, Argentina, [2]Department of Psychiatry and Behavioral Sciences, Stanford University, Stanford, California, United States, [3]Department of Radiology, Hospital de Clínicas José de San Martín, Facultad de Medicina, Universidad de Buenos Aires, Buenos Aires, Argentina.

E-mail: *Pablo Raul Devoto - pablodevoto7892@gmail.com; Federico Eduardo Minghinelli - minghinelli.f@gmai.com; Juan José Mezzadri - jjmezzadri@gmail.com; Derek Orlando Pipolo - dpipolo@stanford.edu; Matias Facundo Lacsi - lacsifacundo1994@gmail.com; Pablo Gustavo Jalon - pablojalon@yahoo.com

***Corresponding author:**
Pablo Raul Devoto,
Department of Neurosurgery,
Hospital de Clínicas José de San Martín, Facultad de Medicina,
Universidad de Buenos Aires,
Buenos Aires, Argentina.

pablodevoto7892@gmail.com

Received: 10 May 2024
Accepted: 22 July 2024
Published: 23 August 2024

DOI
10.25259/SNI_356_2024

Quick Response Code:

ABSTRACT

Background: We evaluated how and whether the pedicular morphometry of the C7 and T1 vertebrae might impact C7/T1 spinal fusions for patients from Argentina.

Methods: Using computed tomography (CT) scans, we evaluated the pedicular morphology at the C7 and T1 levels.

Results: Among 102 male and female CT studies, we observed significant differences in the height, width, length, and morphometry of the C7 and T1 pedicles.

Conclusion: This study of C7/T1 CT scans revealed significant sex-based morphometric differences, particularly in pedicle height, width, and length at C7 and T1. Given the notable variability in vertebral characteristics observed in our study sample, we recommend preoperative planning with CT scans for C7/T1 fusion.

Keywords: Argentine population, Cervicothoracic junction, Computed tomography, Pedicle morphometry, Transpedicular screws

INTRODUCTION

Performing C7/T1 fusions is crucial for treating various spinal pathologies. Notably, the C7 and T1 pedicles are relatively small and typically require pedicle screws.[2] In this study, we analyzed the anatomy and morphology of the C7 and T1 pedicles to minimize the risk of neurological and vascular injuries during surgical fusions at these levels.[6,7]

MATERIALS AND METHODS

A retrospective cross-sectional study analyzing the C7/T1 pedicle morphology in adult computed tomography (CT) scans from male and female patients in Argentina between 2021 and 2022 was performed. The variables studied included age, C7–T1 pedicular laterality, pedicle width (PW), pedicle height (PH), pedicle axis length (PAL), and transverse angle [Table 1 and Figures 1-4]. The statistical tests utilized are summarized in Table 2.

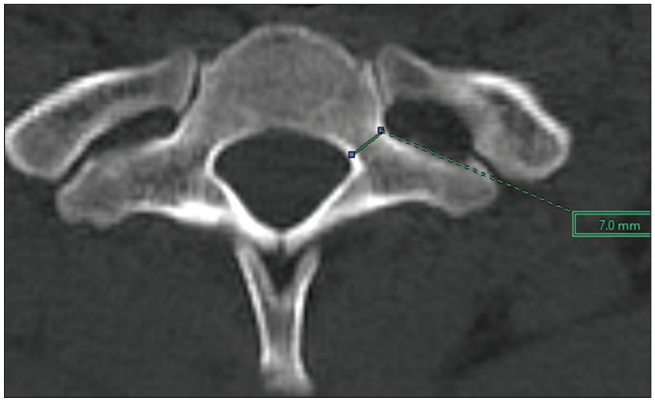


Figure 1: Width of the T1 pedicle in an axial section.

RESULTS

A total of 102 CT scans (60 males and 42 females) were included in this study. Patient ages ranged from 23 to 69 years (mean 52). At both C7 and T1, males had greater PH, PW, and PAL compared to females [Tables 3-5]. At C7, the mean pedicle size for males was 7.5 mm in height, 6.7 mm in width, and 34.2 mm in length. For females, the average pedicle size was 6.7 mm in height, 5.6 mm in width, and 30.4 mm in length. At T1, the mean pedicle measurements for males were 8.5 mm in height, 7.8 mm in width, and 35 mm in length. For females, the measurements were 7.2 mm in height, 6.5 mm in width, and 32 mm in length. For both sexes, age and laterality did not differentially impact C7 or T1 pedicle morphometry [Table 6].

Table 1: Parameters measured on computed tomography images.

Measurament	Abbreviation	Description
Pedicle width	PW	The narrowest external cortical dimension of the pedicle in an axial plane [Figure 1].
Pedicle height	PH	The shortest superior-inferior distance of the pedicular isthmus in the sagittal plane [Figure 2].
Pedicle axis length	PAL	The length from the laminar cortex through the center of the pedicle to the anterior wall of the vertebral body [Figure 3].
Transverse angle	TA	The angle between the pedicle axis length (PAL) and a vertical line from the center of the vertebral body through the center of the spinous process [Figure 4].

Table 2: Descriptive statistics and normality tests for statistical data

Descriptive Statistics and Normality Tests for Statistical Data

- The mean, median, standard deviation, standard error of the mean, minimum, maximum, first quartile (Q1) and third quartile (Q3) were analyzed. Assumptions of normality and homogeneity of variances were verified in all cases.
- For variables demonstrating normal distribution, parametric tests were performed using the T student test to compare the means of the different study groups.
- For variables that did not meet the normality criteria, non parametric tests, particularly the Kruskal Wallis test, were conducted to compare the medians of each analyzed group
- *P* values were evaluated for each test, considering a 95% confidence interval, thus $\alpha = 0.05$.

Table 3: Statistical analysis of the distances analyzed without considering their laterality according to sex.

Variable	Classificatory variable	*n*	Media	SEM	SD	Media CI	Minimum	Q1	Median	Q3	Maximum
Pedicle Height C7	Female	84	6.377	0.071	0.649	6.3774±0.282	4.9	6.1	6.4	6.7	8.1
	Male	120	7.573	0.056	0.614	7.5725±0.222	6.1	7.2	7.6	8.1	8.8
Pedicle Width C7	Female	84	5.644	0.064	0.582	5.644±0.253	4.3	5.3	5.6	5.975	7.4
	Male	120	6,734	0.064	0.704	6.7342±0.254	5	6.225	6.8	7.2	8.5
Pedicle Length C7	Female	84	30.412	0.286	2.62	30.412±1.137	22.6	28.9	30.15	31.75	36.3
	Male	120	34.204	0.247	2.704	34.204±0.978	24.2	32.5	34.7	36.1	39.9
Pedicle Angle C7	Female	84	34.046	0.372	3.406	34.046±1.479	25.5	31.3	34.6	35.75	41.5
	Male	120	33,867	0.368	4.033	33.867±1.457	20.2	31.05	34.45	36.85	42.8
Pedicle Height T1	Female	84	7.231	0.097	0.89	7.231±0.386	5.4	6.7	7.1	7.85	9.4
	Male	120	8.553	0.054	0.595	8.5525±0.215	6.5	8.2	8.6	8.9	9.8
Pedicle Width T1	Female	84	6.514	0.091	0.832	6.5143±0.361	4.9	6	6.4	6.9	8.5
	Male	120	7.802	0.06	0.658	7.8017±0.238	6.2	7.4	7.8	8.275	9.5
Pedicle Length T1	Female	84	32.331	0.356	3.265	32.331±1.417	22.4	29.95	33.25	34.6	40.1
	Male	120	35.004	0.273	2.994	35.004±1.082	27.2	33.425	35.55	37.45	39.6
Pedicle Angle T1	Female	84	32.511	0.438	4.018	32.511±1.744	21.4	30.225	33.2	35.4	39.5
	Male	120	32.678	0.293	3.211	32.678±1.161	24.5	30.35	32.7	35.1	39.8

SD: Standard deviation, SEM: Standard error of the mean, CI: Confidence interval, Q1: Quartile 1, Q3: Quartile 3

Table 4: Results of the T-student tests. *P*-values that are highlighted in red represent comparisons with statistically different means.

Comparative variable	Variable	DF	t-value	*P*-value
Sex	Right Pedicle Height C7	100	−9.33	0.000
	Right Pedicle Axis Length C7	100	−8.67	0.000
	Right Pedicle Transverse Angle C7	100	0.67	0.502
	Left Pedicle Height C7	100	−9.5	0.000
	Left Pedicle Width C7	100	−8.33	0.000
	Left Pedicle Axis Length C7	100	−5.73	0.000
	Left Pedicle Transverse Angle C7	100	−0.25	0.800
	Right Pedicle Width T1	100	−8.33	0.000
	Left Pedicle Width T1	100	−9.14	0.000
	Left Pedicle Transverse Angle T1	100	0.21	0.836
Age	Right Pedicle Height C7	100	0.94	0.350
	Right Pedicle Axis Length C7	100	0.52	0.602
	Right Pedicle Transverse Angle C7	100	0.7	0.484
	Left Pedicle Height C7	100	1.2	0.233
	Left Pedicle Width C7	100	0.63	0.532
	Left Pedicle Axis Length C7	100	1.51	0.135
	Left Pedicle Transverse Angle C7	100	−0.02	0.983
	Right Pedicle Width T1	100	1.4	0.165
	Left Pedicle Width T1	100	1.35	0.181
	Left Pedicle Transverse Angle T1	100	0.74	0.459
Laterality	Pedicle Width C7	201	−0.36	0.717
	Pedicle Width T1	200	0.84	0.404

DF: Degrees of freedom

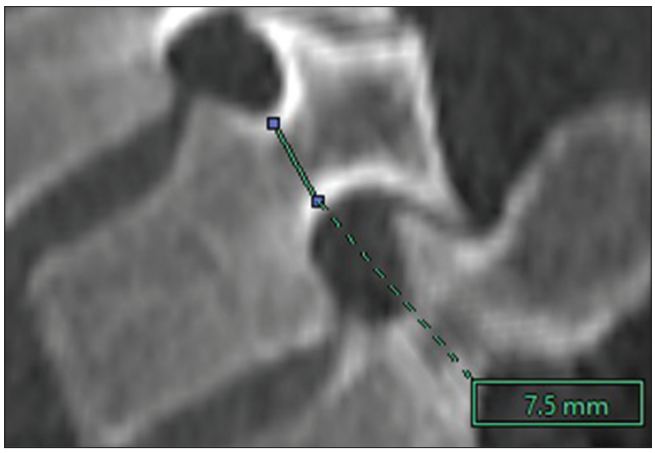


Figure 2: Height of the T1 pedicle in a sagittal section.

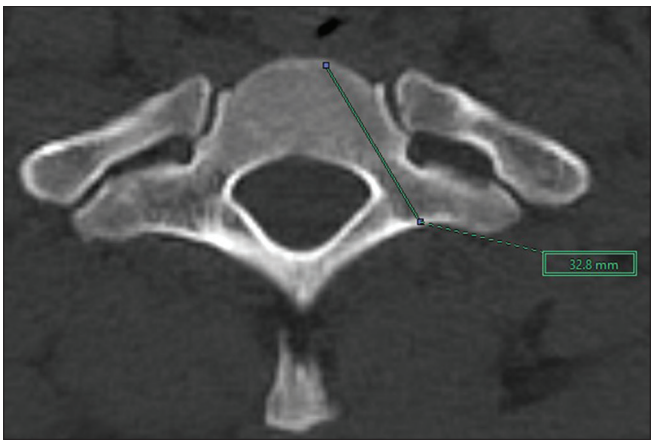


Figure 3: T1 pedicle length in an axial section.

DISCUSSION

Many reports have studied the dimensions of C7 and T1 pedicles, which are relatively small and typically require 3.5–4-mm diameter screws; considering this, larger screws may breach the pedicle wall. Here, we evaluated C7 and T1 PH, PW, and PAL based on 102 CT scans obtained in male and female patients from Argentina.[3,6]

The pedicle dimensions of certain patients in our sample were twice as large as those reported in the previous studies,[3,4,8] suggesting the potential use of larger diameter screws, enhancing construct strength, and significantly decreasing the risk of screw pullout. This finding is crucial as, for fixation involving these vertebrae, it is advisable to measure PH and PW on CT scans and select screws that match these dimensions accurately.

Kotani *et al*.[5] demonstrated that transpedicular screws might provide greater stability compared to other techniques, especially at the C7/T1 levels. The average axial angle obtained in our study was 33.94° for C7 and 32.60° for T1

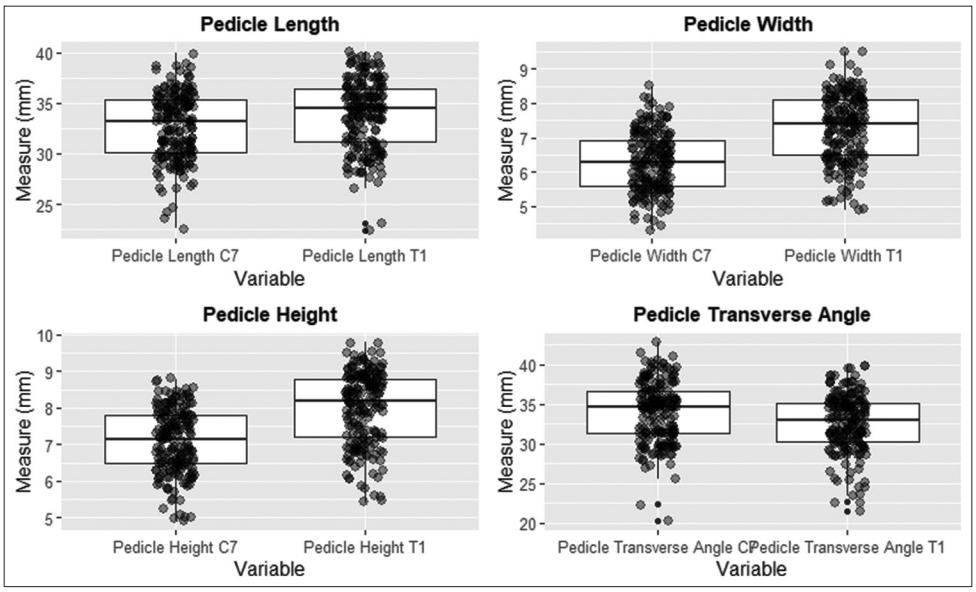
Table 5: Kruskal-Wallis test results. *P*-values that are highlighted in red represent comparisons with statistically different means.

Comparative variable	Variable	W	*P*-value
Sex	Right Pedicle Height C7	1236	0.000
	Right Pedicle Height T1	1208	0.000
	Right Pedicle Axis Length T1	1488	0.000
	Right Pedicle Transverse Angle T1	2065	0.570
	Left Pedicle Height T1	1209	0.000
	Left Pedicle Axis Length T1	1642	0.000
Age	Right Pedicle Width C7	2364	0.470
	Right Pedicle Height T1	2232	0.107
	Right Pedicle Axis Length T1	2245	0.129
	Right Pedicle Transverse Angle T1	2463	0.957
	Left Pedicle Height T1	2290	0.223
	Left Pedicle Axis Length T1	2241	0.122
Laterality	Pedicle Height C7	10342	0.789
	Pedicle Axis Length C7	9884	0.176
	Pedicle Transverse Angle C7	10763	0.465
	Pedicle Height T1	10294	0.704
	Pedicle Axis Length T1	10953	0.238
	Pedicle Transverse Angle T1	10593	0.734

Table 6: Statistical analysis of the variables studied.

Variable	*n*	Media	SEM	SD	Media CI	Minimum	Q1	Median	Q3	Maximum
Pedicle Height C7	204	7.08	0.06	0.861	7.080±0.240	4.9	6.5	7.15	7.8	8.8
Pedicle Width C7	204	6.285	0.059	0.847	6.285±0.230	4.3	5.6	6.3	6.9	8.5
Pedicle Length C7	204	32.643	0.228	3.255	32.64±0.900	22.6	30.1	33.2	35.3	39.9
Pedicle Angle C7	204	33.941	0.265	3.78	33.94±1.040	20.2	31.3	34.6	36.6	42.8
Pedicle Height T1	204	8.008	0.069	0.978	8.008±0.270	5.4	7.2	8.2	8.8	9.8
Pedicle Width T1	204	7.272	0.068	0.97	7.271±0.270	4.9	6.5	7.4	8.1	9.5
Pedicle Length T1	204	33.903	0.236	3.369	33.90±0.930	22.4	31.2	34.5	36.45	40.1
Pedicle Angle T1	204	32.609	0.249	3.557	32. 0.60±0.980	21.4	30.3	32.95	35.1	39.8

SD: Standard deviation, SEM: Standard error of the mean, CI: Confidence interval, Q1: Quartile 1, Q3: Quartile 3



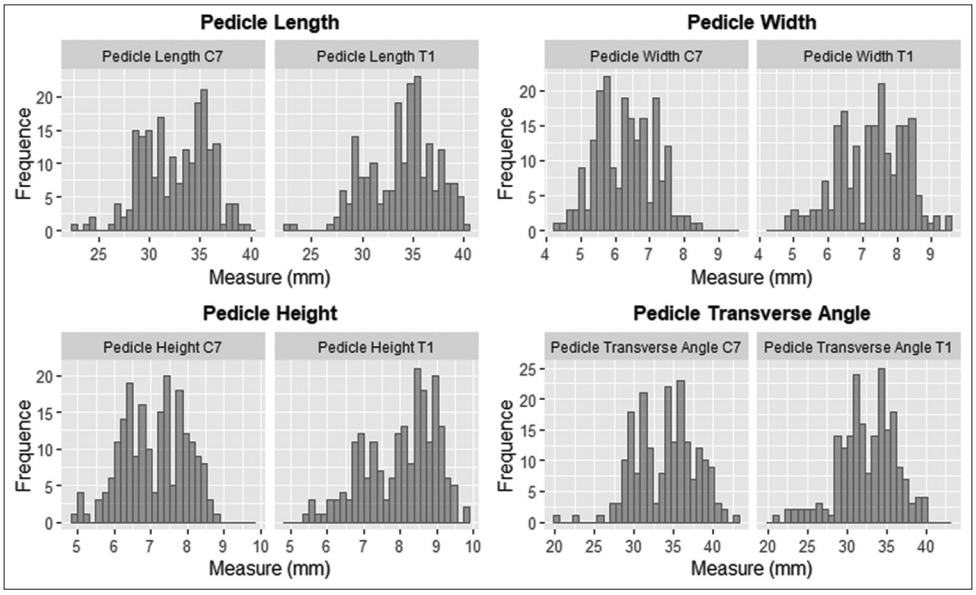
Graph 1: Box plots displaying the distribution of the measures under study without classifying variables.

Table 7: Axial angle of C7 compared with others studies

Variable	Herrero *et al.*[4]	Munusamy *et al.*[9]	Onibokun *et al.*[10]	Faghih-Jouibari *et al.*[3]	Cho *et al.*[1]
Pedicle Angle C7	40.9±6°	38±5.5°	37.8±5°	38.0±11.0°	26±4.8°

Table 8: Axial angle of T1 compared with others studies

Variable	Morita *et al.*[8]	Faghih-Jouibari *et al.*[3]	Liau *et al.*[7]
Pedicle Angle T1	31±5.2°	35.0±7.3°	27.5±4°



Graph 2: Histograms showing the distribution of the measurements under study without any classifying variable.

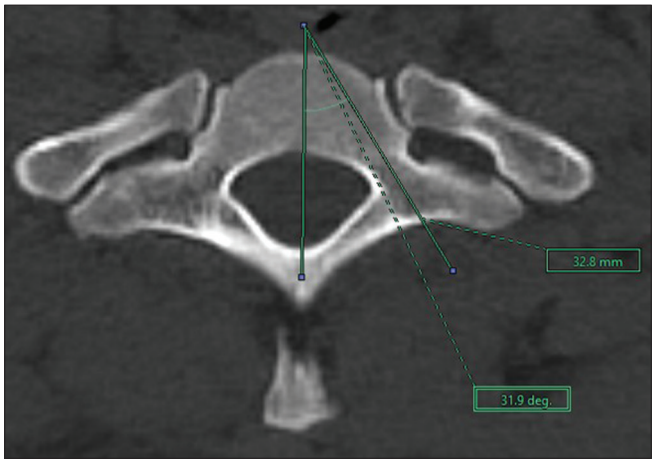


Figure 4: Axial angle of T1 in an axial section.

[Tables 7 and 8]. The remaining parameters for both C7 and T1 vertebrae were similar to those reported in the previous studies.[1,3,6,9,10] In addition, considerable variation in vertebral characteristics was observed, particularly in angulation and pedicle length [Graphs 1 and 2].

CONCLUSION

This study of C7/T1 CT scans revealed significant sex-based morphometric differences, particularly in PH, PW, and PAL at C7 and T1. Given the notable variability in vertebral characteristics observed in our study sample, we recommend preoperative planning with CT scans for C7/T1 fusion.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Cho W, Eid AS, Chang UK. The use of pedicle screw-rod system for the posterior fixation in cervico-thoracic junction. J Korean Neurosurg Soc 2010;48:46-52.
2. Demiroz S, Erdem S. Computed tomography-based morphometric analysis of thoracic pedicles: An analysis of 1512 pedicles and their correlation with sex, age, weight and height. Turk Neurosurg 2020;30:206-16.
3. Faghih-Jouibari M, Moazzeni K, Amini-Navai A, Hanaei S, Abdollahzadeh S, Khanmohammadi R. Anatomical considerations for insertion of pedicular screw in cervicothoracic junction. Iran J Neurol 2016;15:228-31.
4. Herrero CF, Luis Do Nascimento A, Maranho DA, Ferreira-Filho NM, Nogueira CP, Nogueira-Barbosa MH, *et al*. Cervical pedicle morphometry in a Latin American population. Medicine (United States) 2016;95:e3947.
5. Kotani Y, Cunningham BW, Abumi K, McAfee PC. Biomechanical analysis of cervical stabilization systems. An assessment of transpedicular screw fixation in the cervical spine. Spine 1994;19:2529-39.
6. Lee DH, Lee SW, Kang SJ, Hwang CJ, Kim NH, Bae JY, *et al*. Optimal entry points and trajectories for cervical pedicle screw placement into subaxial cervical vertebrae. Eur Spine J 2011;20:905-11.
7. Liau KM, Yusof MI, Abdullah MS, Abdullah S, Yusof AH. Computed tomographic morphometry of thoracic pedicles: Safety margin of transpedicular screw fixation in Malaysian Malay population. Spine 2006;31:E545-50.
8. Morita K, Ohashi H, Kawamura D, Tani S, Karagiozov K, Murayama Y. Thoracic and lumbar spine pedicle morphology in Japanese patients. Surg Radiol Anat 2021;43:833-42.
9. Munusamy T, Thien A, Anthony MG, Bakthavachalam R, Dinesh SK. Computed tomographic morphometric analysis of cervical pedicles in a multi-ethnic Asian population and relevance to subaxial cervical pedicle screw fixation. Eur Spine J 2015;24:120-6.
10. Onibokun A, Khoo LT, Bistazzoni S, Chen NF, Sassi M. Anatomical considerations for cervical pedicle screw insertion: The use of multiplanar computerized tomography measurements in 122 consecutive clinical cases. Spine J 2009;9:729-34.

How to cite this article: Devoto PR, Minghinelli FE, Mezzadri JJ, Pipolo DO, Lacsi MF, Jalon PG. Pedicle morphometry of the C7 and T1 vertebrae in an argentine population. Surg Neurol Int. 2024;15:295. doi: 10.25259/SNI_356_2024