

Evaluation of the Effect of the Restoration of Lost Vertical Dimension with Permissible Splint on Posture using Photogrammetry and S-EMG - An *In-Vivo* Study

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ABSTRACT

Introduction: Occlusion is a multidimensional phenomenon of which vertical dimension is an important factor. Maintenance of occlusal harmony along vertical dimension helps in better prognosis of the treatment performed. Along with the stomatognathic system, it has also been found to be beneficial for overall health of the postural muscles. Therefore, co-relation between vertical dimension and postural muscles analysis is significant.

Aim/Objectives: To evaluate the effect of the restoration of lost vertical dimension with permissible splint on posture using photogrammetry and S-EMG.

Methods and Material: Fifteen patients were selected according to the inclusion and exclusion criteria for the study. Vertical dimension of rest and occlusion were measured using Niswonger's technique. Posture was evaluated using photogrammetry and S-EMG. For photogrammetry, CVA angle and Gaze angle were measured using photographs on Kinovea software. The posture was evaluated by measuring the activity of postural muscles, namely Sternocleidomastoid [SCM], upper trapezius and spinous erectae using S-EMG. Permissible splints were constructed at restored vertical relation and given to the patient after occlusal equilibration. 30 days post restoration, the posture was re-evaluated using same methods.

Results: Difference between right and left side reduced from pre to post but was not statistically significant. Relation was found only between right upper trapezius and right spinous erectae and left upper trapezius and left SCM.

Conclusion: Posture is affected by a number of factors, one of which happens to be occlusion. This study proved that occlusion does have an effect on body posture and an improvement in occlusion will only aid in improving body posture.

Key Words: Vertical Dimension, Postural Muscles, Photogrammetry, Body Posture, S-EMG, Occlusion

INTRODUCTION

Vertical dimension is an important aspect of occlusion. It is the static relation between incisive or occluding surfaces of the maxillary and mandibular teeth or analogues.¹ The repetitive contracted length of the closing muscles determines vertical dimension of occlusion. Maintenance of occlusal harmony helps in better patient comfort and better prognosis of any treatment.

Cervical lesions, loss of all teeth, loss of molar support and single tooth restoration from time to time are among the various causes for loss of vertical dimension. Symptoms associated with a loss in VDO are appearance of lesions such as angular cheilitis, facial disharmony, and TMDs and signs of Coston's syndrome such as impaired hearing, noises in the ear, stuffiness of the ear, sinus disturbances, headaches, burning of the side of nose, and throat, burning tongue and vertigo. Raising the VDO has been used to treat this condition with much debate.²

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Alteration in vertical dimension not only affects the stomatognathic system but also has been shown to affect the body posture.

Posture is basically the position of the body whether characteristic or assumed for a special purpose. It is the alignment of body segments at a particular time.³ Posture is studied by viewing the various segments of the body with respect to an established reference line. This reference (gravity) line/plumb line divides the body into equal front and back halves and bisect it laterally.⁴

Head posture has been studied in patients with bruxism, patients with TMDs, malocclusion, parafunctional habits, and different mandibular positions. Studies have found that all of these aspects of the stomatognathic system led to a change in the mandibular position and hence the head posture. So, the current study was designed to evaluate the effect of vertical dimension during occlusal rehabilitation on posture using S-EMG and Photogrammetry in patients with loss of VDO.

OBJECTIVES

1. To evaluate the posture in patients with lost vertical dimension pre restoration using Photogrammetry and S-EMG.
2. To evaluate the posture in patients with lost vertical dimension post restoration with permissible splint using Photogrammetry and S-EMG.
3. To compare the posture using Photogrammetry and S-EMG between pre and post restoration with permissible splints in patients with lost vertical dimension.

MATERIAL AND METHODS

Fifteen patients were selected according to the inclusion and exclusion criteria for the study. Vertical dimension of rest and occlusion were measured, using Niswonger's technique. Posture was evaluated using photogrammetry and S-EMG. For photogrammetry, CVA angle and Gaze angle were measured using photographs on Kinovea software. The posture was evaluated by measuring the activity of postural muscles, namely Sternocleidomastoid [SCM], upper trapezius and spinous erectae using S-EMG. Permissible splints were constructed at restored vertical relation and given to the patient after occlusal equilibration. 30 days post restoration, the posture was re-evaluated using same methods.

Inclusion criteria:

1. Presence of attrition with Turner and Missirilian classification, category 1

Exclusion criteria:

1. Absence of more than 4 teeth, except/excluding third molars

2. Presence of temporomandibular joint problems
3. Trauma or surgery influencing posture
4. Visual problems or vestibular problems
5. Any disorder capable of influencing posture

Well extended diagnostic impressions were made using alginate or irreversible hydrocolloid material recording both maxillary arch and mandibular arch.

Facebow were recorded and maxillary cast were mounted on a semi-adjustable articulator. Vertical dimension of rest and occlusion were measured, using Niswonger's technique.

Posture was evaluated using photogrammetry and S-EMG. During evaluation, the patients were asked to sit in their habitual sitting posture on a chair such that their thighs were parallel to the floor, feet resting on the ground with hand resting on the thighs. A Nikon D5300 camera was mounted on a tripod and was placed at a distance of 100cm from the subject and parallel to the sagittal axis of the patients. The height was such that tragus became the focus of the camera. [figure 1]

For photogrammetry, CVA angle and Gaze angle were measured.

Adhesive markers were placed near tragus of the ear, C7 and outer canthus of the eye.

- a. The CVA angle was measured as the angle formed between line joining C7 to tragus and horizon.
- b. The Gaze angle was measured as the angle formed between line joining tragus and outer canthus of eye and horizon. [figure 2 and 3]

A 3-minute video was recorded and photographs were taken repeatedly. They were then utilized to measure CVA and Gaze angles in open access Kinovea software to get readings using photogrammetry. [figure 4]

The posture was also evaluated by measuring the activity of postural muscles, namely Sternocleidomastoid [SCM], upper trapezius and spinous erectae using S-EMG. [figure 5] The electrodes were placed on the muscles as follows: [Fig 6 A, B, C]

- a. SCM: 3cm below the mastoid process parallel to the muscle's long axis.
- b. Trapezius: center of line joining C7 and acromion process.
- c. Erector spinae: 2cm bilaterally to the spinous process of the 2nd lumbar vertebrae.

To find the muscle belly, concentric contraction of each muscle was requested.

- a. SCM- Cervical flexion and rotation to the right and to the left
- b. Upper trapezius- simultaneous elevation of both shoulders.

- c. Spinous erectae- flexes the spine with the pelvis fixated.

The patients were asked to sit in their habitual posture and S-EMG values [RMS values] were recorded at rest. For normalization, Maximum voluntary isometric contraction [MVIC] was advocated. All these activities were manually resisted. Maximum voluntary isometric contraction [MVIC] value was calculated.

Final readings were calculated as a percentage of the MVIC values.

$$\text{final reading} = \frac{S - EMG \text{ at rest}}{MVIC \text{ values}} \times 100$$

These readings acted as pre-treatment values. Anterior deprogrammer was constructed on the cast with the flat plane bite platform made perpendicular to the long axis of the opposing mandibular incisors with a thickness equivalent to the amount of vertical dimension to be restored. Centric relation was evaluated using anterior deprogrammer. [figure 7] Mandibular model was mounted using this jaw relation record. Permissible splints were constructed at restored vertical relation and given to the patient after occlusal equilibration. The patients were advised to continuously use it, except during sleeping.

30 days post restoration, posture was re-evaluated using same photogrammetry and S-EMG procedures as discussed. These readings were noted down as post-treatment values. Both the pre- and the post treatment readings were recorded in a similar manner for all the patients in the study and were then statistically analyzed.

RESULTS

The recorded readings and the values were tabulated as follows:

- Table 1 showed Pre-and Post-restoration CVA angle and Gaze angle.
- Table 2 showed Percentage S-EMG value of muscles.
- Table 3 showed Tests of normality
- Table 4 showed Descriptive statistics for CVA angle, Gaze angle, Right and left -SCM muscle, upper trapezius muscle, spinous erectae muscle
- Table 5 showed Descriptive statistics for differences between right and left- SCM, upper trapezius, spinous erectae muscle
- Table 6 showed Descriptive statistics for inter-relationship between Right and left- SCM muscle, upper trapezius muscle, spinous erectae muscle
- Graph 1 showed Mean of pre and post, right and left -SCM muscle, trapezius and spinous erectae.
- Graph 2 showed Mean of pre and post, CVA angle and gaze angle

- Graph 3 showed Mean difference between pre and post for CVA angle, Gaze angle
- Graph 4 showed Mean difference of pre and post between right and left of all muscles.
- Graph 5 showed Mean and standard deviation of pre and post CVA angle.
- Graph 6 showed Mean difference of pre and post for right and left SCM
- Graph 7 showed Mean difference of pre and post for right and left upper trapezius
- Graph 8 showed Mean difference of pre and post for right and left spinous erectae
- Graph 9 showed Mean difference of pre and post for CVA angle and gaze angle
- Graph 10 showed Mean difference of pre and post for right and left of all muscles.

Shapiro-Wilk test and Kolmogorov-Smirnov test was used to test normality of the given samples. Paired t test was used to measure the statistical significance of the difference between pre and post value of the muscles and of the CVA and Gaze angle. Unpaired t test was used to determine the statistical significance of the difference between pre and post value of the difference in the muscle activity between right side muscle and corresponding left side muscle.

Pearson correlation test was used to determine the interrelationship between all the muscles.

Table 4 Interpretation:

1. Since the p value for the difference in pre- and post-treatment value of CVA angle is more than 0.05 there is no significant difference in the CVA angle before and after vertical restoration.
2. Since the p value for the difference in pre- and post-treatment value of Gaze angle is less than 0.05, there is significant difference in the Gaze angle before and after vertical restoration
3. Since the p value for the difference in pre- and post-treatment value for muscles is more than 0.05, there is no significant difference before and after vertical restoration

Table 5 Interpretation:

Since the p-value for the change in difference between right and left SCM, upper trapezius and spinous erectae from pre to post treatment is greater than 0.05, there is no significant difference.

Table 6 Interpretation:

Since the p-value for the Pearson correlation between the left SCM muscle and left spinous erectae is greater than 0.05, the correlation is not significant between right SCM and right upper trapezius.

DISCUSSION

The role of occlusion in treatment planning is undefined. A complete occlusal analysis is often a neglected factor because of prevailing misconceptions and confusion related to this aspect. Occlusion is guided by the relationship of the maxilla to the mandible, TMJ and muscles and occlusal form and surfaces. Of these, TMJ and muscle should be maintained constant; while the remaining two, i.e., occlusal form and surfaces can be altered along with some changes in maxillomandibular relation. The maxillomandibular relationship consists of orientation, centric and vertical, out of which centric and orientation relation are better left unmodified. The vertical relation on the other hand has been manipulated since ages. In a healthy situation, the vertical relation is usually maintained by the maxillary and mandibular teeth. However, several patients come with a clinical scenario of attrition, abrasion, loss of molar support. When all the compensating mechanisms fail or the loss in the tooth structure exceeds the compensation process, there is a loss in vertical dimension of occlusion and patients show related signs and symptoms.

Nonetheless, for rehabilitation of such patients, increasing/restoring the vertical dimension of occlusion becomes important aspect of treatment planning. While Urbanowicz M⁵ believed that it is not convenient to increase the vertical dimension of occlusion as it can cause craniovertebral extension leading to suboccipital compression and upset the postural balance between the head and neck; Some other authors like Carlsson G and coworkers, Hellsing G, Gross MD and coworker^{6,7,8} believed that increasing the vertical dimension of occlusion will not have any deleterious effects on masticatory system. There are sufficient studies showing reduced activity of masticatory muscle on improving the vertical dimension of occlusion. Apart from the effects of altered occlusion on the orofacial system, there are studies linking changes in body posture with occlusion. Yuh-Yan S et al.⁹ found that masticatory muscle activity increased during clenching and would cause stretching of neck.

This connection has been made because of the existence of muscle fascicle chain, i.e., all the muscles are interlinked with each other and any problem or injury with one set of muscle can lead to changes or compensation in the other and secondly, to the presence of extensive anatomical connection of other nuclei with the trigeminal system.¹⁰ Other reason for this connection was believed to be the trigeminal nerve complex. The changes associated with the loss of VDO send afferent signals to the mesencephalic nucleus of the trigeminal. This nucleus because of its anatomical and functional connection with vestibular system, cerebellum and superior colliculus, would stimulate these areas and thus send efferent signals to the postural system as well, causing postural adjustments.^{11,12}

Researchers like Yoshida¹³, Carr et al.¹⁴, kang and lee and Abduljabbar T et al.¹⁵ found splint therapy useful for the health of masticatory and postural muscles. The 30 days' time period was selected as sufficient changes in muscle activity

Forward head posture occurs when the neck slants forward, placing the head further in front of the shoulders rather than directly above. This forward positioning of the head causes a reduction in the CVA angle. The forward positioning of the head activates the neck reflex causes the head to tilt downwards causing an increase in the Gaze angle. It is anterior shifting of the head from the line of gravity leading to increased stress on the cervical spine, hyperflexion and hyperextension.

When the vertical dimension of occlusion is reduced, the suprahyoids are shortened thereby lengthening the infrahyoids which activates the neck flexors leading to forward head posture. On restoring the vertical dimension of occlusion, the mandible is displaced downward that releases the suprahyoid musculature which further disrupts the position of hyoid bone and reduces the pharyngeal space. To compensate for this reduction and to maintain the airway patency, the neck is extended moving the hyoid bone position. This causes an increase in the CVA angle. The neck extension activates the tonic neck reflex which in conjugation with ocular and vestibular system brings eyes to a more upright position thereby reducing the Gaze angle. This process corrects the forward head posture.

Restoration of vertical dimension of occlusion would restore the lengths of the suprahyoids and continuing with the chain the head will be pulled backward in a favorable position. The improvement was noted in SCM and upper trapezius muscle and spinous erectae muscle.

Al-Abbasi H et al.¹⁶ found that increasing vertical dimension of occlusion positively affected the isometric strength of cervical flexors. Mandibular position was also found to impact cervical flexors' isometric strength.

Fujino S. et al.¹⁷ found that voluntary clenching of teeth affected the patient's ability to rapid postural adaptation when they were perturbed antero-posteriorly in upright position. Parafunctional habits were also found to cause muscular symptoms in the SCM muscle.¹⁸

Full mouth rehabilitation should be done with full knowledge of muscles and joints. Change in vertical dimension of occlusion will change the muscle activity causing changes in muscle mass, strength and muscle metabolism leading to muscle fatigue. The neutral posture is associated with elastic equilibrium, such that the least elastic stress and lowest joint load are produced. This equilibrium is verified by reduced muscle activity. This activity will further help in reduced effort required to stabilize spine, less muscle fatigue and improved comfort.

Limitations:

1. Long term RCT studies required for further evaluation of the relation between occlusion and posture.
2. Posture evaluation post full mouth rehabilitation would give a better idea about relation between occlusion and posture.
3. Effect of Life style habits and occupation could be considered to exclusively study relation between occlusion and posture.
4. S-EMG value of masticatory muscles can also be recorded along with changes in the TMJ movement pre and post restoration.

CONCLUSION

Posture is affected by a number of factors, one of which happens to be occlusion. This study proved that occlusion does have an effect on body posture and an improvement in occlusion will only aid in improving body posture. Correcting body posture would still require proper physiotherapy treatment. It can also be said that a study of a still larger scale will be required to establish an infallible connection between the two. Also, it would require the control of other factors affecting posture in daily life, such as the use of electronic gadgets which is rampant in today's age. Thus, it can be said that occlusion will always help in improving and not degrading posture.

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Figure 1: Setup for photogrammetry.



Figure 2 and 3: CVA and gaze angle.

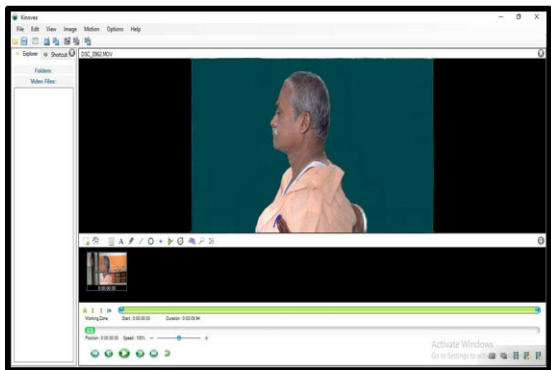


Figure 4: Kinovea software.



Figure 5: s-EMG.



Figure 6 (A, B, C): Electrodes placement of SCM, trapezius, and spinous erectae muscles.



Figure 7: Bite record using anterior deprogrammer and Alu-max.

Table 1: Pre- and Post- CVA angle and gaze angle

Sr. no.	Pre- value CVA angle In degrees	Post-value CVA angle In degrees	Pre- value Gaze angle In degrees	Post-value Gaze angle In degrees
1	48	53	23	21
2	50	52	21	25
3	51	46	26	10
4	47	53	11	8
5	62	47	18	18
6	53	45	16	15
7	42	47	12	10
8	36	45	19	14
9	45	53	30	8
10	40	48	5	7
11	55	53	19	12
12	36	42	8	4
13	55	53	26	12
14	51	53	24	20
15	48	50	12	9

Table 2: Percentage S-EMG value of SCM, upper trapezius and spinous erectae muscle.

Sr. no.	Scm pre-value		Scm Post value		Upper trapezius pre-value		Upper trapezius post value		Spinous erectae pre value		Spinous erectae post value	
	r	l	r	l	r	l	r	l	r	l	r	l
1	6.772529	6.849078	15.63083	17.8628	8.322663	9.846827	19.77076	25.65267	52.35216	23.65624	18.88338	39.40622
2	32.63152	54.25401	43.9566	54.74493	19.63746	11.13195	41.66928	65.86345	43.74202	23.41469	51.19165	54.20105
3	20.75456	8.412888	13.88148	14.48642	63.81988	27.82136	65.08108	35.86089	119.6839	22.25	79.09398	8.873239
4	29.18277	19.34694	13.45496	6.648308	18.39001	18.61862	60.89951	33.6408	44.75501	37.79956	26.75487	33.49736
5	61.10709	45.69607	76.08803	28.25362	22.14121	51.28617	53.99042	33.25359	28.89126	65.21438	48.62385	66.34673
6	13.74619	19.13876	21.80294	30.66231	38.16592	62.36712	29.96578	41.45642	19.8909	23.73418	30.35585	27.58089
7	49.26604	18.78287	14.20323	30.28112	20.64852	44.88818	39.54971	35.66967	38.18002	38.1005	56.83162	48.64479
8	79.94875	24.76415	82.03742	30.24133	96.75945	35.8365	95.08965	47.03608	65.10828	26.36068	29.22794	38.7931
9	56.96869	44.35429	49.90801	19.82379	43.67127	55.25588	13.69714	26.09512	36.60847	25.11805	17.74751	40.04329
10	33.12858	37.33144	16.37866	9.159919	6.711555	18.77729	8.420528	12.43557	29.1274	27.84372	13.62462	14.8835
11	25.31064	20.89888	30.30303	36.47712	13.14343	22.30588	11.69441	12.70789	42.29854	44.0853	79.81257	44.73266
12	14.58746	12.62715	29.12609	7.729805	20.53117	3.457795	20.82882	3.723856	6.751936	17.11663	11.66667	33.09392
13	31.39535	23.23789	28.12176	39.53695	42.6825	21.42857	61.11822	57.88787	54.44894	27.5729	30.69821	26.23331
14	36.92559	20.15678	20.54358	10.59675	38.00284	28.89887	54.47876	51.23497	78.2392	10.53531	53.68661	26.95079
15	13.46188	9.886128	7.839806	9.901457	54.85725	53.76889	35.66186	41.78136	17.89307	26.46829	21.49286	26.09086

Table 3: Tests of normality

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Right SCM - Pre	.157	15	.200 [*]	.939	15	.369
Right SCM - Post	.223	15	.044	.892	15	.072
Left SCM - Pre	.244	15	.017	.818	15	.006
Left SCM - Post	.146	15	.200 [*]	.917	15	.174
Right Upper Trapezius - Pre	.218	15	.053	.882	15	.050
Right Upper Trapezius - Post	.148	15	.200 [*]	.940	15	.387
Left Upper Trapezius - Pre	.127	15	.200 [*]	.946	15	.460
Left Upper Trapezius - Post	.127	15	.200 [*]	.979	15	.965
Right Spinous Erectae - Pre	.108	15	.200 [*]	.985	15	.993
Right Spinous Erectae - Post	.278	15	.003	.852	15	.018
Left Spinous Erectae - Pre	.228	15	.035	.896	15	.082
Left Spinous Erectae - Post	.134	15	.200 [*]	.980	15	.971
CVA Angle - Pre	.116	15	.200 [*]	.967	15	.810
CVA Angle - Post	.232	15	.029	.848	15	.017
Gaze Angle - Pre	.129	15	.200 [*]	.973	15	.898
Gaze Angle - Post	.158	15	.200 [*]	.950	15	.520

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 4: Descriptive statistics for CVA angle, Gaze angle, Right SCM muscle, Left SCM muscle, Right upper trapezius muscle, left upper trapezius muscle, right spinous erectae muscle and left spinous erectae muscle (Paired T test)

	Mean	Std. Deviation	Std. Error Mean	Mean	t	p value
Right SCM - Pre	32.5941	21.57298	5.57012	8.21157	1.800	.093
Right SCM - Post	24.3825	14.49030	3.74138			
Left SCM - Pre	30.8851	22.73847	5.87105	7.79132	1.428	.175
Left SCM - Post	23.0938	14.09395	3.63904			
Right Upper Trapezius - Pre	33.8323	24.28126	6.26939	2.78635	.446	.662
Right Upper Trapezius - Post	31.0460	18.52338	4.78272			
Left Upper Trapezius - Pre	40.7944	24.39578	6.29896	5.84105	1.184	.256
Left Upper Trapezius - Post	34.9533	17.17460	4.43446			
Right Spinous Erectae - Pre	41.8211	19.89938	5.13800	12.53638	1.857	.085
Right Spinous Erectae - Post	29.2847	12.94247	3.34173			
Left Spinous Erectae - Pre	37.9795	22.32141	5.76336	2.68803	.417	.683
Left Spinous Erectae - Post	35.2914	14.78271	3.81688			

Table 5: Descriptive statistics for differences between right and left SCM, right and left upper trapezius, and right and left spinous erectae muscle (unpaired T test)

Side	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t	P value
CVA Angle - Pre	47.9333	7.26505	1.87583	-1.40000	-0.805	0.434
CVA Angle - Post	49.3333	3.81101	.98400			
Gaze Angle - Pre	18.00	7.260	1.875	5.13333	2.824	0.014
Gaze Angle - Post	12.8667	5.91447	1.52711			
SCM Right	-8.2116	17.66773	4.56179	-0.42024	-0.059	0.953
Post - Pre Left	-7.7913	21.13230	5.45634			
Upper Trapezius Right	-2.7863	24.17124	6.24099	3.05470	0.384	0.704
Post - Pre Left	-5.8410	19.11084	4.93440			
Spinous Erectae Right	-12.5364	26.15255	6.75256	-9.84834	-1.055	0.300
Post - Pre Left	-2.6880	24.96124	6.44496			

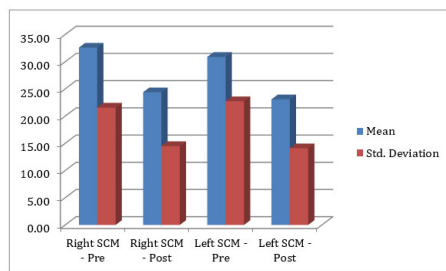
Table 6: Descriptive statistics for inter-relationship between Right SCM muscle, Left SCM muscle, right upper trapezius muscle, left upper trapezius muscle, right spinous erectae muscle and left spinous erectae muscle. (Pearson correlation coefficient)

		Correlations		
		Right SCM Post - Pre	Right Upper Trapezius Post - Pre	Right Spinous Erectae Post - Pre
Right SCM Post - Pre	Pearson Correlation	1	.311	.145
	Sig. (2-tailed)		.259	.607
Right Upper Trapezius Post - Pre	Pearson Correlation	.311	1	.640 [*]
	Sig. (2-tailed)	.259		.010
Right Spinous Erectae Post - Pre	Pearson Correlation	.145	.640 [*]	1
	Sig. (2-tailed)	.607	.010	
		Left SCM Post - Pre	Left Upper Trapezius Post - Pre	Left Spinous Erectae Post - Pre

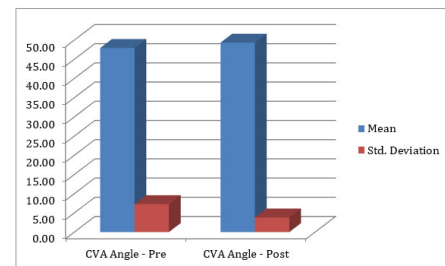
Table 6: (Continued)

		Correlations		
		Right SCM Post - Pre	Right Upper Trapezius Post - Pre	Right Spinous Erectae Post - Pre
Left SCM Post - Pre	Pearson Correlation	1	.576*	-.400
	Sig. (2-tailed)		.025	.140
Left Upper Trapezius Post - Pre	Pearson Correlation	.576*	1	.151
	Sig. (2-tailed)	.025		.591
Left Spinous Erectae Post - Pre	Pearson Correlation	-.400	.151	1
	Sig. (2-tailed)	.140	.591	

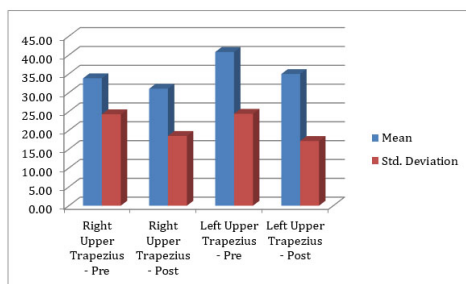
*. Correlation is significant at the 0.05 level (2-tailed).



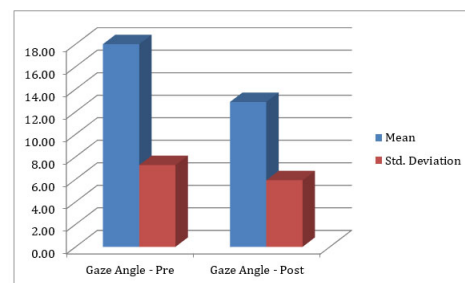
Graph 1: Mean and standard deviation of pre and post treatment right and left SCM.



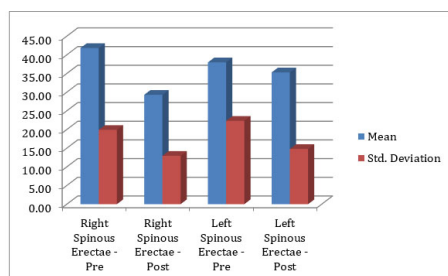
Graph 4: Mean and standard deviation of pre and post CVA angle.



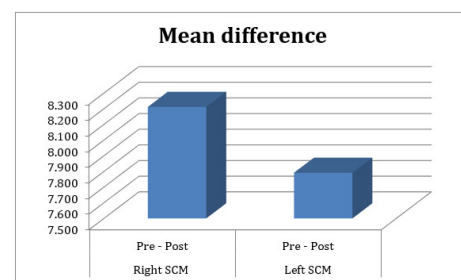
Graph 2: Mean and standard deviation of pre and post right and left upper trapezius.



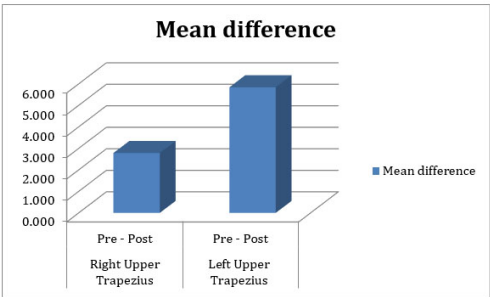
Graph 5: Mean and standard deviation of pre and post gaze angle.



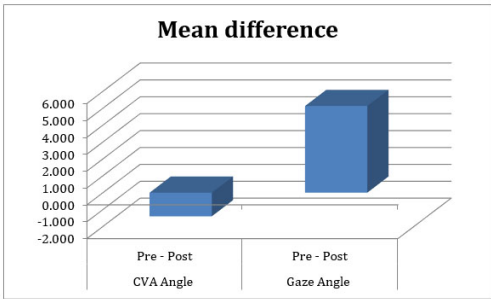
Graph 3: Mean and standard deviation of pre and post right and left spinous erectae.



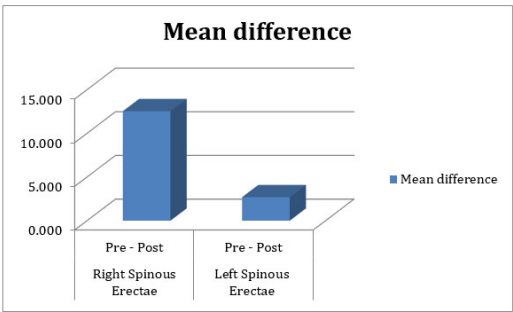
Graph 6: Mean difference of pre and post for right and left SCM.



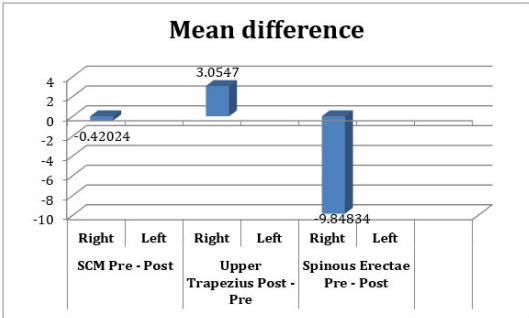
Graph 7: Mean difference of pre and post for right and left upper trapezius.



Graph 9: Mean difference of pre and post for CVA angle and gaze angle.



Graph 8: Mean difference of pre and post for right and left spinous erectae.



Graph 10: Mean difference of pre and post for right and left of all muscles.