



ASSESSMENT OF SAGITTAL PARAMETERS OF THE CERVICAL SPINE USING 1.5 T MRI

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Abstract

Background: Degenerative diseases, spinal deformity, surgical planning, and postoperative recovery all require proper spinal sagittal alignment. The previous studies have shown the following significant correlation between the thoracic inlet angles, neck tilt in proportion to age but did not show any significant correlation in proportion to gender.

Aim & Objective: There have been many studies who have considered Thoracic Inlet Angle, Neck Tilt, T1 slope, Anterior Vertebral Body Line & Spinous Process Line individually & how they affect a population age wise and gender wise. The study was purposed to look into the measurement cervical sagittal parameters and how they affect age and gender individually, in addition to how they interact using MRI.

The objective of the study is to evaluate the correlation of TIA, T1 Slope, NT and Anterior Vertebral Body Line with various age groups, to correlate NT, TIA, T1 slope, and AVBL with gender, calculates T1 Slope using TIA and Neck Tilt.

Materials and Methods: 106 asymptomatic patients were prospectively selected and their cervical sagittal parameters including TIA, T1 Slope, NT, SPL, AVBL using OSIRIX measuring tools. Cervical and whole body MRI cases were considered and T2 sagittal sequence was used to measure the parameters. T1 intensity image produced with a TE/TR of 9.7/550 intensity image was produced; the slice thickness was 3.0mm. Using the scaling option from the software, measure the angles and lengths of the desired parameters.

Result: The relation between TIA, Neck Tilt, AVBL, SPL, and T1 Slope according to age was found using the Pearson correlation coefficient. TIA was related positively ($p < 0.05$) with Neck Tilt, AVBL & T1 Slope. The Neck Tilt was related positively ($p < 0.05$) with AVBL & SPL. A positive correlation was present ($p < 0.05$) between AVBL and SPL. The SPSS software was used to compare TIA, Neck TILT, AVBL, SPL, and T1 Slope according to age and no difference ($p > 0.05$) was found according to age. The “t” test (independent sample) was used for comparing these sagittal parameters according to gender and a difference ($p < 0.05$) in TIA, AVBL, SPL, and T1 Slope between males and female.

Conclusion: After observing the test results and varied outcomes which are different from our previous studies, we conclude that the cervical vertebrae parameters are related to one another individually and also change according to gender but not age. The lordotic and kyphotic tilts, degeneration and sagittal balance of the cervical spine can easily be evaluated with the help of these parameters and their dependency on each other

Key Words: TIA, NT, T1Slope, AVBL, SPL, sagittal parameter.

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INTRODUCTION

It is widely acknowledged that poor sagittal spinal alignment can affect one's quality of life in terms of their health. In both patients with and without spinal diseases, the thoracolumbar spine alignment in sagittal plane has been linked in a number of published studies over the past few decades. Various standards for the typical thresholds of regional or global sagittal alignment parameters for have been established. (1) In addition to having a large range of motion, the cervical spine's main job is to support the head weight, which makes it a very complicated structure. Using the neck tilt & T1 slope one can evaluate the cervical spine sagittal parameter (NT). Few studies have been conducted with respect to the relationship between degenerative cervical disease and these parameters, despite a recent study finding a significant correlation between TIA, NT, T1S, and ageing in an asymptomatic population. (2)

Previous studies considered age groups of 25-55, which included kyphotic patients; other studies included major health risks such as Neck Disability Index, Sagittal imbalance, and paraspinal muscle degeneration. BMI and bone density were also taken into account in several studies. Along with NT, TIA (thoracic inlet angle) & T1 slope, we included two more parameters in our study: spinous process line and anterior vertebral body line. The values of these two parameters vary depending on whether the neck is kyphotic or lordotic. (2)

MATERIAL AND METHOD

Randomly patients were selected who visited the Radiology Department, Teerthanker Mahaveer Hospital and Research Centre, Moradabad, Uttar Pradesh, India from 20th March 2022 to 21st March 2023. The study included 106 patients aged 20 to 45 who had available and clear cervical MRI images. Patients excluded from the study included the group with any pathology (coronal deformity, symptomatic osteoporotic fractures, and orthopaedic diseases), history of any prior spine surgery or any road traffic accidents. There was no neck disease in any of these patients. A prospective observational study was conducted. We divided the patients into three age groups (less than 20-30, 31-40, and 41-50) and enrolled 47, 39, 20 patients in each group, with 58 females and 48 males. Routine Cervical spine MRI scan was performed using Siemens Magnetom Avanto Tim Dot 1.5T. There was only one sequence involved in this study is t1_tse_sag. T1 intensity image produced with a TE/TR of 9.7/550 intensity image was produced, the slice thickness was 3.0mm. Few studies being done regarding the relation between all degenerative cervical diseases and the mentioned parameters, despite a recent study finding a distinguished relation between NT, TIA, T1S & ageing in an asymptomatic population T1 angle constitute the T1 upper end plate & horizontal line. TIA constitutes the angle b/w a line perpendicular & the upper part of the endplate of first thoracic vertebrae & a line running from the centre of the upper part of the endplate of T1 to sternum tip. T1S and NT are thus combined to produce TIA. The AVBL depicts the anterior border of the vertebral bodies. The SPL is a bony extension that extends from the back of each vertebra.



Figure – Colours depicting various sagittal parameters : Green (Anterior Vertebral Body Line), Blue (Spinous Process Line), Red (Neck Tilt, Thoracic Inlet Angle)

RESULT

For the statistical analysis, SPSS was used. All data are represented using the mean standard deviation. To determine whether there is a linear relationship between the cervical spine curvature parameter and age, the Pearson product-moment relation has been applied. To examine gender differences t test was used in the same group of age. ANOVA (one-way analysis of variance) is used to find differences between age groups. The interobserver reliability was assessed using the interclass correlation coefficient (ICC). Age-

related differences in Neck TILT (angle) were present (p 0.05). For the multiple comparisons of Neck Tilt (angle) according to age groups, the post hoc analysis, Tukey test was employed. Neck Tilt (angle) between the age groups of 20 to 30 and 31 to 40 years was different (p 0.05). The AVBL and SPL between males and females differed (p 0.05). The relationship between the Neck Tilt (angle) and the AVBL and SPL was positive (p 0.05). Additionally, there was a positive correlation between AVBL and SPL (p 0.05).

Table1: Frequency % of age and gender distribution

(n = 106)		Frequency	%
Age groups	20-30	47	44.3
	31-40	39	36.8
	41-50	20	18.9
Gender	Male	48	45.3
	Female	58	54.7

Table 2: Comparison of TIA (angle), Neck TILT (angle), AVBL, SPL, and T1 Slope according to age

		Mean	S.D.	"F"	p value
TIA (angle)	20-30	61.0	11.9	1.68	0.191
	31-40	65.4	10.1		
	41-50	64.0	12.1		
NECK TILT (angle)	20-30	50.8	9.7	5.51	0.005*
	31-40	57.9	10.3		
	41-50	57.1	12.6		
AVBL (Cm)	20-30	10.6	1.0	1.96	0.146
	31-40	11.1	0.9		
	41-50	10.8	1.2		
SPL (Cm)	20-30	9.4	1.0	1.55	0.218
	31-40	9.8	0.8		
	41-50	9.5	1.0		
T1 SLOPE	20-30	10.3	6.8	3.06	0.051
	31-40	8.1	4.1		
	41-50	6.9	4.8		

DISCUSSION

Degenerative diseases, spinal deformity, surgical planning, and postoperative recovery all require proper spinal sagittal alignment. The previous studies have shown the following significant correlation between the TIA, neck tilt in proportion to age but did not show any significant correlation in proportion to gender. Whereas these five parameters all together were not studied in a single case study, there have been considerable amounts of correlation between each parameter individually and in proportion to age and gender.

Wangmi Liu et al.³ conducted a study to evaluate the relationships of parameters of cervical sagittal in healthy and cervical disc degeneration patients.

They included fifty symptomatic and fifty asymptomatic patients whereas in our study we have included around 106 all asymptomatic patients. The study concluded that thoracic inlet angle could be regarded as a morphological parameter that is constant in both cervical disc degeneration and normal populations, and that TIS was involved in the onset and progression of cervical disc degeneration. According to the findings of our study, which showed a correlation between TIA and age, gender, AVBL, neck tilt, and SPL, we came to the same conclusion that TIA is a crucial morphological parameter to study both normal and pathological cases.

Rong Xing et al.⁴ concluded in their findings, a change in position had a significant impact on almost all sagittal parameters, and supine MRI could not replace cervical radiographs that were used for measuring most of the parameters of the cervical sagittal other than the thoracic inlet angle in a population that is asymptomatic. Rather in our study as we could observe the dependence and correlation of TIA and all the other parameters with age and gender so we conclude that for symptomatic and TIA related cases MRI could be examined on the MRI machine with more precision.

Hyo Jeong Lee et al.⁵ in their research clearly demonstrated that the severity of cervical disc degeneration was significantly correlated to the parameters of the sagittal cervical that represented the jaw lifting posture and cervical kyphosis, and that loss of the cervical spine's natural sagittal lordosis, rather than forward head posture, might give contribution to disc degeneration progression. In our study we came out with the conclusion that for our selected sample size the pattern of kyphotic or lordotic neck was observed with increasing TIA Angle and with increasing / decreasing AVBL and SPL length.

Wanli Li et al.⁶ concluded in their study that females had significantly lower thoracic inlet parameters than males. The TIA, on the other hand, was unrelated to the degree of cervical disc degeneration. In our study we observed the variation in the TIA (angle) as it was a positively correlated ($p < 0.05$) with Neck TILT (angle), AVBL, and T1 Slope.

Ryoma Aoyama et al.⁷ concluded in their study that it is more likely to perform its function when the extension unit of the spinous process, the lower part of the cervical spine and its attached muscles are cephalic. In our study the spinous process line according to age showed minimum value in age group of less than 20 and maximum in the age group of 31-40 and 51-60, hence we can say that TIA increases steadily with age but also fluctuates and gradually decreases with age as the age group >70 is reached also there was a positive correlation ($p < 0.05$) between AVBL and SPL.

Shuang Ao et al.⁸ investigated concluded in his study that in the prevalence of cervical kyphosis in 235 asymptomatic volunteers is 38.3%. CK influences few parameters of spine. Health-related quality of life is associated with CK. In our study we have opted for a lower sample size of asymptomatic patients as our parent study had a

lower sample size too, therefore if further studied and the percentage of cervical kyphosis influencing spinal parameters can be calculated. If we chose to increase the sample size our study would give us more significant results.

CONCLUSION

We conclude that the cervical vertebrae parameters are related to one another individually and change according to gender but not age after observing the test results and varied outcomes that differ from our previous studies. In healthy patients, the evaluation of NT, TIA, T1 SLOPE, AVBL, and SPL will serve as guidelines for radiological evaluation of the cervical spine. The lordotic and kyphotic tilts, sagittal balance of the cervical spine and degeneration could be easily evaluated using these parameters and their interdependence. In fact, we contribute to a better understanding of the pathology of disc degeneration, specifically sagittal balance.

CONFLICT OF INTEREST

The author has no conflict of interest to declare.

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