INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881; IMPACT FACTOR :6.514(2021); IC VALUE:5.16; ISI VALUE:2.286
Peer Reviewed and Refereed Journal: VOLUME:10, ISSUE:4(5), April:2021
Online Copy Available: www.ijmer.in
Digital certificate of publication:http://ijmer.in/pdf/e-Certificate%20of%20Publication-IJMER.pdf

TO COMPARE THE CENTER OF PRESSURE (COP) EXCURSION ACROSS THE SCI-FCS SCORE BY MODIFIED FUNCTIONAL REACH TEST

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Abstract

Aim and Objective

1. **Aim**: To compare the center of pressure excursion across spinal cord injury – fall concern scale (SCI-FCS) by performing Modified functional reach test (MFRT) inSpinal Cord Injury (SCI).
2. **Objective**

- To compare the center of pressure excursion across high fall concernby performing Modified functional reach test in SCI.
- To compare the center of pressure excursion across low fall concernby performingModified functional reach test in SCI.

Methods

Thirty subjects with Spinal Cord Injury (SCI) were recruited. In all subjects, the measurement of fear of fall concerned was measured by using Spinal cord injury – fall concern scale (SCI-FCS) and on the basis of SCI-FCS Score the subjects are divided into two group i.e., the high fall concern and low fall concern in SCI, and measurement of their center of pressure excursion respectively by performing MFRT.

Result

There was significant correlation difference were found between fear of fall concern and center of pressure for high fall concern subjects. But for the low fall concern there was no significant correlation difference were found. Because, we could not find the subjects with low fall concern in SCI.

Conclusion

This study concluded that the psychological factor i.e., high fall concern has a significant impact on center of pressure which could affect the sitting balance in subjects with SCI. and it also, concluded that anterior weight shifts via performing Modified Functional Reach Test could helpful in minimization of pressure over the loading gluteal regions and improving the sitting balance.

Keywords: Spinal Cord Injury, Occupational Therapy, Correlation of Data,Postural Balance.

Introduction

Spinal cord injury (SCI) is an abuse to the spinal cord and leading to a change, either temporary or permanent, within the cord's normal motor, sensory, or autonomic function. (49) Spinal cord injury (SCI) is the low-incidence and high-cost injury that results in a massive change in an individual's life. Paralysis of the muscles below the level of injury can lead to limited and altered mobility, self-care, and the ability to play a role in socially-valued activities. The psycho-social impact of SCI can be just as great as physical impact. (51) Limited physical capacities or inability to get around and carry out daily routine activities, and feeling of confusion, discouragement is link with loss of job and questions about the ability to return home. (52)

Both the physical performance and psychological factors are associated with fall-related concerns. Fall or nearly all fall experiences, leading to low balance confidence, leading to activity avoidance, leading to functional decline, and leading to a greater risk of falls. (17) Falls are common among individuals living with spinal cord injury (SCI).

Falls are the most common problem in people with spinal cord injury (SCI) who is wheelchair dependent. In which about 40-60% of people using manual wheelchair reports fall.(17) Falls are most often appear during transfer (44%), reaching (11%), propelling a wheelchair (15%), moving in bed (22%), transferring to or riding in a vehicle (30%), and taking a shower (8%).(17) Wheelchair users with SCI have been found to have decreased or absent trunk control, leading to poor sitting balance and stability, which in turn may cause falls during transfer.(2) Falls Concern in a wheelchair using people with spinal cord injury (SCI) is a relatively new field but indicates that falls are common. Fear of falling is closely connected to falls in people with neurological diseases. (36) Because of fear of fall concern in SCI, it may lead to the limitations in activity and restrictions in participation in daily routine life. (36)

Asymmetry of static sitting in SCI can create complication such as spine deformity, a common secondary effect of muscle imbalance, and loss of sensory ability and perception may lead to an asymmetry in loading. This asymmetry will further exacerbate the consequence of high pressure on the Loading regions (ischial tuberosity, sacrum/coccyx or greater trochanter). (32) The increase in pressure ulcers is the main problem for people with SCI. These patients are at high risk of skin breakdown, because of narrow mobility and sensation. [13] The wheelchair users are at high risk to develop a sitting-acquired pressure ulcer, which occurs in the regions of the ischial tuberosity, sacrum/coccyx or greater trochanter. [16]

Emelie Butler Forslund et al. in 2017, did a study on 87 persons with traumatic SCI and 73 healthy subjects. The study aimed to identify the incidence of falls and recurrent falls (>2 falls) and the incidence and severity of fall-related injuries in wheelchair users with SCI. The data were collected by fall reported by text messages every second week for one year and were followed-up by telephone interviews. The outcomes were measured by the incidence of falls and related injuries, risk indicators for recurrent falls, and injuries. Spinal Cord Injury – Fall Concern Scale (SCI-FCS) was translated to Swedish and tested for validity. This study concluded that ambulatory persons fell more than wheelchair users. Spinal Cord Injury – Fall Concern Scale (SCI-FCS) showed promising validity. Downton fall risk index could not predict those who fell, while the question of falls previous year was more accurate. [24]

Vivien Jørgensen et al. in 2016, did a study on 180 persons with complete and incomplete SCI. The study aimed to determine fear of fall (FoF) in ambulating persons and wheelchair users with SCI and to investigate the relationship between FoF and age, gender, ability to get up from the ground, and previous falls. The outcomes were measured by FoF using FES-I and Spinal Cord Injury – Fall Concern Scale (SCI-FCS). Higher scores indicate high levels of FOF. A cut-off score of 23 points was used for the high concern of falling. The study was concluded in following - (1) Ambulatory persons had high and wheelchair users low fear of falling, (2) Self-reported falls the previous year or inability to get up from the ground, significantly raised the concerns about falling in wheelchair users, (3) Highest concern about falling was rated when walking on slippery and uneven surfaces in ambulating persons and when pushing on uneven surfaces and up and down curbs in wheelchair users. [40]

Methodology
Study Design
- Observational study

Method of Study
- Qualitative research

Study Model
- Correlation

Type of Inquiry
- Retrospective

Study Setting
- Department of Rehabilitation, Indian Spinal Injuries Center, Vasant Kunj, New Delhi

Method of Sampling
- Convenience sampling

Sampling Size
- 30

Duration of Study
- Six months.

Criteria
Inclusion Criteria
- Age 16 years and above.
- Both male and female.
- Level C6 to T5, traumatic and non-traumatic.
- The person with ASIA –A or B.
- Sub-acute and chronic conditions.
- Spinal Cord Injury – Fall Concern Scale (SCI-FCS) response was not less than for any item.
- Subject who could perform dynamic equilibrium activities with the upper limb of the trunk control test.

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Exclusion Criteria

- Subjects who were unable to co-operate.
- Subjects with hearing and visual deficits.
- Severe ulcer or orthopedics problems in the upper limb.
- Subject who were unable to read and wrote English.

Variables

- Dependent variables
- Independent variables

Instrument

- **Dependent variables**

1. Spinal Cord Injury Falls Concern Scale

- **Independent variables**

2. Center of Pressure (COP) During Sitting in Erect Position (COP-E)
3. Center of Pressure (COP) During MFRT in Test -1 Position (COP-T1)
4. Center of Pressure (COP) During MFRT in Test -2 Position (COP-T2)
5. Center of Pressure (COP) During MFRT in Test -3 Position (COP-T3)

- **Baseline measurement**

1. Trunk Control Test
2. Spinal Cord Injury –Fall Concern Scale
3. Modified Functional Reach Test
4. Center of Pressure

- **Other equipment**

1. Computer
2. Dartboard
3. Basketball
4. Measuring –tape

Procedure

This study carried outthirty subjects with Spinal Cord Injury (SCI) were recruited. In all subjects, the assessed fear of fall concerned was measured by using Spinal cord injury – fall concern scale (SCI-FCS) and on the basis of SCI-FCS Score the subjects were divided into two group i.e., the high fall concern and low fall concern in SCI. In all subjects, a change in the center of pressure at the performance as used to measure Modified functional reach test (MFRT). it's used by TEKSCAN Pressure Mat (TPM) while the subjects were seated in a wheelchair.

Analyzed the Maximum Center of pressure (COP) by TEKSCAN Pressure Mat (TPM) by the following steps: Step 1: Open a Software CONFORMat clinical 7.60, Step 2: Click- File, Step 3: For creating a new data file-click- New client, Step 4:Taking the Identification Data in Client Records, Step 5:After saving the client Data-Click the Clients detail to open client data, Step 6: Click the TOOLS and Click - Self Calibration, Step 7: Click -Show Panes – It would divide the pressure distribution area in four- compartment- right, left, upper, and lower, Step 8: Click- Add box- It would divide the pressure distribution area between Mark the Ischial tuberosity regions, Step 9: Assessment of Evaluation of Modified Functional Reach Test (MFRT) i.e., test 1- maximum weight shift with arms crossed over the chest, test 2- maximum weight shift with both arms extending forward with a 90° shoulder flexion, test 3- maximum weight shift with both arms extending forward with a 90° shoulder flexion and holding aBasketball. the baseline of assessment this study was carried out respectively.

Data Analysis and Result

Data Analysis: Data was analyzed by used of SPSS version 22.

1. Pearson correlation coefficients (r) were used to analyze the relationship between the spinal cord injury fall concern scale (SCI-FCS) and center of pressure (COP) excursion in erect position (E).
2. Pearson correlation coefficients (r) were used to analyze the relationship between the spinal cord injury fall concern scale (SCI-FCS) and center of pressure (COP) excursion in the Test-1 position (T1).

3. Pearson correlation coefficients (r) were used to analyze the relationship between the spinal cord injury fall concern scale (SCI-FCS) and center of pressure (COP) excursion in the Test -2 position (T2).
4. Pearson correlation coefficients (r) were used to analyze the relationship between the spinal cord injury fall concern scale (SCI-FCS) and center of pressure (COP) excursion in the Test -3 position (T3).

Results

This study shows that there was significant correlation difference between fear of fall concern and maximum center of pressure (COP) for people with high fall concern in Spinal Cord Injury (SCI). There was no significant correlation difference between low fall concern, because we could not get the subjects of low fall concerns in SCI.

Table 1: Correlations between COP-E and SCI-FCS score

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
SCI-FCS SCORE	45.63	8.092	30
COP-E	30.767	7.9456	30

Table1: Data shows descriptive statistics between COP-E and SCI-FCS score of all 30 subject mean value are 45.63 and 30.767 respectively, standard deviation 8.092 and 7.9452 respectively.

Table 2: Correlations Between COP-E and SCI-FCS Score

Correlations			
		SCI-FCS SCORE	**COP-E**
SCI-FCS SCORE	Pearson Correlation	1	.439*
	Sig. (2-tailed)		.015
	N	30	30
COP-E	Pearson Correlation	.439*	1
	Sig. (2-tailed)	.015	
	N	30	30
*Correlation significant at 0.05 level (2-tailed).			

Table 2: Data shows correlations between COP-E and SCI-FCS score of all 30 subject the relationship (r = .439) was positive, moderate in strength and statistically significant (p <.015, 2-tailed) respectively

Graph 1: Shows that Scatter Plot Graphical Representation of Correlations Between COP-E and SCI-FCS Score

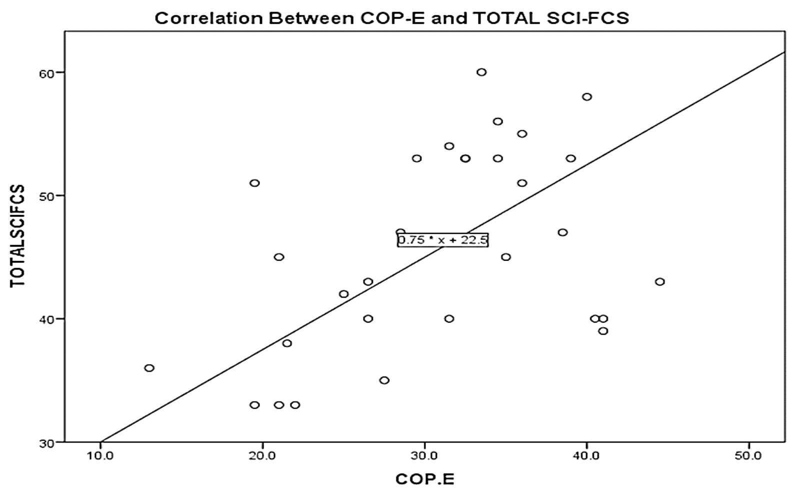

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Table 3: Correlations between COP-T1 and SCI-FCS score

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
SCI-FCS SCORE	45.63	8.092	30
COP-T1	26.333	8.8174	30

Table 3: Data shows descriptive statistics between COP-T1 and SCI-FCS score of all 30 subject mean value are 45.63 and 26.333 respectively, standard deviation 8.092 and 8.8174 respectively.

Table 4: Correlations Between COP-T1 and SCI-FCS Score

Correlations			
		SCI-FCS SCORE	**COP-T1**
SCI-FCS SCORE	Pearson Correlation	1	.553**
	Sig. (2-tailed)		.002
	N	30	30
COP-T1	Pearson Correlation	.553**	1
	Sig. (2-tailed)	.002	
	N	30	30
**Correlation significant at 0.01 level (2-tailed).			

Table 4: Data shows correlations between COP-T1 and SCI-FCS score of all 30 subject the relationship ($r = .553$) was positive, moderate in strength and statistically significant ($p < .002$, 2-tailed) respectively.

Graph 2: Scatter Plot Graphical Representation of Correlations Between COP-T1 and SCI-FCS Score

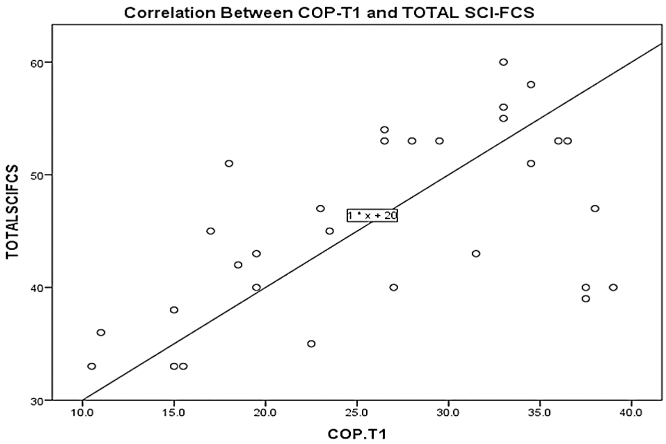


Table 5: Correlations between COP-T2 and SCI-FCS score

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
SCI-FCS SCORE	45.63	8.092	30
COP-T2	21.417	6.4809	30

Table 5: Data shows descriptive statistics between COP-T2 and SCI-FCS score of all 30 subject mean value are 45.63 and 21.417 respectively, standard deviation 8.092 and 6.4809 respectively.

Table 6: Descriptive Statistics Between COP-T2 and SCI-FCS Score

Correlations			
		SCI-FCS SCORE	COPT-2
SCI-FCS SCORE	Pearson Correlation	1	.532**
	Sig. (2-tailed)		.002
	N	30	30
COP-T2	Pearson Correlation	.532**	1
	Sig. (2-tailed)	.002	
	N	30	30
**. Correlation significant at 0.01 level (2-tailed).			

Table 6: Data shows correlations between COP-T2 and SCI-FCS score of all 30 subject the relationship (r = .552) was positive, moderate in strength and statistically significant (p <.002, 2-tailed) respectively

Graph 3: Scatter Plot Graphical Representation of Correlations Between COP-T2 and SCI-FCS Score

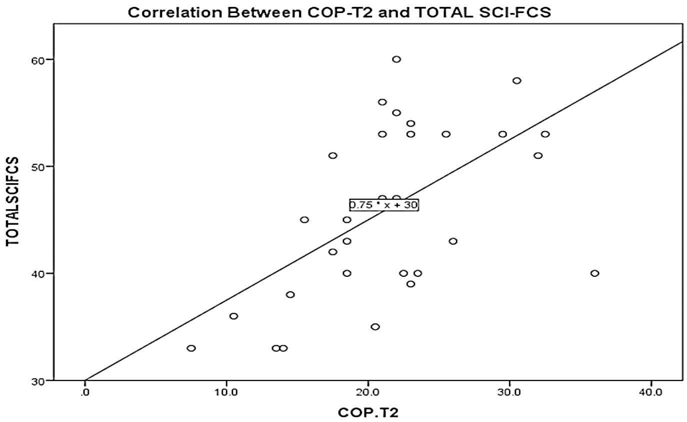


Table 7: Correlations between COP-T3 and SCI-FCS score

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
SCI-FCS SCORE	45.63	8.092	30
COP-T3	17.500	6.7849	30

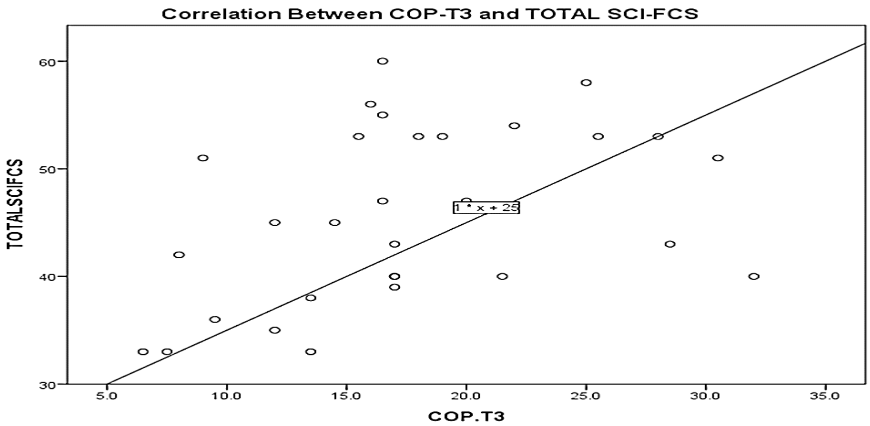
Table 7: Data shows descriptive statistics between COP-T1 and SCI-FCS score of all 30 subject mean value are 45.63 and 17.500 respectively, standard deviation 8.092 and 6.7849 respectively.

Table 8: Descriptive Statistics Between COP-T3 and SCI-FCS Score

Correlations			
		SCI-FCS SCORE	COP-T3
SCI-FCS SCORE	Pearson Correlation	1	.410*
	Sig. (2-tailed)		.025
	N	30	30
COP-T3	Pearson Correlation	.410*	1
	Sig. (2-tailed)	.025	
	N	30	30
*. Correlation significant at 0.05 level (2-tailed).			

Table 8: Data shows correlations between COP-T3 and SCI-FCS score of all 30 subject the relationship (r = .410) was positive, moderate in strength and statistically significant (p <.002, 2-tailed) respectively

Graph 4: Scatter Plot Graphical Representation of Correlations Between COP-T3 and SCI-FCS Score



Discussion

This study discussed the major findings related to the impact of psychological factors i.e., Fear of falling concern on the COP while performing anterior weight shifting (via MFRT) in person with SCI [15].

The results of the present study support the alternate hypothesis that there is a significant impact of fear of fall concern in the change of center of pressure (COP) on pressure mapping device in all three anterior weight shifts methods i.e., test 1- maximum weight shift with arms crossed over the chest, test 2- maximum weight shift with both arms extending forward with a 90° shoulder flexion, test 3- maximum weight shift with both arms extending forward with a 90° shoulder flexion and holding a Basketball.

The current finding of this study suggested that while performing the anterior weight shifting methods via MFRT the COP was highest in the erect position which was 30.767, As we moved from erect position to test-1 position the COP was 26.333, and from erect position to test-2 position the COP was 21.417, and from erect position to test-3 position the COP was 17.500. These results showed that the pressure was released in test-3 was maximum on the loading regions (ischial tuberosity, sacrum/coccyx or greater trochanter). And moderate pressure was release in test-2 and mild pressure was release in test-1 [15].

The result of this study indicates that a statistically significant positive correlation coefficient [test - E (r =.439), test-1 (r =.553), test-2 (r =.532), test-3 (r = .410)] was found amongst the all variables. This finding supports the previous literature which concluded that postural control of individuals with cervical and high thoracic SCI are worse than that of healthy individuals [14,46]

Postural control allows the individual to maintain balance when body movement occur [9]. Poor postural control in SCI leads to a poor sitting balance which further leads to high incidence of falls [47] and a history of falls may put individuals with SCI at risk of developing a fear of falling [47]. Fear of falling is associated with depression, reduced participation in mobility and activities of daily living (ADL), and physical and mental decline.[44,47]

SCI individual could develop an abnormal sitting habit due to fear of fall [16] which could lead to asymmetry of static sitting in SCI [35].The anterior weight shifting (via MFRT) was helpful in to improving the sitting balance and prevent falls from sitting in SCI [9], and it is also helpful in to lower the sitting load on the loading regions such buttock's, and those areas which is close to ischial tuberosities [26].

Complication in SCI such as spine deformity, muscle imbalance, and loss of sensory ability and perception may lead to asymmetry in loading regions [35]. This asymmetry will further exacerbate the consequences of high pressure on the loading regions [35] which could lead pressure ulcer which is most common in higher SCI (cervical/thoracic) level than lower SCI (lumbar/sacral) level [45]. Pressure ulcer could cause vast complication such as local, systemic, chronic or even life-threatening infections. It is also associated with increased duration of hospitalisation, increases re-hospitalization rates, decreased life expectancy and death [48].

To prevent pressure ulcer, previous literature suggests that anterior weight shifting method was helpful in toreduced tissue deformations, and increased (functional) mobility (proximal stability gives distal mobility) [50].

The present study revealed that by performing Anterior weight shifting methods via MFRT is helpful in reducing the pressure over the Loading regions (ischial tuberosity, sacrum/coccyx or greater trochanter) and also helpful in preventing the pressure ulcers.

Clinical Implications

The result of this study proves that the fear of fall could affect the center of pressure (COP). The findings of the study will be helpful in to improving the dynamic sitting balance control [18] and for the clinicians to prepare the protocol which could help in prevention of pressure ulcer in Spinal Cord Injury (SCI).

Limitations of the Study

The main limitation of this study was the following:

- The small sample sizes.
- Due to shortage of time, we could not get the subjects with low fall concern in Spinal Cord Injury (SCI).

Recommendations

The future recommendations are as follow:

- Future studies need to be done on the comparison between the low fall concern and high fall concern in subjects with Spinal Cord Injury (SCI).
- Research should also emphasize on the impact of weight on center of pressure (COP).
- Future studies can include healthy individuals to check the impact of anterior weight shifting methods on center of pressure and a comparative study can be done with healthy individuals.

Conclusion

This study concluded that psychological factor i.e., Fear of fall concern has an impact on center of pressure (COP) which could affect the sitting balance in individual with Spinal Cord Injury (SCI). This study also concluded that the anterior weight shifts via the modified functional reach test (MFRT) could assist in minimization of pressure over the loading regions (ischial tuberosity, sacrum/coccyx, or greater trochanter) in Spinal Cord Injury (SCI).

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