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ORIGINAL PAPER

Effect of immobilization on urine calcium excretion in orthopedic patients with pelvic fracture treated by skin traction

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Summary ***Objectives: To determine the effects on urine calcium excretion of immobilization by skin traction in patients with pelvic fracture. Methods: In a prospective study, a consecutive series of patients with pelvic fracture treated by skin traction were enrolled. Serum (calcium, phosphorous, alkaline phosphatase, sodium, potassium, uric acid, BUN, creatinine) and fasting urine calcium, creatinine, sodium, potassium and uric acid were checked within 48 hours of hospitalization and at 7, 14 and 21 days of immobilization and then after 3 months of mobilization. Trends in changes of variables were recorded.***

Results: Fifty five patients were enrolled in this study; they were 45 (81.8%) males and 10 (18.2%) females with a mean age 19.4 ± 12.7 years. We found that serum levels of calcium (p = 0.004), phosphorous (p = 0.047) and alkaline phosphatase (p = 0.001) increased significantly during the 3 weeks of immobilization. In the same way, urine calcium/urine creatinine ratio increased significantly in the study period (p = 0.004). No symptomatic renal stone formation was observed during the study period.

Conclusions: Immobilization even in short term causes hypercalciuria in orthopedic patients. Although it is transient and improves with subsequent mobilization, it is needed to be considered specifically by the team caring for this group of patients.

KEY WORDS: Hypercalciuria; Short term immobilization; Pelvic fracture; Skin traction.

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INTRODUCTION

Hypercalciuria is the most common metabolic cause of renal stone in children and adults (1-4). Hypercalciuria is defined as urinary calcium excretion of more than 4 mg/kg in 24 hour urine or a calcium/creatinine ratio of 0.20 mg/mg in a random urine sample (5, 6). In addition to urinary stones, hypercalciuria can cause hematuria, dysuria, frequency, urgency and occasionally enuresis (7-11).

Long term immobilization causes hypercalciuria and hypercalcemia in patients with meningomyelocele who are immobilized (12, 13). Also the effect of immobilization on hypercalciuria and hypercalcemia at intermediate term has been studied (14). There are only few reports (mostly case reports) regarding the hypercalciuria in patients who are immobilized temporarily due to orthopedic fractures (15-20). In this study, we have investigated the effect of short term immobilization on urinary calcium excretion and also on serum calcium and parathormone in patients who are immobilized with skin or skeletal traction for a pelvic fracture in orthopedic wards.

PATIENTS AND METHOD

Study population

This was a prospective cross-sectional study being performed during a 1-year period from 2012 to 2013 in *Chamran and Nemazi* hospitals, both tertiary orthopedics healthcare centers affiliated with *Shiraz University of Medical Sciences*. The study protocol was approved by institutional review board (IRB) and ethics committee of *Shiraz University of Medical Sciences*. All the recruited patients provided their informed written consents before inclusion in the study. We consecutively included all the patients younger than 40 years of age with traumatic pelvic fractures who underwent skin traction and were immobilized. The age limit of 40 was selected to lower the risk of interaction of natural process of resorption induced by aging. Patients with metabolic bone disease, patients with primary or metastatic bone tumor, patients on steroid, calcium or vitamin D supplements, and patients with abnormal baseline serum or urinary calcium level were excluded from the study. We also excluded those patients who were lost at follow-up during the initial 3 weeks of the study, those with renal insufficiency at any time during the study, those with urinary tract infection and any those taking any medication interfering with urinary calcium excretion. All of the patients were in complete physical health before the accident which led to hospitalization.

Study protocol

All the patients underwent complete physical examination by attending physician and the findings were recorded in a

No conflict of interest declared.

data gathering form. We arbitrarily defined the short term immobilization as immobilization of less than 3 weeks. The first sampling was done within 48-hour of hospitalization. Serum levels of albumin, calcium (Ca), phosphorous (P), blood urea nitrogen (BUN), creatinine (Cr), sodium (Na), potassium (K) were measured. We also obtained spot urine sample to measure urine Ca, Cr, Na and K. The samples were tested with the same technique in the two university hospital laboratories. The tests were repeated on days 7, 14 and 21 of hospitalization (immobilization). Also, they were repeated 2 to 3 months after mobilization. In addition, parathormone (PTH) level was measured on day 21 day of admission and the sera were refrigerated; after collection of all PTH samples, it was examined in a special reference endocrine and metabolism laboratory.

Statistical analysis

All the data was analyzed using *Statistical Package for Social Science (SPSS Inc., Chicago, USA)* software for *Window version 16.0*. Frequency distribution of the variables, means and standard deviations of the values were presented in tables and charts. The mean values were compared in different time intervals using repeated measure and paired t-test. Proportions were compared using Chi-square test. A 2-sided p-value less than 0.05 was considered statistically significant.

Results

Fifty five patients were enrolled in this study; they were 45 (81.8%) males and 10 (18.2%) females with a mean age 19.4 ± 12.7 years. The baseline characteristics are summarized in Table 1. We found that serum levels of calcium increased significantly during the 3 weeks of immobilization (p = 0.004). In the same way, the serum level of phosphorous increased significantly during 3 weeks of immobilization (p = 0.047). The serum levels of alkaline phosphatase also increased during the study period (p = 0.001). However there was no significant difference in serum levels of BUN, creatinine and albumin after the 3 weeks of skin traction. The values for serum sodium and potassium were within normal limits throughout the study. The urine calcium/urine creatinine ratio increased in the study period significantly (p = 0.004) (Figure 1).
After mobilization, we had the opportunity to check the urine calcium/urine creatinine ratio in 47 patients who had returned for follow-up visit 2 to 3 months after discharge from the hospital. The ratio after the 3 months was similar to the baseline (0.13 ± 0.04 vs. 0.13 ± 0.06; p = 0.381).

Figure 1.
Calcium/creatinine ratio at baseline and throughout the study.

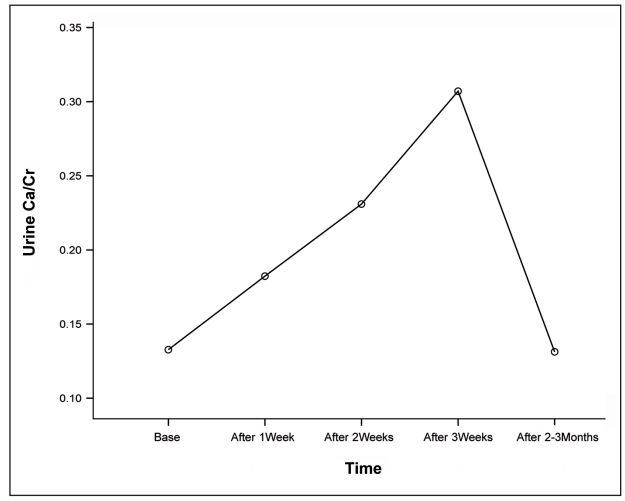

Figure 2.
Urine Ca/Cr ratio in patients < 20 years and 20-40 years.

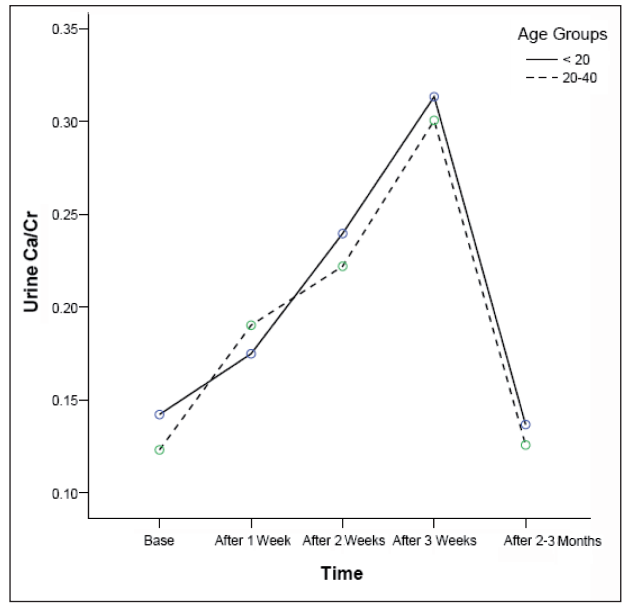

Table 1.
The baseline characteristics and changing trend of laboratory findings in 55 patients with pelvic fracture treated by skin traction.

	Baseline	Day 7	Day 14	Day 21	p-value
Serum Ca (mg/dL)	9.2 ± 0.74	9.3 ± 0.65	9.3 ± 0.85	10.1 ± 0.87	0.004
Serum P (mg/dL)	4.6 ± 1.2	4.5 ± 0.9	4.8 ± 1.3	5.0 ± 0.71	0.047
Urine Ca/Urine Cr	0.13 ± 0.06	0.17 ± 0.11	0.22±0.12	0.29 ± 0.17	0.001
BUN (mg/dL)	14.4 ± 4.5	14.1 ± 2.9	13.9 ± 3.6	13.8 ±5.9	0.186
Creatinine (mg/dL)	0.81 ± 0.28	0.79 ± 1.7	0.94 ± 0.84	0.93 ± 0.16	0.098
ALP (IU)	424.6 ± 316.2	448.6 ± 298.3	561.6 ± 181.6	575.3 ± 227.1	0.001
Albumin (g/dL)	4.1 ± 0.32	3.9 ± 0.14	4.0 ± 0.56	4.1 ± 0.32	0.783

ALP: Alkaline phosphatase; BUN: Blood Urea Nitrogen; Ca: Calcium; P: Phosphorous

Serum PTH was checked only once at the end of the 3rd week and it was 17.42 ± 10.04 ng/ml. The study population was then divided into 2 groups; 28 patients were between 2-20 years with a mean age of 8.8 ± 6.6 years and 27 were 21-40 years with the mean age of 30.3 ± 6.7 years (Figure 2). The above mentioned parameters were similar to the results in the whole group and no significant inter-group differences were observed. No symptomatic renal stone formation was observed during the study period.

Discussion

Hypercaciuria is the most common metabolic cause of renal stone in children and adults (1-4). Hypercalciuria may present with different signs and symptoms specifically in children such as hematuria, abdominal pain, frequency, dysuria and occasionally enuresis (7-11). In a well-designed study by *Zerwekh et al.*, the biochemical markers of bone turnover and calcium homeostasis were evaluated in normal volunteers subjected to 12 weeks of bed rest. They found a significant rise in biomarkers of the bone turn over, urine, and serum calcium (21).

Hypercalciuria is a known consequence of long and intermediate term immobilization which leads to decreased bone mineral density. This entity has been studied in patients with stroke and long term immobilization and also in children with intermediate term immobilization with *Legg-Calvé-Perthes disease* and developmental dysplasia of the hip joint (12-14). In this study, even after one week of immobilization in children with *Legg-Calve-Perthes disease* urine calcium increased 2.3 times as compared to the baseline value but this did not happen in children with developmental dysplasia of the hip who had never been ambulated before immobilization. Immobilization and associated hypercalciuria can lead to stone formation which has been reported even within a few days of immobilization in children (17).

In this prospective study, the effect of short term immobilization in 55 orthopedic patients with pelvic fracture who were assigned for short term immobilization (skin traction) was studied. Even after the first week of immobilization, urine calcium excretion increased from the baseline level and the test was repeated in the 2nd and 3rd weeks of immobilization; we found higher levels of calcium/creatinine ratio but not significantly different from the first week value. This indicates that immobilization induces bone resorption and is associated to hypercalciuria even after a few days.

We had the opportunity to check urine calcium/creatinine ratio 2-3 months after mobilization in the majority of our patients (number = 47); it had returned to previous values in the majority of patients, 0.13 ± 0.04 (p = 0.38) with Pearson correlation = 0.846. This indicates that the effect of immobilization on urine calcium excretion is transient.

Serum calcium was also checked simultaneously with urine calcium in the first, second and third week, although it was higher than the baseline level in the third week of immobilization but the P value didn't reach a statistically significant level (p = 0.057). Regarding the serum calcium level, we didn't reach the same conclusion as previous studies which were mostly case reports (12, 13, 16, 18, 22, 23). In some of these reports, the period of immobilization was more than that of our study. Our results regarding serum parameters were similar to the results of *Korkes et al.* (14) with almost no change in serum parameters in that study. Symptomatic stone formation was not seen in any case in our study as in those of *Korkes F* (14) and *Andrews PI* (18).

In conclusion, immobilization even in short term causes hypercalciuria in orthopedic patients. Although it is transient and improves with subsequent mobilization, it is needed to be considered specifically by the team caring for this group of patients.

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