

Incidence and clinical significance of abnormalities in potassium, sodium and calcium levels in elderly patients with hip fractures during the perioperative period



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OBJECTIVE: *This study aims to investigate the incidence and clinical significance of sodium, potassium and calcium electrolyte disturbances in elderly patients with hip fracture before an operation.*

METHODS: *The clinical data of 220 patients with intertrochanteric fracture and 261 patients with femoral neck fracture from September 2013 to December 2016 in our hospital (≥ 60 years old) was reviewed. The sodium, potassium and calcium values, and the underlying diseases of patients were recorded after the first blood test. These patients were divided into two groups according to the fracture site: femoral neck fracture group and intertrochanteric fracture group. Then, the differences between these two groups were compared to analyze the proportion of electrolyte disturbances in elderly patients with hip fracture, and explore its clinical significance.*

RESULTS: *Patients with intertrochanteric fractures were older than patients with femoral neck fracture. There was no significant difference in the prevalence of underlying diseases between these two groups. The incidence of hyponatremia, hypokalemia and hypocalcemia was 10.0%, 32.9% and 1.4%, respectively, in the femoral neck fracture group, and 24.3%, 21.1% and 7.7%, respectively, in the intertrochanteric fracture group. The incidence of hypernatremia, hyperkalemia and hypercalcemia was 1.4%, 1.4% and 0.9%, respectively, in the femoral neck fracture group, and 1.1%, 0.7% and 0.8%, respectively, in the intertrochanteric fracture group.*

CONCLUSION: *Patients with old hip fractures before an operation are prone to hyponatremia, hypokalemia and hypocalcemia, and most of them have mild electrolyte disorders, which needs to be corrected in time. Furthermore, some patients urgently need urgent supplementation of blood electrolytes for some diseases, the correction of electrolyte disorders, and the prevention of serious adverse consequences.*

KEY WORDS: Femoral neck fracture, Femoral intertrochanteric fracture, Hyponatremia, Hypokalemia, Hypocalcemia

Introduction

The number of patients with hip fractures worldwide has reached as high as 1.3¹, and more than half of these patients have femoral intertrochanteric fractures². These

patients mainly comprise of the elderly, who are often complicated with various chronic diseases and certain degrees of electrolyte disturbances, and have poor overall condition and a high risk of operation³.

Hypokalemia, hyponatremia and hypocalcaemia are electrolyte disorders that are often handled in clinic. A considerable number of elderly patients with hip fractures are complicated with the above-mentioned electrolyte disturbance, which can aggravate a patient's condition, increase the fatality rate, and cause poor prognosis. Furthermore, some patients even have life-threatening electrolyte disorders that needs urgent treatment. In recent years, although there are some reports on the incidence of electrolyte disorders in elderly patients at home

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and abroad, these are very one-sided, and the systematic study on the incidence of potassium, sodium and calcium electrolyte disturbances in elderly patients with hip fractures before an operation has not been reported. The present study systematically explores the incidence and clinical significance of potassium, sodium and calcium electrolyte disturbances before an operation in elderly patients with hip fractures.

Materials and Methods

GENERAL DATA

From September 2013 to December 2016, 220 patients with femoral neck fracture and 261 patients with femoral intertrochanteric fracture (all patients were ≥ 60 years old), who were admitted to our hospital, were enrolled as the study subjects. The age, gender, initial blood potassium ion value, initial blood sodium ion value, and initial blood calcium ion value of patients after hospitalization, as well as the determination of whether the patient had medical underlying diseases, such as hypertension, diabetes, cardiovascular diseases, cerebrovascular diseases, liver and kidney diseases, and respiratory diseases, were recorded.

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria: patients with complete relevant data, patients with unilaterally and freshly closed femoral intertrochanteric fractures or femoral neck fractures caused by low energy injuries, patients ≥ 60 years old, patients without previous acute or chronic digestive system diseases, patients without multiple traumas, and patients without serious underlying diseases.

Exclusion criteria: patients with fractures caused by high-energy injuries, patients with craniocerebral or cervical spinal cord injuries, patients with open fractures, patients with multiple fractures, patients with multiple injuries, and patients with recent or long-term use of drugs that can affect water and electrolyte metabolism, such as diuretics, tricyclic antidepressants and cyclophosphamide. A total of 481 patients met the inclusion criteria.

The present study was approved by the Ethics Committee of our hospital, and an informed consent was obtained from each patient.

RECORDING INFORMATION

Routine blood test and biochemical tests were completed for patients within 24 hours after admission. The blood potassium ion value, sodium ion value, and calcium ion value during the initial blood test after admission were recorded. General data and chronic medical

underlying diseases, such as hypertension, diabetes, cardiovascular diseases, cerebrovascular diseases, liver and kidney diseases and respiratory diseases, were recorded. Furthermore, the determination of whether the patient has previously or recently used drugs that could affect water and electrolyte metabolism, such as diuretics, tricyclic antidepressants, and cyclophosphamide was also recorded.

GROUPING

A total of 481 patients were divided into two groups, according to the difference in fracture sites: femoral neck fracture group (group A) and intertrochanteric fracture group (group B). Group A comprised of patients with femoral neck fractures, while group B comprised of patients with femoral intertrochanteric fractures. The general data and chronic medical underlying diseases, such as hypertension, diabetes, cardiovascular diseases, cerebrovascular diseases, liver and kidney diseases, and respiratory diseases between these two groups were compared. Furthermore, the incidence of hypokalemia, hyponatremia and hypocalcemia between these two groups were also compared. The proportion of patients with hypokalemia and hyperkalemia, hyponatremia and hypernatremia, and hypocalcemia and hypercalcemia, as well as patients without electrolyte disorders, were further analyzed.

Statistical software SPSS 19.0 was used to analyze the data. For the collected data, count data were expressed in percentage (%), and underwent inter-group comparisons using χ^2 -test. Tables that had some values < 5 were evaluated using Fisher's exact probability test. $P < 0.05$ was considered statistically significant.

Results

GENERAL SITUATIONS

Compared with group A, the age of patients in group B was older, and the difference was statistically significant ($P < 0.05$, Table I). The differences in chronic internal diseases between the two groups were not statistically significant ($P > 0.05$, Table I). The incidence of hyponatremia, hypokalemia and hypocalcemia was 10.0%, 32.9% and 1.4%, respectively, in group A and 24.3%, 21.1% and 7.7%, respectively, in group B (Table II). The incidence of hypernatremia, hyperkalemia and hypercalcemia was 1.4%, 1.4% and 0.9%, respectively, in group A, and 1.1%, 0.7% and 0.8%, respectively, in group B (Table III). The proportion of patients with mild, moderate and severe hypokalemia, patients with normal blood potassium levels, and patients with hyperkalemia in the two groups are presented in Fig. 1. The proportion of patients with mild, moderate and severe

TABLE I - Comparison of general conditions and basic medical diseases between the two groups

	Group A	Group B	χ^2	P
Gender			0.005	0.945
Male	71(32.3)	85(32.6)		
Female	149(67.7)	176(67.4)		
Age			34.431	0.000
60-69	73(33.2)	39(14.9)		
70-79	92(41.8)	97(37.2)		
80-	55(25.0)	125(47.9)		
Combined disease				
Hypertension			1.626	0.202
Yes	90(40.9)	92(35.2)		
No	130(59.1)	169(64.8)		
Diabetes			0.057	0.811
Yes	32(14.5)	40(15.3)		
No	188(85.5)	221(84.7)		
Cardiovascular diseases			0.072	0.788
Yes	58(26.4)	66(25.3)		
No	162(64.8)	195(74.7)		
Cerebrovascular diseases			0.000	0.996
Yes	48(21.8)	57(21.8)		
No	172(78.2)	204(78.2)		
Liver diseases			0.352	0.553
Yes	4(1.8)	5(1.9)		
No	216(98.2)	256(98.1)		
kidney disease			0.075	0.785
Yes	5(2.3)	5(1.9)		
No	215(97.7)	256(98.1)		
Respiratory diseases			0.046	0.830
Yes	33(15.0)	41(15.7)		
No	187(85.0)	220(84.3)		

TABLE II - Comparison of hyponatremia, hypokalemia and hypocalcemia between the two groups

	Group A	Group B	χ^2	P
Hyponatremia			8.440	0.004
Yes	22(10.0)	51(19.5)		
No	198(90.0)	210(80.5)		
Hypokalemia			6.607	0.010
Yes	69(31.4)	55(21.1)		
No	151(68.6)	206(78.9)		
Hypocalcemia			10.404	0.001
Yes	3(1.4)	20(7.7)		
No	217(98.6)	241(92.3)		

TABLE III - Comparison of occurrence of hypernatremia, hyperkalemia and hypercalcemia between the two groups

	Group A	Group B	χ^2
Hypernatremia			1.000
Yes	3(1.4)	3(1.1)	
No	217(98.6)	258(98.9)	
Hyperkalemia			0.664
Yes	3(1.4)	2(0.8)	
No	217(98.6)	259(99.2)	
Hypercalcemia			1.000
Yes	2(0.9)	2(0.8)	
No	218(99.1)	259(99.2)	

hyponatremia, patients with normal blood sodium levels and patients with hypernatremia in the two groups are presented in Fig. 2. The proportion of patients with mild, moderate and severe hypocalcaemia, patients with normal blood calcium and patients with hypercalcemia in the two groups are presented in Fig. 3. The most common electrolyte disorders in all patients were hypokalemia, hyponatremia and hypocalcemia, and the incidence of moderate to severe hypokalemia and hyperkalemia that needed urgent treatment was relatively low. Furthermore, patients with hyperkalemia in both groups had long-term chronic kidney disease, but renal function (creatinine and urea nitrogen) was significantly abnormal.

Discussion

Hip fracture mainly occurs in the elderly, and its cause is mainly mild violence force action^{4,5}. Blood sodium refers to the concentration of sodium ion in serum, and the normal range is within 135-145 mmol/L. Hyponatremia refers to a state with blood sodium concentrations of less than 135 mmol/⁶, and is one of the most common electrolyte disorders in elderly patients. The results of the present study revealed that

the incidence of hyponatremia in elderly patients with femoral neck fracture and femoral intertrochanteric fracture was 10% and 19.5%, respectively. Zhi Li et al. revealed that⁷ compared with patients with femoral neck fracture, the incidence of hyponatremia in patients with femoral intertrochanteric fracture was high. This was consistent with the result of the present study (Table II). The reason may be as follows: 1. Compared with patients with femoral neck fracture, patients with femoral intertrochanteric fractures are older, and have a longer chronic disease course, lower digestive and absorption function of gastrointestinal tract, and poorer compensatory ability of the organism². Femoral intertrochanteric fracture is an extraarticular fracture, the soft tissue gap around the fracture is larger, and the occult blood loss is greater⁸. Most femoral intertrochanteric fractures have larger displacements and obvious pain. This influences the appetite of patients, and decreases sodium intake and affects the patient's mood, which in turn affects the patient's water and electrolyte metabolism through the nerve-neuroendocrine system. The main clinical manifestations of hyponatremia in the elderly are somnolence, apathy, disorientation, slow reaction, unstable gait and inattention⁹⁻¹¹. These cause patients to easily fall, and most of these elderly patients have osteoporosis to a certain extent, and are prone to fracture. This suggests that

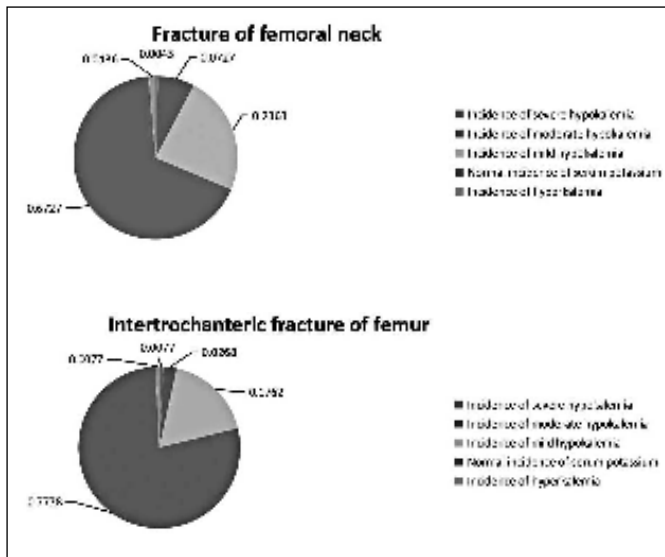


Fig. 1: The proportion of hypokalemia and hyperkalemia in the two groups.

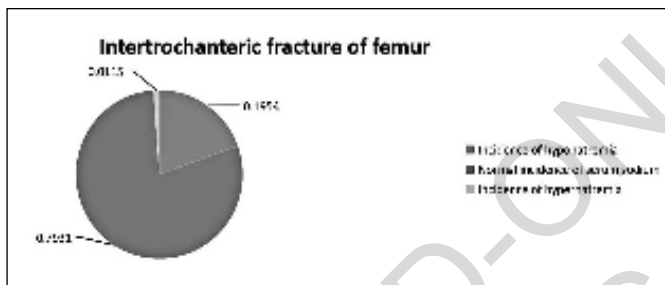


Fig. 2: The proportion of hyponatremia and hypernatremia in the two groups.

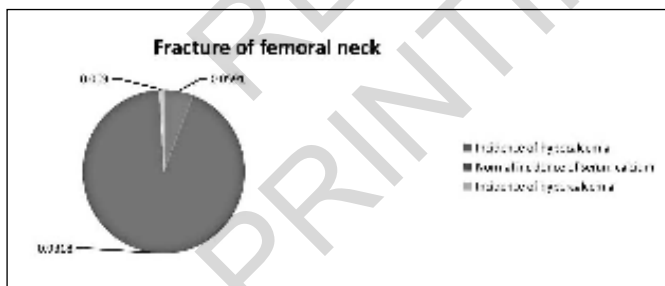


Fig. 3: The proportion of hypocalcaemia and hypercalcemia in the two groups.

hyponatremia may be one of the causes of hip fracture in elderly patients. In recent years, more and more studies have confirmed that hyponatremia was correlated to osteoporosis and fracture¹²⁻¹⁴. Hyponatremia is one of the causes of osteoporosis, and the majority of hip fractures in the elderly are osteoporotic fractures. In the pre-

sent study, most of the patients with sodium disorders in the two groups had hyponatremia, and the proportion of hypernatremia patients was 1.36% (group A) and 1.15% (group B), respectively. This research suggests that elderly patients with hip fracture should be guided in the use of salt according to blood sodium concentration, and in avoiding the frequent intake of low-salt diet. Blood potassium has physiological functions, such as maintaining neuromuscular excitability and normal myocardial function. In clinical, the normal value of blood potassium is usually within 3.5-5.5 mmol/L, and when blood potassium concentration exceeds 5.5 mmol/L, this is called hyperkalemia^{15,16}. Hypokalemia can cause a decrease in muscle strength, while hyperkalemia can cause arrhythmia, and even serious consequences, such as cardiac arrest¹⁷. Therefore, the purpose of detecting blood potassium concentration is to detect the abnormal blood potassium concentration in time, and correct this in time, avoiding serious life-threatening consequences. In the present study, the most common potassium disorder was mild hypokalemia. Some patients had moderate to severe hypokalemia and hyperkalemia, the proportion of moderate to severe hypokalemia and hyperkalemia in patients with femoral neck fracture was 7.72% and 1.36%, respectively, and the proportion of moderate to severe hypokalemia and hyperkalemia in patients with femoral intertrochanteric fracture was 3.45% and 0.77%, respectively. Patients with hyperkalemia in both groups had long-term chronic kidney disease, and their creatinine and urea nitrogen levels were significantly higher than normal levels. Potassium disorders in elderly patients with hip fracture are correlated to factors, such as long-term chronic diseases and long-term dietary control due to disease effects. Therefore, for elderly patients with hip fractures, there is a need to inquire about the history of chronic diseases in detail after admission, while for patients with poor diet, kidney disease or suspected kidney disease, drawing blood and urgent examination should be performed in time, the test results should be checked in time, and corresponding measures should be taken, in order to avoid serious adverse consequences.

Calcium is an essential trace element for the human body. Normal blood calcium concentration plays an important role in maintaining neuromuscular excitability. In addition, calcium also participates in intracellular signal transduction, which plays an important role in many pathways. A study revealed that¹⁸ elderly patients were prone to hypocalcaemia, and the lower the concentration of Ca²⁺ in blood, the longer the duration, and the poorer the prognosis became. A study confirmed that¹⁹ the incidence of hypertension was negatively correlated to high blood calcium level. Hypercalcemia mainly occurs in malignant bone tumors, hyperparathyroidism, and endocrine system diseases²⁰. In the present study, the incidence of hypocalcaemia in group A and group B was 1.4% and 7.7%, respectively, and the incidence of

hyponatremia in patients with femoral intertrochanteric fracture was relatively high. The reason may be that patients with femoral intertrochanteric are older and have a longer history of hypertension. Patients with hypocalcemia needs to be corrected in time, and the related causes should be identified. In addition to timely correction, for patients with hypercalcemia, there is a need to determine whether there are causes for the hypercalcemia, such as hyperparathyroidism, bone tumors and renal failure, in order to fundamentally treat the calcium disorder.

The limitations of the present study are as follows: the present study is a retrospective study, the sample size was limited, and there were some limitations in the use of blood potassium ion, sodium ion and calcium ion levels in the initial blood test after admission, since the diagnostic criteria of patients included recent electrolyte disturbance. Hence, prospective multi-center studies with large sample sizes, and multiple blood tests are needed to confirm this findings.

In the present study, the incidence of disturbances of blood sodium, potassium and calcium in elderly patients with hip fracture was systematically analyzed, and the proportion of hyponatremia, hypernatremia, hypokalemia, hyperkalemia, hypocalcemia and hypercalcemia in elderly patients with hip fractures was analyzed. It was confirmed that hyponatremia, hypokalemia and hypocalcemia are the most common, and had the highest percentage in elderly patients with hip fractures. Furthermore, it was emphasized that life-threatening electrolyte disorders in elderly patients with hip fracture, such as moderate to severe hypokalemia and hyperkalemia, requires urgent treatment. Therefore, elderly patients with hip fracture often have a certain degree of electrolyte disorder, in addition to timely correction, and the etiology should be further investigated. Furthermore, patients need to be inquired about their medical history in detail at admission, and blood tests should be urgently performed when necessary, in order to determine whether there is an electrolyte disorder that needs urgent treatment, and prevent serious consequences.

References

1. Lewis PM, Waddell JP: *When is the ideal time to operate on a patient with a fracture of the hip: A review of the available literature.* Bone Joint J, 2016; 98-B:1573-581.
2. Sambandam SN, Chandrasekharan J, Mounasamy V, Mauffrey C: *Intertrochanteric fractures: A review of fixation methods.* Eur J Orthop Surg Traumatol, 2016; 26:339-53.
3. Liu K, Sun LT, Deng XH, Wang ZJ, Shi XL, Wu LG, Liang BC: *Clinical observation of improved proximal femoral locking plate in treating osteoporotic intertrochanteric fractures.* China Journal of Orthopaedics and Traumatology, 2016; 29:689-92.
4. Chen WG: *Clinical efficacy of PFNA in the treatment of elderly patients with osteoporotic intertrochanteric fractures.* Jiangsu Medical Journal, 2015; 41:682-84.
5. Cauley JA, Cawthon PM, Peters KE, Cummings SR, Ensrud KE, Bauer DC, Taylor BC, Shikany JM, Hoffman AR, Lane NE, Kado DM, Stefanick ML, Orwoll ES: *Osteoporotic fractures in men (mros) study research group. risk factors for hip fracture in older men: the osteoporotic fractures in men study (MrOS).* J Bone Miner Res, 2016; 31:1810-819.
6. Sterns RH: *Disorders of plasma sodium-causes, consequence, and correction.* N Engl J Med, 2015; 372:55-65.
7. Li Z, Liang Y, Zhao CP, Zhang XB, Song CH: *Hyponatremia for the elder people after hip fracture.* Journal of Hebei Medical University, 2012; 33:1402404.
8. Yu WG, Zhang XC, Wu RB, Zhu XF, Hu J, Xu YF, Yi JH, Liu YJ: *The visible and hidden blood loss of Asia proximal femoral nail anti-rotation and dynamic hip screw in the treatment of intertrochanteric fractures of edlly high-risk patients:a retrospective comparative study with a minimum 3 years of follow-up.* BMC Musculoskeletal Disord, 2016; 11:269.
9. Buffington MA, Abreo K: *Hyponatremia: A review.* J Intensive Care Med, 2016; 31:223-36.
10. Sterns RH, Silver SM: *Complications and management of hyponatremia.* Curr Opin Nephrol Hypertens, 2016; 25:114-19.
11. Podestà MA, Faravelli I, Cucchiari D, Reggiani F, Oldani S, Fedeli C, Graziani G: *Neurological counterparts of hyponatremia: Pathological mechanisms and clinical manifestations.* Curr Neurol Neurosci Rep, 2015; 15:18.
12. Negri AL, Ayus JC: *Hyponatremia and bone disease.* Rev Endocr Metab Disord, 2017; 18:67-78.
13. Usala RL, Fernandez SJ, Mete M, Shara NM: *Verbalis JGHyponatremia is associated with increased osteoporosis and bone fracture in patients with diabetes with matched glycemic control.* J Endocr Soc, 2019; 3:411-26.
14. Holm JP, Amar AOS, Hyldstrup L, Jensen JEB: *Hyponatremia, a risk factor for osteoporosis and fractures in women.* Osteoporos Int, 2016; 27:989-1001.
15. Kovesdy CP: *Management of hyperkalaemia in chronic kidney disease.* Nat Rev Nephrol, 2014; 10:653-62.
16. Lehnhardt A, Kemper MJ: *Pathogenesis, diagnosis and management of hyperkalemia.* Pediatr Nephrol, 2011; 26:377-84.
17. Ran XW, Wang C, Dai F, Jiang JJ, Tong NW, Li XJ, Liang JZ: *a case of gitelman's syndrome presenting with severe hypocalcaemia and hypokalemic periodic paralysis.* Journal of Sichuan University Medical Science Edition, 2005; 36:583-87.
18. Yang XQ, Liu SG, Wang XB, Zhang K, Wei XD: *Clinical comparative analysis of low serum calcium in severe senile patients.* Chinese Journal of Gerontology, 2011; 8:3166-68.
19. Sun H, Shi J, Wang H, Fu L, Zhou B, Wu X, Dong W, Li H, Wang W: *Association of Serum Calcium and Hypertention Among Adolescents Aged 12-17 Years in the Rural Area of Northeast China.* Biol Trace Elem Res, 2013; 155:344-51.
20. Ahmad S, Kuraganti G, Steenkamp D: *Hypercalcemic crisis: A clinical review.* Am J Med, 2015; 128:239-45.