Journal of Iranian Medical Council, Volume 7, Issue no. 3
http://dx.doi.org/10.18502/jimc.v7i3.15731

Effect of Cervical Index Changes on Cervical Pain

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Received: 13 May 2023
Accepted: 30 Sept 2023

Citation to this article
Jahangiri Babadi A, Nejadie Kouti R, Zeinali M, Ardeshiri Lordejani M, Jafari Marandi H, Farhadi E. Effect of Cervical Index Changes on Cervical Pain. *J Iran Med Counc*. 2024;7(3):538-43.

Abstract
Background: The study of the angles between the vertebrae and the curvatures of the spine plays an important role in the pathogenesis of spinal disorders. The nature of the cervical region makes it susceptible to various cervical disorders, many of which can be caused by imbalanced alignment.

Methods: In the present study, patients with chronic neck pain were compared with the normal population for cervical indexes.

Results: One hundred subjects were selected, including 57 males (57%) and 43 females (43%). Neck tilting was significantly lower in the case group than control (41.5 *vs.* 45.8) (p=0.01). The mean of C0-C2 angle did not differ between groups (p=0.503), however, a significant increase was found for C2-C7 and C0-C7 angles (p=0.012) and (p=0.05), respectively. Further analysis revealed that cranial offset (21.9 *vs.* 8.6) and cranial tilting (21.3 *vs.* 10.1) significantly increased in patients with chronic neck pain (p<0.001) and (p=0.004), respectively. Also, cervical Sagittal Vertical Axis (SVA) has shown a significant increase in patients than control (24.8 *vs.* 9.7) (p<0.001).

Conclusion: The data have indicated that cervical indexes. Thus, spine surgeons should obtain standing cervical radiographs and evaluate the relationship between T1 slope, Spino Cranial Angle (SCA), and cSVA in all cases affected by cervical pathogenesis, even without obvious deformity.

Keywords: Humans, Lordosis, Male, Neck pain

Introduction

The study of the angles between the vertebrae and the curvatures of the spine plays an essential role in the pathogenesis of spinal disorders. Cervical region pains significantly affect people's quality of life, and trauma alone is responsible for 85% of cervical injuries (1). The most reported statistics are chronic pains that worsen over time and occur without a specific etiology (1,2). Cervical pains are related to various anthropometric, postural, muscular, and movement variables and indices. On the other hand, unlike the thoracic and lumbar regions, cervical injury is associated with extensive pathogenesis and causes more disabilities, especially in the lower limbs (3,4). Most of the studies conducted in improving this category of patients are more focused on risk factors such as age, underlying disorders, race, and even the type of occupation of individuals (5,6).

The nature of the cervical region makes it susceptible to various cervical disorders, many of which can be caused by imbalanced alignment. Chronic pressure, stress, injuries, and degenerative diseases may also be involved in developing neck pain (7,8).

Injury to this area can damage the bones, ligaments, or even the arteries that carry blood to the brain. Several cervical spine parameters, including C7 slope, T1 slope (T1S), C2C7 offset, C2C7 lordosis, Spino Cranial Angle (SCA), the cervical Sagittal Vertical Axis (cSVA), Thoracic Inlet Angle (TIA), and Neck Tilt (NT) have been proposed to assess sagittal balance in asymptomatic, scoliosis, and elderly subjects (9).

Cervical spine deformity develops consequently abnormal head posture compared to the chest and shoulders, accompanied by breathing and swallowing difficulty (10). Congenital, trauma, inflammatory, and iatrogenic are some of the causes of cervical spine deformity (11). 10-20˚ was declared as normal cervical lordosis (11). There is a need to understand how cervical spine sagittal deformity relates to cervical symptoms and health-related quality of life. Among the essential topics, the cervical sagittal parameters are widely used in evaluating cervical spine disorders and surgery. In this regard, the present survey investigates the changes in cervical indexes on cervical pain development.

Material and Methods

Study population

In the present case-control study, patients with neck pain for at least six months were compared with the normal population. Subjects without neck pain were considered for control, although after demonstrating normal cervical lordosis, they were included as the control group.

Inclusion criteria for selection were lack of trauma history and no history of specific diseases associated with neck musculoskeletal disorders. Patients who were candidates for surgery and congenital disorders in the cervical spine were excluded. The current study is based on the ethical committee of Medical Sciences (IR.AJUMS.HGOLESTAN.REC.1399.093).

Angle measurement

Cervical spine radiographs (vertically, horizontally, and laterally) were taken from all the patients standing and in a neutral head position in the Frankfurt horizontal plane. Since the Frankfurt plane extends from the upper limit of the external ear hole to the lower limit and the lower border of the orbit, it is the best line for placing the skull in a natural state. In this regard, it is considered for the present study. To improve the diagnostic accuracy, all the graphs were evaluated by an experienced radiologist. Cervical lordosis was divided into two parts, the upper cervical lordosis, including the C0-C2 angle, and the lower cervical lordosis, consisting of the C2-C7 angle.

Cobb measurement

Cobb angle is the most widely used measurement for quantifying spine curvature. The measurement method includes choosing the most crooked bead in the upper part of the beads and the most crooked in the lower part and then drawing two tangent lines on these two beads by the user. The characteristic angle of the intersection of these two lines is the Cobb angle. Parameters including T1S, C0-C2 angle, C0-C7 angle, neck tilting, C0-C2/C2-C7 ratio, C2-C7/C0-C7 ratio, C0 angle, C2-C7 angle, cranial offset, cranial tilting, cranial SVA, and TiA were measured. The measurements were done using a negatoscope and radiant software.

Statistical analysis

All the data were analyzed by SPSS software (IBM SPSS, Version 22). Quantitative data were analyzed using descriptive tests and presented as Mean±SD. The mean of parametric data between the two groups was analyzed using an independent sample t-test. A p-value < 0.05 was considered statistically significant.

Results

One hundred subjects were selected, including 57 males (57%) and 43 females (43%) (Table 1).

Neck tilting was significantly lower in the case group than control (41.5 *vs.* 45.8) (p=0.01). The mean of C0-C2 angle did not differ between groups (p=0.503); however, a significant increase was found for C2-C7 and C0-C7 angles (p-value =0.012) and (p-value = 0.05), respectively (Table 2). In contrast, the C0 angle has not differed between the two groups; hence, significant differences were not found between groups for C0-C2/C2-C7 ratio and C2-C7/C0-C7 ratio (p-value >0.05) (Table 2).

Further analysis indicated that cranial offset (21.9 *vs.* 8.6) and cranial tilting (21.3 *vs.* 10.1) significantly increased in patients with chronic neck pain (p-value <0.001) and (p-value = 0.004), respectively (Table 2). Also, cervical SVA has shown a significant increase in patients than control (24.8 *vs.* 9.7) (p-value <0.001) (Table 2).

Regardless of the groups, all the parameters were compared between the two genders. The results did not show any significant differences (p-value>0.05) (Table 3).

Table 2. Comparing two groups for the cervical parameters

Variables	Group	Mean	Std. deviation	p-value
TiA	Case	72.5	7.8	0.512
	Control	74.8	8.6	
T1 slope	Case	30.6	6.7	0.04
	Control	29	8.3	
Neck Tilting	Case	41.5	6.8	0.01
	Control	45.8	10.3	
C0-C2 Angle	Case	37.1	10.3	0.503
	Control	44.9	8.4	
C2-C7 Angle	Case	19.7	8.9	0.012
	Control	12	6.1	
Cervical Tilting	Case	21.3	6.2	0.081
	Control	19.1	7.9	
C0-C2/C2-C7 Ratio	Case	3.9	7.1	0.148
	Control	4.9	3	
C2-C7/C0-C7 Ratio	Case	0.38	0.17	0.597
	Control	0.32	0.38	
C0 Angle	Case	20	6.5	0.320
	Control	14.1	6.9	
Cranial Offset	Case	21.9	12.6	<0.001
	Control	8.6	4.3	
Cranial Tilting	Case	21.3	6.2	0.043
	Control	10.1	3.9	
Cervical SVA	Case	24.8	9.8	<0.001
	Control	9.7	3.3	
C0-C7	Case	51.2	8.7	0.058
	Control	49.08	12.1	

Thoracic inlet angle (TiA), Sagittal Vertical Axis (SVA).

Discussion

Knowing the exact number of spinal curvatures can effectively prevent, diagnose, and treat spinal abnormalities (12). There is no standard method for assessing cervical sagittal alignment (13). Previous studies have reported normal ranges or abnormal values of parameters such as T1 slope, cSVA, and SCA to measure cervical sagittal alignment parameters (14,15).

Table 1. The demographic information of the participants

Variable	Control	Case	Total
Mean age±SD (year)	42.7±3.3	46.9±2.4	44.8±2.8
Gender (%)			
Male	33(66)	24(48)	57(57)
Female	17(34)	26(52)	43(43)

In the present survey, the mean of cervical parameters was compared between the normal population and patients with chronic neck pain. Our results have indicated a significant difference between the two groups for T1 slope, neck tilting, and C0-C7 angle. In the same investigation, a T1 slope less than 40 degrees is optimal for favorable sagittal balance (16). Considerable literature has demonstrated that factors such as age, BMI, and gender directly influence

Table 3. The differences between the two genders for cervical parameters

Variables	Sex	Mean	Std. deviation	p
TiA	Male	73.42	8.3	0.634
	Female	74.04	8.3	
T1 slope	Male	29.80	7.5	0.762
	Female	29.94	7.6	
Neck Tilting	Male	43.34	9.8	0.391
	Female	44.17	7.9	
C0-C2 Angle	Male	40.47	10.9	0.519
	Female	41.88	9	
C2-C7 Angle	Male	16.58	8.8	0.102
	Female	14.99	8.2	
Cervical Tilting	Male	20.41	7.8	0.063
	Female	20.07	6.2	
C0-C2/C2-C7 Ratio	Male	4.5874	6.6	0.710
	Female	4.2670	3.3	
C2-C7/C0-C7 Ratio	Male	0.3882	0.3	0.308
	Female	0.3161	0.1	
C0 Angle	Male	18.14	7.2	0.234
	Female	16.51	7.8	
Cranial Offset	Male	14.23	10.7	0.09
	Female	16.74	12.5	
Cranial Tilting	Male	15.95	8.2	0.134
	Female	15.48	6.9	
Cervical SVA	Male	16.66	10.3	0.381
	Female	18.10	10.9	
C0-C7	Male	49.91	11.2	0.071
	Female	50.52	9.8	

Thoracic inlet angle (TiA), Sagittal Vertical Axis (SVA).

cervical sagittal; also, it was shown that T1 slope and cSVA in males with aging increase (17). It contrasts with our findings; our data do not differ significantly between the sexes for cervical parameters. It should be noted that the T1 slope is one of the essential parameters of sagittal spine balance. However, due to the overlying anatomic structures, the end plane of T1 is difficult to visualize on radiographs. Recently, researchers have shown that upper and lower C7 slopes are highly correlated with the T1 slope and can be used as a surrogate for T1 slope estimation when the T1 endplate is poorly visualized (18).

Additionally, the C2 slope can be represented by T1s minus cervical lordosis and show the same changes with each other (19).

Further analysis revealed that with increasing T1 slope, the C2-C7 angle rises, too. Along with our data, the SVA C2-7 decreases with the T1 slope increase (20). Also, the T1 slope directly influences the C2-C7 angle (21), in accordance with our data that the C2-C7 angle significantly differs between normal population and asymptomatic patients. In this line, the higher T1 slope and cSVA can be considered for predicting kyphosis following laminoplasty (22). No association was found between C0-C2 angle and neck pain development, where it demonstrated that kyphosis improved with C0-C2 compensation (23,24).

Thoracic inlet alignment significantly influenced the cervical tilting (25), which is in agree with our findings. Our data have demonstrated that cranial offset considerably is higher in the case group. Knott *et al*'s results agreed that T1 slopes more than 30 degrees are accompanied by thoracic deformity (26). Initial observations suggested that age affects cervical sagittal balance. With aging, the motion ranges are reduced in the cervical spine. However, this variation does not follow a regular pattern since it increases in some ages and decreases in others (27). With aging, the T1S of the first dorsal vertebra increases, and C2-C7 lordosis is followed by C0-C7 increase (28). Age results in destructive degeneration affecting the joint's alignment. These alterations cause tolerance reduction against the additional extensor forces (29).

Limitations

The absence of parts of the skull bone, such as nasion and opisthion, as well as the upper end plate of the T1 vertebra or the sternum in some simple radiographs, limits the detailed examination of the indices. In this regard, it is suggested to evaluate these areas with higher accuracy in the imaging field in future studies.

Conclusion

Based on the findings of the present survey, it is believed that spine surgeons should obtain standing cervical radiographs and evaluate the relationship between T1 slope, SCA, and cSVA in all cases affected by cervical pathogenesis, even without obvious deformity. Future studies should investigate the clinical correlates of cervical spine disorder and T1 slope, SCA, and cSVA to confirm the influence of these parameters on clinical outcomes.

Consent for publication

Informed consent was obtained from all individual participants included in this study.

Ethical approval

The current study is based on the ethical committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.HGOLESTAN.REC.1399.093).

Acknowledgement

We thank the patient for his consent to publish the case report. The authors would like to thank the colleagues at Golestan Hospital, Ahvaz Faculty of Medical Sciences, for their guidance and encouragement.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

References

1. Stigson H, Boström M, Kullgren A. Health status and quality of life among road users with permanent medical impairment several years after the crash. Traffic Inj Prev 2020;21(S1).

2. De Vestel C, Vereeck L, Reid SA, Van Rompaey V, Lemmens J, De Hertogh W. Systematic review and meta-analysis of the therapeutic management of patients with cervicogenic dizziness. J Man Manip Ther 2022 Oct;30(5):273-83.

3. Carlson GD, Gorden CD, Oliff HS, Pillai JJ, Lamanna JC. Sustained spinal cord compression. Part I: time-dependent effect on long-term pathophysiology. J Bone Joint Surg Am 2003 Jan;85(1):86-94.

4. Leemhuis E, Giuffrida V, De Martino ML, Forte G, Pecchinenda A, De Gennaro L, et al. Rethinking the body in the brain after spinal cord injury. J Clin Med 2022 Jan 13;11(2):388.

5. Peterson MD, Kamdar N, Chiodo A, Tate DG. Psychological morbidity and chronic disease among adults with traumatic spinal cord injuries: a longitudinal cohort study of privately insured beneficiaries. Mayo Clin Proc 2020 May;95(5):920-8.

6. Parenteau CS, Lau EC, Campbell IC, Courtney A. Prevalence of spine degeneration diagnosis by type, age, gender, and obesity using Medicare data. Sci Rep 2021 Mar 8;11(1):5389.

7. Predko-Engel A, Kaminek M, Langova K, Kowalski P, Fudalej PS. Reliability of the cervical vertebrae maturation (CVM) method. Bratisl Lek Listy [Internet]. 2015 Oct;116(4):222–6.

8. Zeng Y, Ren H, Wan J, Lu J, Zhong F, Deng S. Cervical disc herniation causing Brown-Sequard syndrome. Medicine (Baltimore). 2018;97(37):e12377.

9. Wang Z, Xu JX, Liu Z, Wang ZW, Ding WY, Yang DL. Spino cranial angle and degenerative cervical spondylolisthesis. World Neurosurg 2021 Jul:151:e517-e522.

10. Dru AB, Lockney DT, Vaziri S, Decker M, Polifka AJ, Fox WC, et al. Cervical spine deformity correction techniques. Neurospine 2019 Sep;16(3):470-82.

11. Cho SK, Safir S, Lombardi JM, Kim JS. Cervical spine deformity: indications, considerations, and surgical outcomes. J Am Acad Orthop Surg 2019 Jun 15;27(12):e555-67.

12. Jin C, Wang S, Yang G, Li E, Liang Z. A review of the methods on cobb angle measurements for spinal curvature. Sensors (Basel) 2022 Apr 24;22(9):3258.

13. Abudouaini H, Wu T, Liu H, Wang B, Chen H, Huang C, et al. Partial uncinatectomy combined with anterior cervical discectomy and fusion for the treatment of one-level cervical radiculopathy: analysis of clinical efficacy and sagittal alignment. BMC Musculoskelet Disord 2021 Sep 12;22(1):777.

14. Azimi P, Yazdanian T, Benzel EC, Hai Y, Montazeri A. Sagittal balance of the cervical spine: a systematic review

and meta-analysis. European Spine Journal 2021 30:6 [Internet]. 2021 Mar 27 [cited 2023 Mar 4];30(6):1411–39.

15. Wang Z, Wang ZW, Fan XW, Gao X Da, Ding WY, Yang DL. Assessment of spino cranial angle of cervical spine sagittal balance system after multi-level anterior cervical discectomy and fusion. J Orthop Surg Res 2021 Mar 17;16(1):194.

16. Ling FP, Chevillotte T, leglise A, Thompson W, Bouthors C, le Huec JC. Which parameters are relevant in sagittal balance analysis of the cervical spine? A literature review. Eur Spine J 2018 Feb;27(Suppl 1):8-15.

17. Oe S, Togawa D, Nakai K, Yamada T, Arima H, Banno T, et al. The influence of age and sex on cervical spinal alignment among volunteers aged over 50. Spine (Phila Pa 1976) 2015;40(19).

18. Ye IB, Tang R, Cheung ZB, White SJW, Cho SK. Can C7 slope be used as a substitute for T1 slope? A radiographic analysis. Global Spine J 2020 Apr;10(2):148-52.

19. Lee HJ, You ST, Sung JH, Kim IS, Hong JT. Analyzing the significance of T1 slope minus cervical lordosis in patients with anterior cervical discectomy and fusion surgery. J Korean Neurosurg Soc [Internet]. 2021;64(6):913.

20. Park JH, Cho CB, Song JH, Kim SW, Ha Y, Oh JK. T1 slope and cervical sagittal alignment on cervical CT radiographs of asymptomatic persons. J Korean Neurosurg Soc [Internet]. 2013;53(6):356.

21. Lee SH, Son ES, Seo EM, Suk KS, Kim KT. Factors determining cervical spine sagittal balance in asymptomatic adults: Correlation with spinopelvic balance and thoracic inlet alignment. Spine J 2015 Apr 1;15(4):705-12.

22. Li XY, Kong C, Sun XY, Guo MC, Ding JZ, Yang YM, et al. Influence of the ratio of C2–C7 Cobb angle to T1 slope on cervical alignment after laminoplasty. World Neurosurg 2019 Apr 1;124:e659–66.

23. Protopsaltis T, Bronsard N, Soroceanu A, Henry JK, Lafage R, Smith J, et al. Cervical sagittal deformity develops after PJK in adult thoracolumbar deformity correction: radiographic analysis utilizing a novel global sagittal angular parameter, the CTPA. Eur Spine J 2017;26(4):1111–20.

24. Lee SH, Hyun SJ, Jain A. Cervical sagittal alignment: literature review and future directions. Neurospine 2020 Sep 1;17(3):478–96.

25. Lee SH, Kim KT, Seo EM, Suk KS, Kwack YH, Son ES. The influence of thoracic inlet alignment on the craniocervical sagittal balance in asymptomatic adults. J Spinal Disord Tech 2012 Apr;25(2):E41-7.

26. Knott PT, Mardjetko SM, Techy F. The use of the T1 sagittal angle in predicting overall sagittal balance of the spine. Spine J 2010;10(11).

27. Norasteh AA, Zolghadr H. The effect of age on the alignment and range of motion of the cervical spine: a review study. J Paramed Sci Rehabilitat 2022 May 22;11(1):109–22.

28. Iorio J, Lafage V, Lafage R, Henry JK, Stein D, Lenke LG, et al. The Effect of Aging on Cervical Parameters in a Normative North American Population. Global Spine J 2018 Oct;8(7):709-15.

29. Loeser RF. Age-related changes in the musculoskeletal system and the development of osteoarthritis. Clin Geriatr Med 2010 Aug;26(3):371-86.