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To Assess Cardiovascular Risk in Cases of Spinal Cord Injury by Screening Impaired Glucose Tolerance and Dyslipidemia – Prospective Study

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Abstract

Aim: To assess cardiovascular risk in spinal cord injury (SCI) by screening IGT and dyslipidemia. **Purpose**: With advances in acute care and management of septicemia, renal failure, pneumonia, and Cardiovascular complication is the leading cause of death in SCI. Physical inactivity, increased abdominal fat promotes insulin resistance and dyslipidemia promoting cardio vascular morbidity. **Methodology:** The sample size of 100 is considered with inclusion and exclusion criteria defined for SCI cases Parameters considered are (a) Fasting lipid profile, (b) HbA1C, (c) OGTT. **Results:** Based on the analysis, patients had hypo as well as hyperglycemia in addition to dyslipidemia. **Conclusion:** Metabolic abnormalities act as a multiplier effect for increasing the CV risk.

Keywords: Cardiovascular risk, Dyslipidemia, IGT, septicemia, Hypoglycemia, Rehabilitation

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Introduction

Spinal cord injury (SCI) is the most devastating condition that transforms the individual from independency to dependency for all basic ADL activities. It is responsible for high-cost disability. SCI produces motor paralysis, sensory disturbances, chronic inflammatory state, dysautonomia, and metabolic derangements. All these factors predispose the individual for pre-mature cardiovascular mortality.[1-4] Etiology of SCI is grossly divided into traumatic and non-traumatic pathologies. Traumatic etiologies are due to road traffic accident (RTA), falls, violence, and sports injuries. Non-traumatic etiology is due to infection, inflammation, tumors, degenerative changes, and vascular malformation involving the spinal cord.

Apart from the prevention and management, the main objective is enabling the ambulation of patients and enabling patients to self-reliant to address the basic ADL.[5] As there is tremendous improvement in acute care management, mortality due to septicemia and respiratory complications is in decreasing trend. Nowadays cardiovascular disease is a growing concern in cases of SCI as it occurs pre-maturely and more prevalent when compared to able bodied counterparts.[6]

As of now, there is no routine screening undertaken to assess the lipid and carbohydrate abnormality in the case of SCI. Hence, including these risk parameters during routine follow-up would help in minimizing the cardiovascular risk.[7]

Aims and Objectives

Aim

To screen individuals with SCI for impaired glucose tolerance and dyslipidemia for early assessment of cardiovascular risk and mortality.

Objective

- To study the incidence of Carbohydrate and lipid abnormality in cases of SCI
- To stress the necessity of early rehabilitative measures.

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Materials and Methods

Study center: Government Institute of Rehabilitation Medicine, KK Nagar, Madras Medical College, Chennai.
Duration of the study: 1 year
Study design: Cross-sectional study.
Sample Size: 100 cases of SCI.

Inclusion Criteria

- Age >20 years
- All traumatic cases of SCI
- Duration <1 year
- Traumatic SCI without any endocrine pathology.

Exclusion Criteria

- Known case of diabetes mellitus – Type II diabetes
- Past history of CAD
- Past history of dyslipidemia
- Spinal Cord Lesion – Non-traumatic causes
- Other endocrine problems.

Methodology

After obtaining informed consent in the patient's comfortable language, venous blood samples were drawn after an overnight fasting for doing.

- Fasting lipid profile,
- HbA1C
- Oral glucose tolerance test.

75 g of anhydrous glucose is mixed with 250 mL of water and orally administered to patients. In case of patients who have a sensation of vomiting, the addition of lemon juice lessens the vomiting sensation.

Recent ADA guideline shown in Table 1 and National Cholesterol Education Project Adult Treatment Panel–III guidelines shown in Table 2 are used for diagnosing glucose intolerance and dyslipidemia, respectively.

The below table 2 provides the ATP III guidelines for diagnosis of dyslipidemia.

LDL is calculated using the below formula.

LDL = Total Cholesterol - HDL - (Triglycerides/5)

Non-HDL is calculated using below formula.

Non-HDL = Total Cholesterol - HDL

Values are considered as abnormal as per table 3.

All these tests were repeated after 3 months of admission. All biochemical analysis is performed by the same laboratory.

The socioeconomic status of the study population is categorized based on Kuppusamy's classification shown in table 4.

Table 1: ADA Guidelines

FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*
OR
2-h PG ≥200 mg/dL (11.1 mmol/L) during OGTT. The test should be performed as described by the
WHO, using a glucose load containing the equivalent of 75-g anhydrous glucose dissolved in water.*
OR
A1C ≥6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is
NGSP certified and standardized to the DCCT assay.*
OR
In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma
glucose ≥200 mg/dL (11.1 mmol/L).
*In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing.
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*In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing.

Rehabilitation Program

All the patients are started on a comprehensive rehabilitative program It includes

- Chest physiotherapy, deep breathing exercises, and an aerobic endurance program (static cycling).
- Functional re-education program
  - Rolling, sitting, Balance training in sitting, strengthening of upper limbs for paraplegics, bed transfer, and transfer bed to wheelchair and back.
- Standing and Gait training with/without orthosis.

Analysis was done using IBM SPSS statistical software.

Analysis

Basic statistical analysis was done in terms of mean, standard deviation, and range in terms of minimum and maximum values as shown in tables 5,6.

The next stage of analysis was performed using the Chi-square test to test the hypothesis. $P < 0.05$ was significant and thereby proved the hypothesis to be correct.

Demographic Analysis

Factors considered here are age, sex, marital status, BMI, and socioeconomic factors.

Lesion Type

The sample population is segregated based on the type of lesion – paraplegia or tetraplegia.

Etiology

Here also the population is categorized based on either RTA or Falls.

Neurological Level

Based on the ASIA impairment scale, the population is classified as having either complete (ASIA–A) or incomplete (ASIA–B) injury. This is shown in figure 6.

Table 2: ATP III Guidelines

LDL Cholesterol - Primary Target of Therapy	
<100	Optimal
100-129	Near optimal/above optimal
130-159	Borderline high
160-189	High
≥190	Very high

Total Cholesterol	
<200	Desirable
200-239	Borderline high
≥240	High

HDL Cholesterol	
<40	Low
≥60	High
Risk Category	LDL Goal (mg/dL)
CHD and CHD Risk Equivalent (10-year risk for CHD >20%)	<100
Multiple (2+) Risk Factors and 10-year risk ≤20%	<130
0-1 Risk Factor	<160

Complications

The percentage of occurrence of complications among the study population is analyzed.

Results

Based on basic statistical analysis, the below tables 5and 6 depict the values.

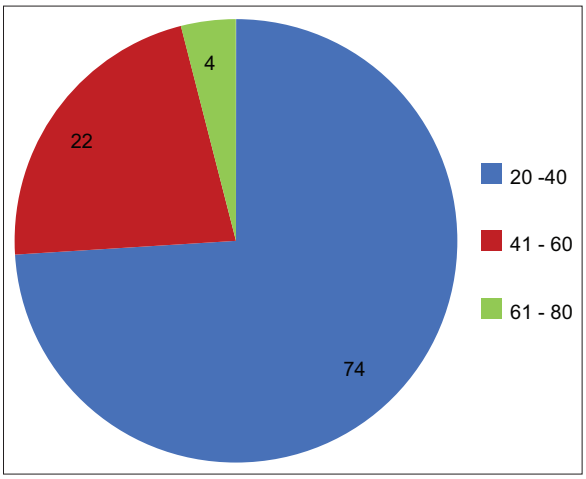

Figure 1: Age distribution

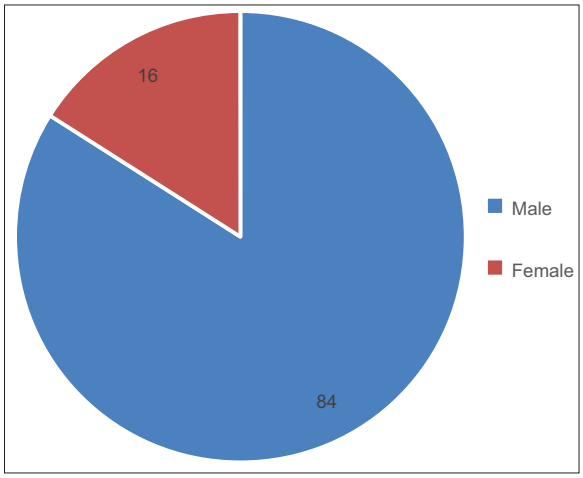

Figure 2: Gender distribution

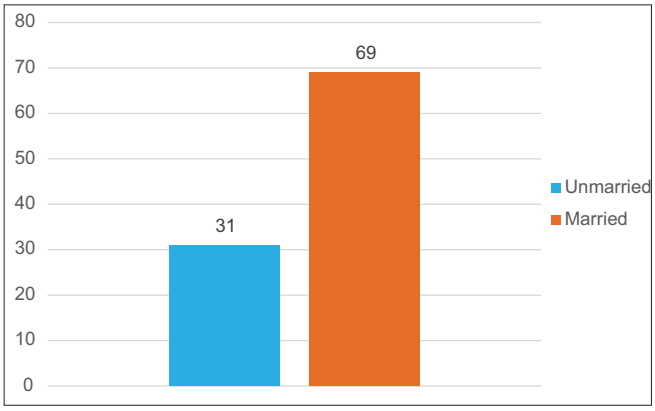

Figure 3: Marital status

Age Distribution

The below table provides a summary of the population distribution according to age.

These data are represented in Figure 1 and table 7.

The average age of the impacted population is around 39 years.

Gender Distribution

The below table shows the gender distribution.

Males are predominantly affected, as seen from the analysis.

Figure 2 is the pictorial distribution of gender and table 8.

Marital Status

Among the total population, 69% are married, signifying the socioeconomic impact, and the same is shown below.

The below table 9 shows the marital population distribution.

Figure 3 shows marital status distribution.

Lesion type

Paraplegia (65%) is more common among the study population than Tetraplegia (35%).

Table 10 showing the lesion distribution.

The below figure 4 depicts the lesion distribution.

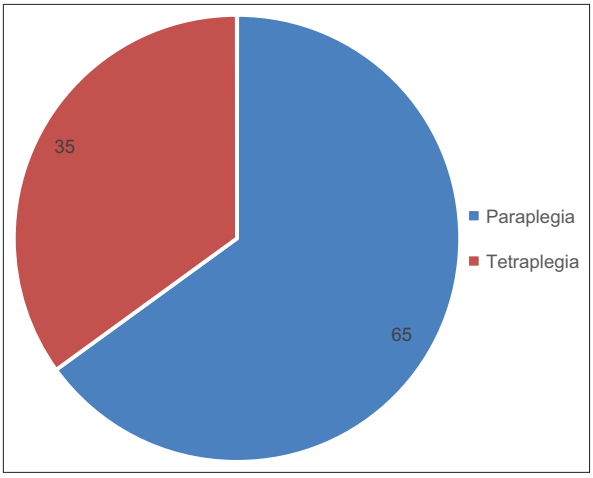

Figure 4: Lesion type

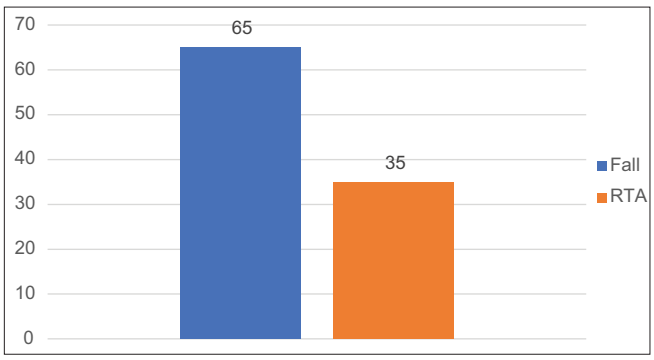

Figure 5: Etiology distribution

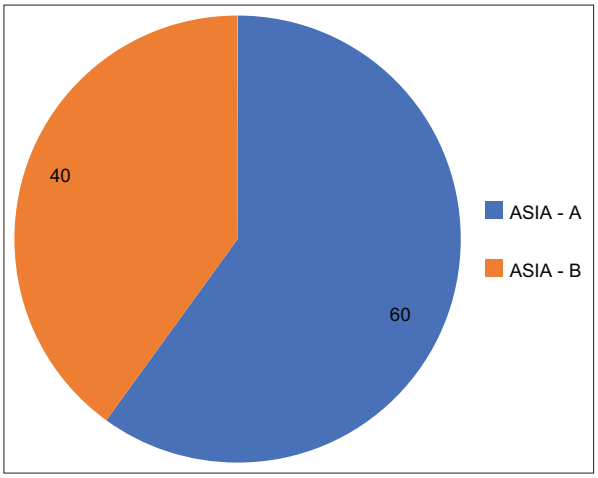

Figure 6: Neurological level distribution

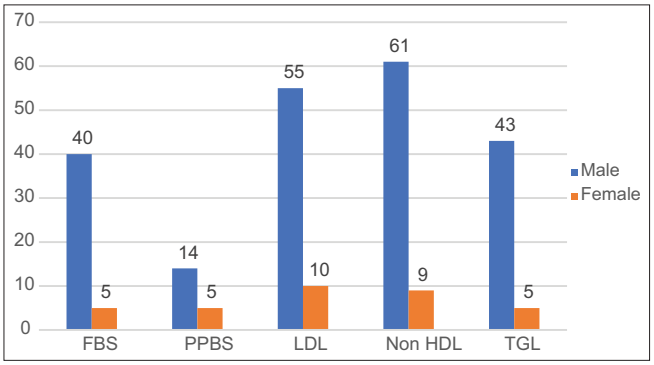

Figure 7: Distribution of risk factors in spinal cord injury

Table 3: Out-of-bounds range for risk parameters

S. no	*Parameters*	*Values*
1	Fasting blood sugar	<70 and >100
2	Post-prandial (2 h)	>140
3	LDL	>100
4	TGL	>170
5	HDL	<40
6	Non-HDL	>130
7	A1C	>6.5

Table 4: Kuppusamy Classification

Total score	*Socioeconomic class*
26-29	Upper class
16-25	Upper middle
11-15	Lower middle
5-10	Upper lower
Below 5	Lower

Traumatic Etiology

Falls are the more common mode of injury (65%) when compared to RTA (35%).

The table 11 depicts the etiology distribution.

Figure 5 below provides the distribution of etiology among the sample population.

Neurological Level

Complete injury (ASIA–A) is more common than incomplete injury (ASIA–B) and same is depicted in figure 6 and table 12.

Table 5: Summary of population distribution

Parameters	*Count*	*%*
Gender		
Male	84	84.0
Female	16	16.0
ASIA		
A	60	60.0
B	40	40.0
Marital status		
Unmarried	31	31.0
Married	69	69.0
Mode of Injury		
Fall	64	65.3
RTA	34	34.7
Lesion		
Tetraplegia	34	34.3
Paraplegia	65	65.7
Smoking		
Yes	36	36.0
No	64	64.0
Alcohol		
Yes	48	48.0
No	52	52.0
Pressure Ulcer		
Yes	33	33.0
No	67	67.0
Deep vein thrombosis		
Yes	6	6.0
No	94	94.0
HO		
Yes	3	3.0
No	97	97.0
Family history		
Yes	0	0.0
No	100	100.0

Risk Factors

Dyslipidemia and hypoglycemia and hyperglycemia enhancing the cardiovascular risk.

The below table 13 summarizes the overall risk factors among the demographic population (Gender based risk factor).

When further analyzed, the risk factors with respect to dyslipidemia, the below table 14 shows the distribution of abnormal values for the risk factors considered.

The same is depicted pictorially in figure 7, to show the distribution of risk factors among gender.

Analysis was also performed for the prevalence of risk factors among complete and incomplete injury and the same is shown in the below table 15.

Risk factors are more prevalent in complete injury.

Further analysis of risk factors was undertaken with respect to lesion type, and below is the table 16 for this distribution.

Below Tables 17-19 show the hypothesis that hypoglycemia, hyperglycemia, and dyslipidemia are having significant impact on cardiovascular risk.

Analysis was performed on the sample population, and it showed that carbohydrate and lipid abnormality had a strong association with cardiovascular risk.

The *P* value was found to be significant and <0.05 at 95% CI.

Discussion

Based on the analysis, the mean age of the population is 36, but among the impacted population, the median age is 39 years. As per the various studies,[7-9] it is found out that the incidence of SCI is more prevalent in the young, active reproductive age group.

Table 6: Basic statistical analysis of population

Parameters	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Age	100	36.210	10.9888	20.0	64.0
FIMS_126	100	60.860	11.8219	44.0	92.0
FBS	100	73.880	13.7314	51.0	128.0
PPBS	100	112.650	33.6339	78.0	284.0
HBA1C	100	5.385	.7277	4.5	8.7
MBG	100	113.194	23.4280	83.0	232.0
Total Cholesterol	100	195.870	29.6350	136.0	277.0
TGL	100	174.480	41.7280	101.0	303.0
HDL	100	46.120	4.3094	34.0	55.0
LDL	100	113.940	27.4928	56.0	190.0
VLDL	100	35.220	8.6860	20.0	61.0
Non-HDL	100	147.700	34.5924	46.0	239.0

Table 7: Age distribution

S. No	*Age range*	*Count*
1	20–40	74
2	41–60	22
3	61–80	4

Table 8: Gender distribution

Gender	*Count*
Male	84
Female	16

Table 9: Marital status distribution

Marital status	*Count*
Married	69
Unmarried	31

Table 10: Lesion type distribution

Lesion type	*Count*
Tetraplegia	35
Paraplegia	65

Table 11: Etiology distribution

Etiology type	*Count*
Fall	65
RTA	35

Table 12: Neurological level

Neurological level	*Count*
ASIA A	40
ASIA B	60

Table 13: Metabolic variable among gender

Parameters	*Gender*			
	Male		*Female*	
	Count	*%*	*Count*	*%*
Glycemia_FBS				
Hypoglycemia	40	88.9	5	11.1
Normal	44	80.0	11	20.0
Glycemia_HbA1C				
HbA1C >6.5	3	75.0	1	25.0
HbA1C <6.5	81	84.4	15	15.6
Glycemia_PPBS				
Hyperglycemia	14	73.7	5	26.3
Normal	70	86.4	11	13.6
Dyslipidemia				
Yes	68	85.0	12	15.0
No	16	80.0	4	20.0

Table 14: Risk factor distribution

Gender	*FBS*	*PPBS*	*LDL*	*Non-HDL*	*TGL*
Male	40	14	55	61	43
Female	5	5	10	9	5

Table 15: Risk factors distribution versus neurological level

Parameters	*ASIA*			
	A		*B*	
	Count	*%*	*Count*	*%*
Glycemia_FBS				
Hypoglycemia	28	62.2	17	37.8
Normal	32	58.2	23	41.8
Glycemia_HbA1C				
HbA1C >6.5	1	25.0	3	75.0
HbA1C <6.5	59	61.5	37	38.5
Glycemia_PPBS				
Hyperglycemia	10	52.6	9	47.4
Normal	50	61.7	31	38.3
Dyslipidemia				
Yes	47	58.8	33	41.3
No	13	65.0	7	35.0

Table 16: Risk factors distribution versus lesion type

Parameters	*Lesion*			
	Quadriplegia		*Paraplegia*	
	Count	*%*	*Count*	*%*
Glycemia_FBS				
Hypoglycemia	15	34.1	29	65.9
Normal	19	34.5	36	65.5
Glycemia_HbA1C				
HbA1C >6.5	3	75.0	1	25.0
HbA1C <6.5	31	32.6	64	67.4
Glycemia_PPBS				
Hyperglycemia	10	52.6	9	47.4
Normal	24	30.0	56	70.0
Dyslipidemia				
Yes	26	32.9	53	67.1
No	8	40.0	12	60.0

Table 17: Hypothesis – 1

Parameters	*Hypo*	*Hyper*	*Marginal Row Total*
Abnormal	44 (31) (5 45)	18 (31) (5 45)	62
Normal	56 (69) (2 45)	82 (69) (2 45)	138
Marginal Column total	100	100	200

Furthermore, from the study, it is found that males are more commonly affected (84%) than females (16%), as the males are

Table 18: Hypothesis – 2

Parameters	*BS Abnormal*	*Hyper*	*Marginal row total*
Abnormal	62 (71) (1 14)	80 (71) (1 14)	142
Normal	38 (29) (2 79)	20 (29) (2 79)	58
Marginal column total	100	100	200

Table 19: Hypothesis – 3

Parameters	*FBS*	*PPBS*	*LDL*	*Non-HDL*	*TGL*	*Row Totals*
Abnormal	44 (52 09) (1 26)	18 (48 23) (18 95)	65 (48 23) (5 83)	70 (48 23) (9 83)	48 (48 23) (0 00)	245
Normal	64 (55 91) (1 17)	82 (51 77) (17 65)	35 (51 77) (5 43)	30 (51 77) (9 16)	52 (51 77) (0 00)	263

causal labors who are involved in high-risk jobs. Furthermore, average body mass index is found between 19 and 24.

Most of the individuals are belonging to the low socioeconomic group and they are the sole breadwinners of the family.

Considering the traumatic etiology fall from height is the predominant mode of injury. This implies the lack of fall preventive measures while involving themselves in high-risk jobs. Paraplegia is the most common lesion type among the study population.

Analyzing the complication of SCI, it is found that 19% of individuals found to have hyperglycemia, which is in line with other studies published.[7,10,11] At the same time, 45% of individuals had hypoglycemia in this study, which is not seen in previous studies. This can be attributed to malnutrition as the study population belonging to a low socioeconomic status, and it may be due to a deficiency of anabolic hormones, such as growth hormone and testosterone, or may be due to underlying infection. Not only hyperglycemia but also hypoglycemia has adverse effects on cardiovascular system.

Observed hyperglycemia in the study population is due to insulin resistance, sedentary lifestyle, and loss of lean body mass.

80% of individuals had dyslipidemia, such as elevated LDL, elevated TGL, and non-HDL.[12,13] This may be because of increased adiposity. In this study, only 6% had low HDL and it may be attributed to the nature of work before injury. Non-HDL is included in this study as one of the risk factors since it is found to be an emergent risk factor for CAD.[13] Six individuals developed Deep Vein Thrombosis and 2 died due to CAD.

After the institution of the Comprehensive rehabilitation program, blood sugar values repeated after 3 months found to be in the near normal range for those individuals with abnormal values found in the first sample after the admission.

Conclusion

As per the study, dyslipidemia and both hypo and hyperglycemia increase the cardiovascular risk in cases of SCI by accelerating atherosclerosis.

This study showed blood sugar and lipid abnormalities act as a multiplier effect for cardiovascular risk.

Recommendations

1. Periodic monitoring of blood sugar and lipid parameters along with other risk factors
2. Appropriate Medical Management & lifestyle modifications
3. Institution of early rehabilitation measures.

Limitation

Below are some of the limitations of the study

a) Single-institution-based study
b) Study population belonging to low socioeconomic status
c) Focusing on a few risk factors
d) Small population
e) No age-matched control group
f) Short duration of the study.

Future Scope

This study can be enhanced by considering,

- Extending the study to the wider geographic area
- Multi-center study
- Longer duration of the study period
- Including all socioeconomic group
- Including the population in different occupational category
- Age-matched control
- Additional risk factors, such as fasting insulin level, HS–CRP, and serum troponin level.

Disclosure

I declare that I have not received financial support from any entity for the work described in this manuscript.

Furthermore, there is no conflict of interest for the research work conducted.

Ethics Committee Approval

Approval certificate

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