Postural Changes in Elderly Hemiplegic Patients and Age Matched Normal Subjects

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ABSTRACT

*The **purpose** of this study was to assess the age-related postural changes in elderly hemiplegic patients and age matched normal subjects. **Subjects.** One hundred and twenty subjects were randomly selected for this study. **Group-I** included 60 elderly stroke hemiplegic patients (39 males and 21 females), with the mean age of (63.7±3.4) years. **Group-II** included 60 age matched elderly normal subjects (44 males and 16 females), with the mean age of (64.6 ± 3.2) years. **Procedures:** Hanon Formeteric System was used for assessing the postural changes in stroke hemiplegic patients and elderly normal subjects. The trunk inclination, trunk imbalance, lateral deviation, pelvic tilting, and pelvic inclination were measured in both groups. Evaluation of the spine was done for both groups when standing in their usual relaxed posture. **Results:** The statistical analysis using independent t-test revealed that there were significant differences in the assessment of the postural changes in the elderly hemiplegic patients in comparison with elderly normal subjects. **Discussion:** Hypokinesia or decreased activity can be a functional cause of loss of flexibility. Older individuals who remain sitting or immobile for long periods of time may develop tightness in those muscles that are shortened in that particular position and may form collagenous adhesions. Loss of flexibility in the aging adult with disability may be even more dramatic. **Conclusion**: The aging process is associated with significant postural changes. These postural changes are aggravated in the elderly hemiplegic patients with significant increases in trunk inclination, trunk imbalance, lateral deviation, and pelvic tilting.*
Key words: *postural changes, elderly subjects, hemiplegic patients.*

INTRODUCTION

Many aging changes will need special attention and management in adults with disabilities. With aging, muscle, skin, and tendons become less flexible and less mobile. The spine becomes less flexible due to collagen changes in the annulus and to decreased water content in the nucleus pulposa. Osteoporotic changes in the vertebral bones may further lead to fractures of the vertebrae, increased collagen scarring, and decreased flexibility of the spine[5].

Age-related changes in posture commonly include a forward head, rounded shoulders, increased thoracic kyphosis, reduced lumbar lordosis and flexed hips and knees. These changes are generally attributed to gradual changes in the structure and mechanics of connective tissues which result in a loss of elasticity and inability to effectively counteract the gravitational torque that pulls the body into a forward bent position. Certainly, muscle weakness can also affect postural alignment[13,15].

During the process of aging, the flexibility of the spine decreases by as much as ten times that of younger individuals. There is also a corresponding loss of strength in the trunk muscles of approximately 1% per year. Between the ages of 30 and 80 years, the strength in cartilage, bone and ligaments reduced by approximately 30%, 20%, and

18%, respectively. In the lumbar region specifically, there is a loss of mobility in the L5-S1 segment with an accompanying increase in the mobility of the other segments[6].

In hemiplegic patients, diminished muscle strength, either paralysis or weakness, is an important category of impairment. A paralyzed muscle is unable to contract to produce enough force for movement. The weak muscle usually contracts insufficiently for joint or body segment movement or to allow functional performance. One of the compensatory patterns is excessive spinal flexion throughout the spine, the convexity on the weak side, and spinal rotation toward the affected side. Patients with the asymmetry usually shift weight onto the stronger hip. This pattern viewed from the front or rear gives the appearance of a low shoulder. This pattern of rotation to the weak side does not occur acutely but develops over time in patients who sit more than they stand or walk[3]. Muscle weakness or abnormal tone in the trunk leads to atypical alignment pattern in the trunk, shoulder and pelvic girdles. This loss of alignment creates an atypical starting position for functional movement that interferes with muscle activation patterns, and limits weight transfer between extremities[2]. Newman et al[16] found that postural stability was optimal within a range of muscle activity, and very large amounts or very small amounts of muscle activity created postural instability.

Loss of trunk control is commonly observed in stroke patients. Impairment in trunk control may lead to: dysfunction in upper and lower limb control; potential for spinal deformity and contracture; impaired ability to interact with the environment due to visual dysfunction secondary to resultant head and neck mal-alignment; symptoms of dysphasia secondary to proximal mal-alignment; decreased independence in activities of daily living; decreased sitting and standing tolerance and impaired balance function[11]. Thus, stroke patients are more prone to falls than non-stroke subjects because of the pathologic condition imposed on their physiologic aging process[4].

This study was done to compare the age-related postural changes in the spine of elderly hemiplegic patients with the age matched normal subjects.

SUBJECTS AND METHODS

Subjects

One hundred and twenty males and females were randomly selected for this study. The ages of all subjects were from sixty to seventy years in both groups. They were free from any advanced neuropathic, musculoskeletal or cardiovascular disorders that could affect postural alignment. They were assigned into two equal groups:

Group-I: Sixty elderly stroke hemiplegic patients diagnosed by physician (according to physical examination and Computerized axial Tomography or MRI) as thrombotic hemiplegia. All patients were selected randomly from the Out Patient’s Clinic, Faculty of Physical Therapy, Cairo University. All patients were selected according to Function Ambulation Category (grade four) (Hess et al., 1994)[14] in which the patient can walk independently on level ground, but requires help on stairs, slops, or uneven surface. Their ages were thirty nine males and 21 females, with the mean age of (63.7±3.4) years. Twenty five patients were with the right side affected and 35 patients were with the left side affected. The duration of illness was more than one year.

Group-II: Sixty age matched elderly normal subjects (44 males and 16 females), with the mean age of (64.6 ± 3.2) years.

This study was conducted in Hanon Formeteric Lab at the Faculty of Physical Therapy, Cairo University.

Instrumentation

Hanon Formeteric System: This device was used for assessing postural alignment in three planes (3D). It consists of adjustable camera. The system is interfaced with computer software maintained through the control panel screen and connected with printer to print test results.

Hanon Formetric System serves for the determination of the geometry of the back surface of human beings based on non-contact 3D – scan. A spatial reconstruction of the 3D spine derived by means of a specific mathematical model. The device is reliable, valid and non-invasive method in assessing any spinal or pelvic deviation. The device uses the three-dimensional analysis so it can detect any deviations in any planes. Also it take a little time for full back analysis, that can be recorded and printed out without sophisticated mathematical calculations In x-ray method or using many devices to get results[8].

Procedure

All subjects were signed a written consent form after they informed about the whole procedures and testing.

Hanon Formeteric System was switched on then the program of measurement started. Each subject removes all his or her clothes except the underwear. Each subject was asked to stand facing to the wall and in a good position without any deviation as much as possible. Subject was asked to little descend the underwear to show the sacrum bone (two dimple lower points). The camera was adjusted for the suitable height (to get complete picture of the spine), then the spine of the subject was taken a photo, then it will be adjusted with removing the head, arms and lower limbs from the point down to the dimple points of the sacrum. This copy will be printed in three planes to show the spine in sagittal plane. The device uses different anatomical landmarks to calculate vertebral column deviation parameters. These landmarks are; the C7 vertebra prominence (VP); the sacrum point (SP); the left lumbar dimple (DL); the right lumbar dimple (DR) and the midpoint between lumbar dimple (DM). The accuracy and reliability of the parameters depend on the determination of these anatomical landmarks. The following parameters were collected and printed for statistical analysis[9].

- Trunk Inclination: The trunk inclination is the angle (in lateral projection) between the line of gravity and the line connecting the anatomical landmarks vertebra prominence (VP) and the midpoint between lumbar dimples (DM). The angle is positive with VP anterior to DM (typical in leaning forward) and negative with VP posterior to DM (leaning backward).
- Trunk Imbalance: The trunk imbalance is defined as the lateral deviation of the vertebra prominence from the dimple midpoint DM. It is measured in millimeters and degrees. A positive value means a shift of VP to the right, a negative value a shift to the left.
- Lateral Deviation: The maximum lateral deviation of the spinal midline from the line of vertebra prominence (VP) and the midpoint between lumbar dimples (DM). A positive or negative value indicates a deviation to the right, or left respectively.
- Pelvic Tilt: The pelvic tilt refers to the height difference of the lumbar dimples relative to a horizontal plane. A positive value means that the right dimple is higher than the left one.

- Pelvic Inclination: It twisting of the pelvis about a transverse axis. It is calculated from the mutual twist of the surface normal at the two lumbar dimples. If the angular difference is positive, the surface normal at the right dimple (DR) is pointing higher than the left one.
- Kyphotic Angle at Thoracic 12: This is the kyphotic angle as measured between vertebra prominence (VP) and the estimated location of T12.
- Kyphotic Apex: The kyphotic apex in the lateral projection curve is the posterior apex of the sagittal profile in the upper part of the spinal profile.
- Maximal Kyphotic Angle: This is the angle between the upper inflection point near vertebra prominence C7 and the thoraco-lumbar inflection point.
- Lordotic Apex: The lordotic apex in the lateral projection curve is the anterior apex of the sagittal profile in the lower part of the spinal profile.
- Lordodic angle: This angle is defined in analogy to the corresponding kyphotic angle where the landmark vertebra prominence C7 is replaced by midpoint between lumbar dimples (DM). The maximum lordotic angle is defined by the thoraco-lumbar inflection point and the lumbar-sacral inflection point near DM.

Statistical Analysis

The collected data were statistically analyzed by calculating the mean and standard deviation. Independent t-test was used to compare the mean values of elderly hemiplegic patients with elderly normal subjects.

RESULTS

The general characteristics of subjects in both groups (Group-I and Group-II) which include age, weight, height, body mass index (BMI) and duration of illness were presented in table 1. There were non-significant differences between both groups indicating homogeneity of both groups.

Table (1): The general characteristics of subjects in both groups.

Variables	Group-I		Group-II		Significance	
	Mean	SD	Mean	SD	t-value	P-value
Age (Yrs)	63.7	3.4	64.6	3.2	3.91	0.07
Weight (Kg)	71.8	5.6	72.3	4.9	0.426	0.664
Height (cm)	175.3	6.87	178.5	4.17	2.18	0.06
BMI	23.5	1.3	23.06	1.1	1.33	0.186
Duration of illness (mo)	15.5	3.1				

The mean value of the trunk inclination was (4.83 ± 2.53) degrees in group-I while it was 3.52 ± 2.49 degrees in group-II. The t-value was 2.1 and the P-value was 0.05 with significant difference between both groups. The mean value of trunk imbalance was 16.7 ± 6.47 degrees in group 1 while it was 7.12 ± 2.79 degrees in group-II. The t-value was 3.69 and the P-value was 0.000 with a very highly significant difference between both groups. The mean value of trunk lateral deviation was 12.6 ± 5.21 degrees in group 1 while it was 11.47 ± 4.62 degrees in group-II. The t-value was 2.72 and the P-value was 0.009 with a very highly significant difference between both groups table 2, fig.1.

Table (2): The mean values of the trunk inclination, trunk imbalance and trunk lateral deviation in hemiplegic patients (G-1) and elderly normal subjects (G-11).

Variables	Group-I		Group-II		Significance	
	Mean	SD	Mean	SD	t-value	P-Value
Trunk inclination	4.83	2.53	3.52	2.49	2.1	0.05*
Trunk imbalance	16.7	6.47	7.12	2.79	3.69	0.000*
Lateral deviation	12.6	5.21	11.47	4.62	2.72	0.009*

*significant level at 0.05

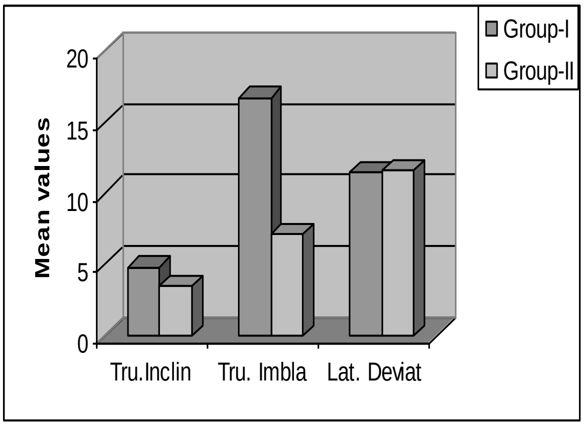

Fig. (1): The mean values of the trunk inclination, trunk imbalance, and lateral deviation in hemiplegic patients (G1) and elderly normal subjects (G11).

The mean value of pelvic tilting was 19.1 ± 9.94 degrees in group-1 while it was 8.8 ± 4.5 degrees in group-II. The t-value was 5.18 and the P-value was 0.000 with a very highly significant difference between both groups. The mean value of pelvic inclination was 21.52 ± 8.5 degrees in group 1 while it was 16.68 ± 4.6 degrees in group-II. The t-value was 2.58 and the P-value was 0.12 with non-significant difference between both groups table 3, fig. 2.

Table (3): The mean values of the Pelvic tilting and pelvic inclination in hemiplegic patients (G-1) and elderly normal subjects (G-11).

Variables	Group-I		Group-II		Significance	
	Mean	SD	Mean	SD	t-value	P-Value
Pelvic tilting	19.1	9.94	8.8	4.5	5.18	0.000*
Pelvic inclination	21.52	8.5	16.68	4.6	2.58	0.12

*significant level at 0.05

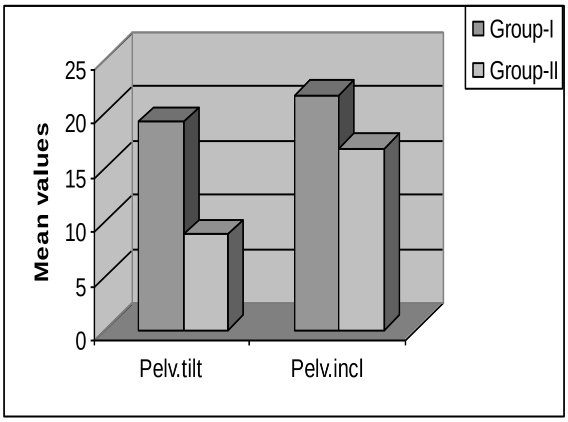

Fig. (2): The mean values of the Pelvic tilting and pelvic inclination in hemiplegic patients (G-1) and elderly normal subjects (G-11).

The mean value of trunk kyphotic angle at thoracic 12 was 46.36 ± 8.5 degrees in group-I while it was 46.96 ± 4.6 degrees in group-II. The t-value was 0.35 and the P-value was 0.72 with no significant difference between both groups. The mean value of trunk kyphotic apex was 147.3 ± 44.31 degrees in group-I while it was 135.5 ± 17.9 degrees in group-II. The t-value was 1.35 and the P-value was 0.18 with no significant difference between both groups. The mean value of trunk maximal kyphotic angle was 44.45 ± 12.21 degrees in group-1 while it was 43.98 ± 7.7 degrees in group-II. The t-value was 0.178 and the P-value was 0.85 with no significant difference between both groups table 4, fig. 3.

Table (4): The mean values of the kyphotic angle at thoracic 12, kyphotic apex, and the maximal kyphotic angle in hemiplegic patients (G-1) and elderly normal subjects (G11).

Variables	Group-I		Group-II		Significance	
	Mean	SD	Mean	SD	t-value	P-Value
kyphotic angle at thoracic 12	46.36	8.5	46.96	4.6	0.35	0.72
kyphotic apex	147.3	44.31	135.5	17.9	1.35	0.18
maximal kyphotic angle	44.45	12.21	43.98	7.7	0.178	0.85

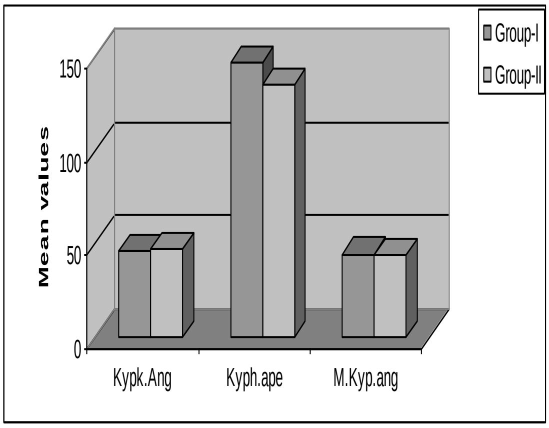

Fig. (3): The mean values of the kyphotic angle at thoracic 12, kyphotic apex, and the maximal kyphotic angle in hemiplegic patients (G-1) and elderly normal subjects (G-11).

The mean value of trunk lordotic apex was 339.17 ± 94.5 degrees in group-1 while it was 314.5 ± 37.1 degrees in group-11. The t-value was 1.13 and the P-value was 0.26 with no significant difference between both groups. The mean value of trunk maximal lordotic angle was 29.4 ± 14.9 degrees in group-1 while it was 29.9 ± 9.8 degrees in group-II. The t-value was 0.145 and the P-value was 0.88 with no significant difference between both groups table 5, fig. 4.

Table (5): The mean values of the Lordotic apex, and the maximal Lordotic angle in hemiplegic patients (G-1) and elderly normal subjects (G-11).

Variables	Group-I		Group-II		Significance	
	Mean	SD	Mean	SD	t-value	P-Value
Lordotic apex	339.17	94.5	314.5	73.1	1.130	0.26
maximal Lordotic angle	29.4	14.9	29.9	9.8	0.145	0.88

*significant level at 0.05

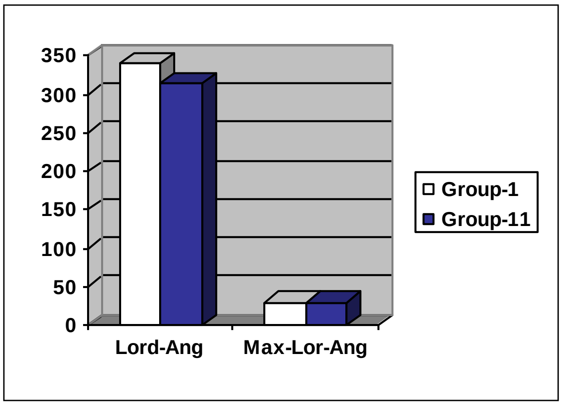

Fig (4): The mean values of the Lordotic apex, and the maximal Lordotic angle in hemiplegic patients (G-1) and elderly normal subjects (G-11).

DISCUSSION

Posture is derived from the relationship of body parts one to another, as well as to the maturation and interaction of the musculoskeletal, neuromuscular, and cardiopulmonary systems. Additionally, psychological well-being may have an impact on the posture of an individual. Upright posture either in sitting or in standing seems to demonstrate the most noticeable changes as one age. In sitting, the older person's head may tend to be forward; the shoulders may be rounded, and the upper back may be kyphotic. In the low back, a flatter lumbar lordosis may be seen. In standing, flexion at the hips and knees may be more noticeable. These changes in the spine and in the lower extremities are most frequently caused by changes in the intervertebral disk as well as by decreased mobility or hypokinesia[20].

In this study the age-related postural changes in the spine of elderly hemiplegic patients were compared with age matched normal subjects. The results of this study showed that there were significant differences of the trunk inclination, trunk imbalance, trunk lateral deviation, and pelvic tilting in hemiplegic patients compared to elderly normal subjects. While there were non-significant differences of pelvic inclination, kyphotic angle at thoracic 12, kyphotic apex, maximal kyphotic angle, Lordotic apex, and the maximal Lordotic angle in the hemiplegic patients compared to elderly normal subjects. These changes may be due to hemiplegia musculoskeletal consequences. Stokes et al[19] indicated that in normal subjects, coactivation between trunk muscles increases with intensity of muscle activation in response to changes in loading and displacement perturbations. This might enforce the concept that trunk muscles share in postural adjustment and prevention of falling.

Reduction in strength of the trunk muscles which accompany stroke may play a role in the postural changes which had been detected in the present study. In this study the trunk lateral deviation and inclination are significantly higher in stroke hemiplegic patients than in normal elderly subjects, these may be due to residual and impairment (muscle weakness and spasticity) of the neurological affection that may be exaggerated by the effect of the gravitational force during sitting and standing positions. Tanaka et al[13] stated that the two possible sources of trunk muscle weakness in hemiplegic patients are the effect of the upper motor neuron lesion and disuse. In these patients, a unilateral upper motor neuron lesion may cause slight muscle weakness on each side of the trunk that cannot be detected by physical examination. In addition, trunk muscles show possible insufficient recruitment of high threshold motor units, which produces poor trunk muscle contraction at high speed.

Archambault et al[1] tested the hypothesis that cortical and sub cortical brain lesions may disrupt the timing of trunk and arm endpoint motion in hemiparetic subjects. Movements in hemiparetic subjects were segmented, slower, and characterized by a greater variability and by deflection of the trajectory from a straight line if compared with healthy subjects. In addition, there was a moderate increase in the errors in movement direction and extent. Moreover, hemiparetic patients were unable to stabilize the sequence of trunk and arm endpoint movements in a set of trials. The results indicated that recruitment and sequencing of different degrees of freedom may be impaired in this population of patients.

Hypokinesia or decreased activity can be a functional cause of loss of flexibility. Older individuals who remain sitting or immobile for long periods of time may develop tightness in those muscles that are shortened in that particular position and may form collagenous adhesions. In particular, decreased passive and active range of motion particularly in the flexor musculature may be seen in elderly who sit for extended times during the day. Loss of flexibility in the aging adult with disability may be even more dramatic. Older persons with neuromotor problems have age-related changes in joint function and bone density in addition to the immobility that they may have experienced all of their lives. If the individual has been inactive, adequate bone density and mass may not have been developed at a younger age, and therefore, that individual is likely to experience an accelerated loss of bone density and mass with age. Individuals with physical disabilities have been noted to experience additional problems in the musculoskeletal system as they age. Pain, soreness, weakness of muscles, and energy decline has been reported along with the tendency to be more susceptible to injury among persons with longstanding disabilities. Loss of muscle strength in individuals who have had difficulty with movement all of their lives may be even greater than that expected solely due to the aging process[7].

Therefore, as with older adults, moderate regular exercise is essential for maintaining mobility in adults with disabilities. Loss of even a small amount of strength may lead to loss of functional abilities in this population because of the very sensitive balance between muscles group that has been developed over time for some functional activities. Additionally, increased occurrences of complications such as pressure sores, contractures, and pneumonia may result from immobility in some older adults who have lifelong limitations in movement. Bed rest or chair rest should be avoided if at all possible, and gross motor activities should be included as a part of the day's activity schedule[19]. Moreover, Spring et al[18] stated that in order to stabilize and balance the trunk and pelvis there should be an optimal interaction of the muscles of the abdomen, the lateral trunk, the back and the flexors and extensors of the hip. If that balance is disrupted, muscular imbalance and weakness or shortening of the muscles involved can occur. That imbalance leads to inadequate and excessive strain of the functional system of spine and pelvis.

Regarding the validity and reliability of the formetric-11 imaging system, Goh et al,[12] studied the reliability of the system by performing repeated imaging of back shape on ten volunteers of widely different ages ranged from 19 to 64 years old. The results indicated the reliability of the formetric-11 imaging system; this reliability was influenced by the variability in subject posture, with minimal errors arising from internal system inaccuracies. Also, Fusco et al,[10] used the formetric machine for the diagnosis and evaluation of their patients, all suffering from postural disorders. Moreover, Pfaff[17] examined his patients by using the three dimensional analysis of the spinal column. The images produced by sophisticated software allow seeing the frontal and lateral projections of the vertebral column and it could calculate exactly the vertebral rotation and express the results in a graded form.

Conclusion

The aging process is associated with significant postural changes. These postural changes are aggravated in the elderly hemiplegic patients with significant increases in trunk inclination, trunk imbalance, lateral deviation and pelvic tilting.

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الملخص العربى

التغيرات فى القوام عند المسنين المصابين بالشلل النصفى الطولى والمسنين الاصحاء فى نفس الشريحه العمريه

كان الهدف من هذه الدراسه هو تقييم التغيرات فى القوام المصاحبه للمسنين بالشلل النصفى الطولى والمسنين الاصحاء من نفس الشريحه العمريه . أختير لهذه الدراسه 120 شخص من السيدات والرجال - المجموعه الاولى وتشمل 60 مريضا تم اختيارهم عشوائيا من مرضى العياده الخارجيه – كليه العلاج الطبيعى – جامعه القاهره. كان متوسط العمر لهذه المجموعة63.7 ± 3.4 سنه ثم المجموعه الثانيه وتشمل 60 شخص من السيدات والرجال الاصحاء متوسط العمر64.6 ± 3.2 سنه . تم استخدام جهاز الهانون فورميترك لقياس التغيرات فى القوام (انحراف الجذع ميل الحوض ، الاتب وميل الحوض) عند المجموعتين بعد معالجه النتائج احصائيا وجد فرق معنوى فى التغييرات فى القوام المصاحبه للمسنين المصابين بالشلل النصفى الطولى عنه فى المسنين الاصحاء. استنتج أن ذلك يسبب قله الحركه والجلوس لفترات طويله عند المصابين بالشلل النصفى الطولى مما يؤدى الى قله المرونه فى القوام وقصر العضلات مما يؤدى الى حدوث التغيرات فى القوام .