

## REDUCTION OF HYPERCALCIURIA AFTER WEIGHT BEARING AND EXERCISES IN PATIENTS WITH SPINAL CORD INJURY

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### ABSTRACT

#### BACKGROUND

Prolonged immobilization of the body following Spinal Cord Injury (SCI) is associated with certain metabolic changes in calcium (Ca) metabolism leading to hypercalciuria. This is associated with an increased risk of developing urinary calculi, urinary tract infection, & osteoporosis. Excretion of excess 24 hours urinary calcium in these cases can be reduced with weight bearing in the form of tilt table standing along with passive and active strengthening exercises.

#### MATERIALS AND METHODS

A prospective study was conducted on 18 patients with spinal cord injury hospitalized for post-acute rehabilitation program after observing all ethical formalities. Urinary calcium excretion was measured for 24 hours period before and after a structured weight bearing given on tilt table for 1 hour a day and passive and active upper limb strengthening exercise program given half an hour daily, for 2 weeks.

#### RESULTS

All the patients belonged to traumatic SCI with immobilization ranging from 2 to 8 months and the structured treatment program lead to significant reduction in hypercalciuria. The level of lesion, diagnosis and different periods of immobilization did not influence the outcome significantly.

#### CONCLUSION

This being a short term longitudinal study, the demographics differed from larger earlier studies. Majority of our patients (94%) were young males of 15-50 years age. Paraplegics constituted 72% of our patients while 28% were quadriplegics. The significant reduction in hypercalciuria after a standard regimen of tilt table standing coupled with exercises in all the cases established the value of the treatment. There was no correlation between the periods of immobilization to the change in urine calcium excretion in response to our treatment. It was a short term, small sample study and needs further validation with a larger study of longer duration to establish the efficacy of tilt table standing coupled with exercises.

#### KEYWORDS

Spinal Cord Injuries, Urinary Calculi, Calciuria, Weight-Bearing, Exercise Therapy.

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#### BACKGROUND

Acute immobilization following spinal cord injury (SCI) causes lack of mechanical load on skeleton leading to efflux of calcium. This results in depressed parathyroid hormone production, increased calcitonin release, hypercalciuria, osteoporosis and associated fractures. Consequently, hypercalciuria is associated with an increased risk of urinary calculi, urinary tract infection, & osteoporosis.<sup>1,2,3</sup> The reversal of these deleterious effects with weight bearing has also been documented in spinal cord injured patients

although the mechanism of improvement is not fully understood.<sup>4,5,6</sup>

Leslie SW<sup>1</sup> defined hypercalciuria as urinary excretion of more than 250mg of calcium per day in women & more than 275mg of calcium per day in men while on a regular unrestricted diet. Watanabe Y et al.<sup>7</sup> found that intravenous Pamidronate prevented femoral bone loss in healthy males during 90 days bed rest but resistive exercises showed no effect while Bauman WA et al.<sup>8</sup> were convinced that pamidronate failed to prevent long term bone loss in persons with complete SCI. Rittweger J et al.<sup>9</sup> concluded that whole body vibration with resistive exercises helped in prevention of bone loss in healthy males. Atalay A and Turhan N<sup>10</sup> studied two high level quadriplegics in acute phase of rehabilitation and found that use of alendronate helped in preventing hypercalciuria and maintaining a successful clean intermittent self-catheterization program. However, drug interventions were not the considerations in our study.

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Many studies have been done over the years on prolonged standing and weight bearing program showing the reduction of hypercalciuria<sup>11</sup> but no guidelines exist about the frequency and duration of the exercises required to achieve the desired goal. So far, no Indian study has been done on this subject.

### Aims and Objectives

1. To assess the hypercalciuria in spinal cord injury patients immobilized in bed.
2. To assess the effects of weight bearing along with strengthening exercises on urinary calcium level in these patients.

### MATERIALS AND METHODS

A Prospective Study on 18 subjects with spinal cord injury was done who were hospitalized for post-acute rehabilitation in spinal injury ward of the Department of Physical Medicine & Rehabilitation of multispecialty hospital of a metro city in India during the study period. Patients of both the sexes ranged from 15 to 65 years. Complete neurological examination was done to ascertain the level of injury, type of lesion, period of immobilization, and the diagnosis. Patients were examined for cause of the lesion as well as for any co-existing disease including pulmonary tuberculosis, diabetes, renal disease, urinary tract infection and calculi, cardiac disease, hypertension and heterotrophic ossification or myositis ossificans. An informed consent was taken from all the patients and all the ethical formalities were observed. A routine 24 hours urinalysis was performed for calcium excretion before starting and after completion of the therapy program of 15 days.

A structured program of tilt table standing and active-passive exercises was instituted for six days a week for two weeks. Tilt table standing at an angle of 45-60 degrees or more was given for an hour along with strengthening exercises for half an hour a day for two weeks. Use of dumb bells, ankle cuffs and spring exerciser was incorporated for upper and lower limbs respectively. All patients were allowed to carry out their routine exercises on mat and wheelchair. Close check was maintained for orthostatic hypotension. No dietary regulation was permitted during this period. No drug or food supplement known to affect bone calcium metabolism was allowed. Serum creatinine and serum urea was measured to monitor the renal functions.

Pre-treatment and post-treatment 24 hours' urinary calcium level was analysed by using SPSS for Windows, version 15. Paired t-test and Wilcoxon Signed rank test was used for statistical analysis of data within the groups. Mann-Whitney tests and Kruskal Wallis tests were applied for analysis of data between the groups. Correlation between period of immobilization and change in urine calcium level is calculated by using Spearman-rank correlation. The results were considered significant at the  $p < 0.001$ .

### Inclusion Criteria

Adult patients of Spinal cord injury (traumatic and non-traumatic, with complete and incomplete lesion) admitted to

spinal injury ward with good spinal stability with informed Consent and willingness to enrol in the study

### Exclusion Criteria

Subjects with heterotrophic ossification, bladder calculi, active urinary tract infection, diabetes mellitus and cardiac disease hypertension were excluded from the study.

### RESULTS

All of our patients were in the age group of 10 to 70 years (Mean Age  $33.27 \pm 11.95$ ) and 94% were males. (Table 1 & Table 2).

Age Group (Years)	No. of Cases	Percentage
10-30	8	44.44
30-50	9	50
50-70	1	5.56
<b>Total</b>	<b>18</b>	<b>100</b>

**Table 1. Age Distribution**

(Mean Age=  $33.27 \pm 11.95$ )

Gender	No. of Cases	Percentage
Male	17	94.44
Female	1	5.56
<b>Total</b>	<b>18</b>	<b>100</b>

**Table 2. Gender Distribution**

All had traumatic origin with five having quadriplegia and thirteen paraplegias (Table 3).

Type of Lesions	No. of Cases	Percentage
Quadriplegia (Cervical)	5	27.78
Paraplegia (Dorsal & Lumbar)	13	72.22
<b>Total</b>	<b>18</b>	<b>100</b>

**Table 3. Level of Lesion**

These patients had immobilization ranging from 2 months to 8 months prior to entering the study (Table 4).

Period (in months)	No. of Cases	Percentage
1-3	4	22.22
3-6	8	44.44
6-9	6	33.33
Range 2-8 months	18	100

**Table 4. Period of Immobilization (Prior to Entry in Study)**

In our study, hypercalciuria was found across the age, gender, level of injury and irrespective of the period of immobilization, prior to entry in the study. (Table 5 and Table 6).

A significant change in 24 hours' urinary calcium excretion was observed in all the patients from pre-treatment ( $333.5 \pm 43.29$ ) to post treatment on 16<sup>th</sup> day

(143.05 ± 69.80) in response to tilt table standing and exercises (p value<0.001) (Table 5).

Sl. No.	Pre-Treatment (n=18)	Post-Treatment (n=18)
1.	276	144
2.	324	34
3.	353	76
4.	308	150
5.	280	58
6.	340	58
7.	375	260
8.	324	220
9.	390	264
10.	320	140
11.	419	140
12.	340	64
13.	279	173
14.	308	159
15.	382	76
16.	302	176
17.	291	191
18.	392	192
<b>Result</b>	<b>333.5 (±43.29)</b>	<b>143.05 (±69.80)</b>
<b>p Value</b>	<b>&lt;0.001</b>	

**Table 5. 24 Hour Urine Calcium Level (in mg.)**

Data was analysed to obtain the correlation between the period of immobilization to the change in value of urine calcium level after treatment and no significant correlation is obtained between the period of immobilization to the change in value of urine calcium level in response to tilt table standing and exercises (r=0.13 and p=0.58). (Table 6)

	Urine Calcium (mgs)	Period of Immobilization (months)	r	p- Value
n-18	190.44±76.10	4.97±2.01	0.13	0.58
Range	(100-306)	(2-8)		

**Table 6. Period of Immobilization Related to Change in Urine Calcium Level (After Treatment)**

(r= Correlation)

## DISCUSSION

This study was done to evaluate hypercalciuria in SCI population and effect of tilt table standing and exercises on it. Urinary excretion of more than 250mg of calcium per day in women & more than 275mg of calcium per day in men while on a regular unrestricted diet is defined as hypercalciuria.<sup>1</sup>

The relationship between immobilization and hypercalciuria has long been established.<sup>2,12,13,14,15</sup> Claus Walker et al. showed a 46% increase in calciuria following only three days of bed rest in normal men.<sup>13</sup> The reversal of this with weight bearing has also been documented in spinal cord injured patients.<sup>4,5,6</sup> but no standard guidelines exist

concerning the frequency and duration of the sessions that are required to achieve the desired goal and as such no Indian study is available on this subject.

Though Issekutz et al.<sup>2</sup> studied healthy non-ambulatory individuals, our results compare favourably with theirs for the effects of standing on hypercalciuria. Our study was a short term longitudinal study and included only 18 patients, hence age and sex ratios cannot be compared on this count with other studies.<sup>16</sup> All our patients belonged to traumatic SCI and presented with hypercalciuria while Eng JJ et al. also found that traumatic SCI accounts for larger proportion of patients while non-traumatic SCI does not even report to Rehabilitation centre.

A significant decrease in 24 hours urinary calcium excretion was obtained in all our patients from pre-treatment (333.5±43.29) to 16<sup>th</sup> day post treatment (143.05 ± 69.80) of exercises and tilt table standing (p value<0.001) and is consistent with the past studies.<sup>17,18,19</sup> Kaplan PE gave 20 minutes of standing with dietary regulation of calcium and obtained reduction of urinary calcium level by 76 mg<sup>17</sup> while we administered tilt table standing for 1hour daily for 2 weeks without dietary regulation and observed significant reduction in Calciuria (190.44±76.10).

Kaplan PE (1981) studied only quadriplegics and found that tilt table exercises are effective in reducing hypercalciuria but strengthening exercises did not have any great effect on hypercalciuria in first six months,<sup>20</sup> while in our study the combined treatment was given, and it proved effective in all patients irrespective of period or level of injury. However, our study matches favorably with the study done by Eng JJ et al. on paraplegics.<sup>19</sup>

In our study the level of lesion, diagnosis and different periods of immobilization have not significantly contributed to the change in urine calcium level which may be attributed to a small sample size. No significant correlation was seen by us between the period of immobilization to the change in urine calcium excretion in response to tilt table standing and exercises (r=0.13 and p=0.58). As was also observed by Clause-Walker et al. in their 1972 study on quadriplegics.<sup>6</sup>

## CONCLUSION

Hypercalciuria occurs in all the patients of traumatic SCI on bed rest. A structured tilt table standing and exercises regimen has significant effect on urinary calcium excretion of these patients with paraplegia and quadriplegia. This protocol may be used as guideline in the treatment of SCI patients.

There is no correlation between the periods of immobilization to the change in urine calcium excretion in response to our treatment. Our study requires further validation with larger sample size and longer follow up for validation and the effect of this on co-morbidities associated with hypercalciuria like osteoporosis and urinary tract calculi.

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