Original Article

Calcium intake in elderly patients with hip fractures

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Abstract

***Background*:** Dietary calcium intake is assumed important in the prevention and treatment of osteoporosis. However, people in countries with a high calcium intake from commodities such as milk and milk products have a high incidence of hip fracture. The effect and influence of calcium intake in the prevention of osteoporotic fracture vary from different studies.
***Objective*:** To investigate premorbid daily calcium intake in patients with low energy hip fractures during four consecutive years.
***Design*:** In total 120 patients (mean age 78 ± 8.5 (SD) years) were included between 2002 and 2005. The patients answered a structured food frequency questionnaire (FFQ) and interviews on patients' daily calcium intake from food and supplements took place during a 6-month period before the fracture. Dual energy X-ray absorptiometry (DEXA) was performed in a subgroup of 15 patients.
***Results*:** The mean daily calcium intake from food and supplementation was 970 ± 500 mg. However, 38% of patients had an intake below the recommended 800 mg/day. There was no significant relationship between calcium intake and age, gender, bone mineral density, serum calcium or albumin, type of fracture or body mass index. The mean free plasma calcium concentration was 2.3 ± 0.1, i.e. within the reference limit. In 2005, 80% of the patients who underwent DEXA had manifest osteoporosis. There was a trend towards decreased calcium intake over the observation period, with a mean calcium intake below 800 mg/day in 2005.
***Conclusion*:** Hip fracture patients had a mean calcium intake above the recommended daily intake, as assessed by a FFQ. However, more than one-third of patients had an intake below the recommended 800 mg/day. The intake appeared to decrease over the investigated years. The relationship between calcium intake and fracture susceptibility is complex.

Keywords: *calcium intake*; *dairy products*; *osteoporosis*; *hip fracture*; *bone mineral density*

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In recent years, there have been great advances in the field of prevention and treatment of osteoporosis. New drugs acting on the modelling and remodelling bone process have been introduced in the management of osteoporosis (1). In osteoporosis, bone mineral density (BMD) is decreased partly due to decreased osteoblast bone formation (2). The consequences of osteoporosis are well known with regard to the risk of fractures (3). In particular, hip fractures are a growing problem worldwide. Half of all women will eventually suffer from a fracture after the age of 50 (4). Men are also affected with a 25% fracture risk after the age of 50 (4). Therefore, osteoporosis prevention is of outmost importance. In order to maximize BMD, the focus is on pharmacological treatment, e.g. with bisphosphonates. To some extent, this focus has decreased the awareness of the importance of energy and nutrients, such as vitamin D and calcium. An adequate intake of these nutrients is also necessary to ensure optimal benefit from drugs (5). A deficiency of calcium intake in itself is considered a major risk factor for osteoporosis (6). Milk and cheese are primary sources of calcium and therefore might be expected to have an impact on osteoporotic bone loss and fracture risk (7). Many patients fail to consume the minimum recommended daily intake of calcium (8, 9), which in Sweden is 800 mg according to the Nordic Nutrition Recommendation (NNR 2004) (10). However, the observed intake in descriptive studies varies between 400 and 1,500 mg. Low calcium intake causes secondary hyperparathyroidism as the calcium homeostasis in blood must be kept stable (11, 12). This causes resorption of calcium from the bone with ensuing bone loss and an increased susceptibility to fractures. There is a lack of studies on calcium intake in patients with hip fractures. The aim of this study was to

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estimate the daily intake of calcium during four consecutive years in patients with hip fracture in relation to age, gender, biochemical markers of nutrition and BMD.

Material and methods

Elderly patients with a low energy hip fracture awaiting an operation were consecutively recruited from a gero-orthopaedic ward at the Karolinska University Hospital, Huddinge, Sweden. A low energy fracture is defined as a fracture caused by falls on the same level as the person is located. Twenty consecutive patients were investigated yearly between 2002 and 2004, and 60 patients in 2005, totalling 120 patients. Criteria for inclusion were age >65 years, able to communicate, and with normal cognitive function, i.e. Mini Mental State Examination (MMSE) >24 points (13). The MMSE is a validated questionnaire consisting of 10 items, used to evaluate cognitive function. Each item is given a score of 0–3 points, with a maximum total score of 30 points.

All patients were questioned about their weight and height. The nutritional status of the patients was evaluated by body mass index (BMI; kg/m^2) and plasma albumin. Blood was sampled before the operation for analyses of haemoglobin, C-reactive protein (CRP), total calcium and calcium conjugated with albumin. During 2005, 15 patients underwent dual energy X-ray absorptiometry (DEXA) to evaluate their osteoporotic state by BMD.

Data collection

One week post-operation, the patients were interviewed on the ward and asked about their average daily consumption of calcium-rich products and intake of calcium supplements before their hip fracture. In order to facilitate the interview with these elderly injured patients, we chose to assess dietary calcium intake using a food frequency questionnaire (FFQ) modified from a questionnaire previously used by Michaelsson et al. (14). This questionnaire has open questions estimating daily consumption over the previous 6 months of dairy products including type and number of glasses of milk, yoghurt, numbers of cheese slices per day, and also supplementary calcium intake with calcium tablets with or without vitamin D. We used eight predefined frequency categories ranging from 'never' or 'seldom', to 'many times per day'. One glass of milk and a dish of soured milk were calculated to contain 200 ml, thus with 232 mg calcium (116 mg/100 ml), and a slice of cheese was similarly calculated to contain 85 mg of calcium according to the Swedish Dairy Association (15).

Statistics

Mean values and standard deviations (±SD) were calculated for all variables. Student's t-test was used to compare means between men and women. Otherwise, non-parametric statistics were used as the number of observations was small and a non-normal distribution was probable. Spearman's rank correlation coefficients were calculated to determine the relationship between calcium intake and age, gender and nutritional indicators. A p value <0.05 was considered statistically significant.

Ethics

All patients gave their informed consent before participation. The study was approved by the ethics committee of Karolinska Institutet, Stockholm (2002-06-12; 02-153).

Results

The study comprised 120 patients, 97 women and 23 men with a mean age of 78±9 years (Tables 1 and 2). The hip fractures were divided into two groups, with a cervical hip fracture in 62 patients (53%) and a trochanteric fracture in 58 patients (48%). Table 1 and 2 show calcium intake during the whole observation period. The mean daily calcium intake was 685±306 mg from food and 283±372 mg from supplementation (mean±SD), respectively. Thus, the total calcium intake was 968±501 mg. Calcium intake through food was <800 mg/day in 74 patients (62%). A corresponding low intake from food and calcium supplementation combined was registered in 46 patients (38%) (Fig. 1). In total, 15 patients had a daily calcium intake <400 mg through food. Fifty-five patients (42%) had no calcium supplementation. The laboratory parameters are depicted in Table 1, and there were no correlations to calcium intake.

There was no significant difference in calcium intake between men and women in total or between the individual years (Tables 1 and 2). However, there was a trend towards lower intake during the last year of the study (Fig. 2), and there was a significantly decreased calcium intake from food and supplements in men during the last year. There was no correlation between calcium intake and age, gender, BMI, plasma calcium or albumin, and there was no significant difference in calcium intake between patients with a cervical hip fracture or a trochanteric fracture.

According to the DEXA examination of 15 patients, 12 patients had osteoporosis, i.e. a T-score below −2.5. Two patients had osteopenia (T score between –1 and –2.5) and one patient had a normal T-score. There was no correlation between calcium intake and BMD.

Discussion

In this study on calcium intake in 120 elderly patients with hip fracture during the years 2002–2005, we found a mean total daily calcium intake of 970 mg of which daily dietary calcium through milk, yoghurt and cheese was 686 mg (71%), and the mean daily calcium supplementation was 284 mg (29%). More than half of the patients had no supplementation. Nearly 40% of the patients had

Table 1. Demographic, biochemical and calcium intake data in elderly patients with hip fractures through 2002–2005

Year	2002 ($n=20$)			2003 ($n=20$)			2004 ($n=20$)			2005 ($n=60$)		
Gender	Female 80% (16)	Male 20% (4)	Total	Female 65% (13)	Male 35% (7)	Total	Female 90% (18)	Male 10% (2)	Total	Female 83% (50)	Male 17% (10)	Total
Age (years)	77.1±7.6	80.8±7.3	77.8±7.5	72.4±8.6	70.6±11.6	71.8±9.5	78.8±10.3	82.5±2.1	78.8±9.8	79.8±7.0	78.9±6.9	79.6±7.1
BMI (kg/m^2)	24.2±3.4	25.9±3.8	24.7±3.4	23.2±4.0	22.75±3.3	23.1±3.7	22.2±39.0	22.5±5.7	22.2±36.5	23.4±3.8	22.3±3.6	23.2±3.8
Hb (g/l)	119±13	136±28	124±19	125±11	122±13	124±11	122±16	135±11	122±16	125±17	130.2±7.6	125.8±15.9
P-Albumin (g/l)	34.7±4.2	33.8±3.9	34.4±4.0	37.3±4.8	37±1.7	37.3±4.4	37.1±3.4	40.5±4.9	37.1±3.6	36.9±3.6	35.7±4.6	36.7±3.8
P-CRP (g/l)	27.8±32.3	49.4±59.0	29.1±42.2	28.8±38.0	42.0±15.7	39.4±32.9	25.1±26.5	10±0	22.9±26.0	15.8±17.5	10.8±14.0	14.9±16.9
P-Ca (mmol/l)	2.3±0.1	2.4±0.1	2.4±0.1	2.3±0.1	2.4±0.1	2.4±0.1	2.4±0.1	2.2±0.0	2.4±0.1	2.2±0.1	2.2±0.1	2.2±0.1
P-Ca/alb (mmol/l)	2.4±0.1	2.5±0.1	2.4±0.1	2.4±0.1	2.2±0.6	2.3±0.3	2.4±0.1	2.3±0.0	2.4±0.1	2.3±0.1	2.2±0.1	2.3±0.1
Ca via food (mg)	814±247	850±464	822±292	792±457	757±223	779±380	706±246	800±141	715±236	594±278	640±220	602±285
Ca via suppl (mg)	536±237	375±250	500±243	250±261	714±393	421±382	268±452	0.0	268±452	224±369	0.0	185±346
Ca total (mg)	1,350±263	1,225±246	1,322±263	1, 042±560	1,471±457	1, 200±554	974±521	800±141	983±495	818±491	640±220	787±459
Ca S/T (%)	39.6	30.6	37.8	24.0	48.5	35.1	27.5	0.0	27.3	27.4	0.0	23.5

Data given as mean±SD. BMI=body mass index (kg/m^2). CRP=C-reactive protein. P-Ca/alb=plasma calcium concentration corrected for albumin. Ca S/T%=calcium intake from supplementation in relation to total intake.

Table 2. Mean values of study variables in 120 elderly patients with hip fractures

Gender	Total ($n=120$)		
	Female 81% (97)	Male 19% (23)	Total
Age±SD	78.68±8.2	76.5±7.3	77.9±8.5
BMI±SD	23.2±3.7	23.0±3.4	23.1±4.0
P-Hb (g/l)±SD	123.9±15.4	128.6±16.6	124.7±15.4
P-Albumin (g/l)±SD	36.9±3.9	35.4±4.3	36.6±3.9
P-CRP (g/l)±SD	21.1±26.7	31.7±29.9	23.1±27.1
P-Ca (mmol/l)±SD	2.3±0.1	2.3±0.1	2.3±0.1
P-Ca/alb. (mmol/l±SD)	2.3±0.1	2.3±0.3	2.3±0.2
Ca via food (mg)±SD	677±314	719±206	685±306
Ca via suppl (mg)±SD	277±367	309±414	283±371
Ca total (mg)±SD	954±501	1,028±474	968±501
Ca S/T (%)	29.0	30.1	29.2

a calcium intake below the recommended 800 mg/day. Over the 4 years, there was a tendency to a gradually decreased calcium intake through food in 27% of patients and through supplements in 63% of patients. There was no gender difference in calcium intake.

In the treatment of established osteoporosis, the main role of calcium supplementation is as a general adjuvant therapeutic measure (16, 17). However, several studies have shown that calcium supplementation rendering a total calcium intake of 1,200 mg/day may slow the rate of bone loss (18). Among healthcare workers, it has been difficult to reach a consensus on what should be considered as the physiological requirement of daily calcium intake. The reality is that currently we have no reliable method on which to determine the requirement of calcium (10). However, the NNR 2004 has recommended

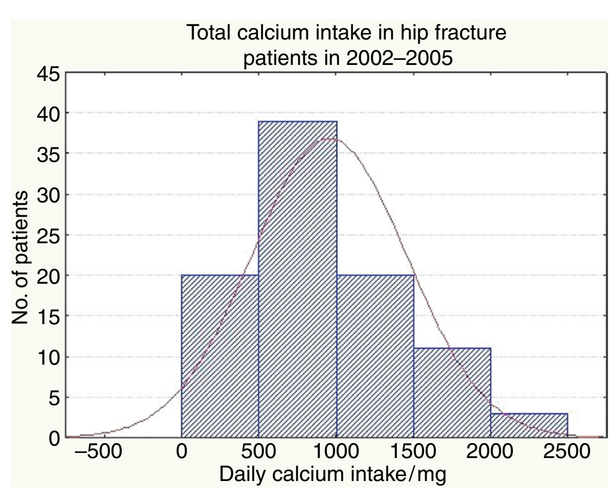

Fig. 1. Total daily calcium intake in 120 hip fracture patients during 2002–2005.

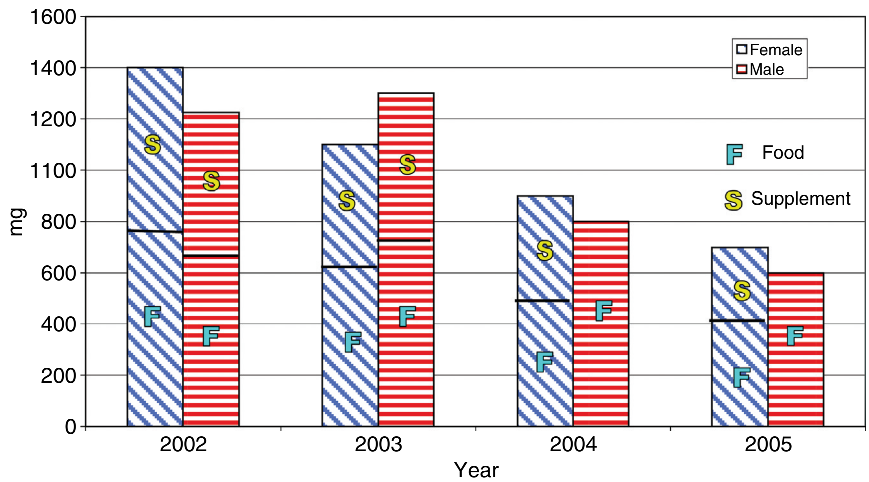

Fig. 2. Mean calcium intake by food and supplementation in men and women with hip fractures from 2002 to 2005.

a daily calcium intake of 800 mg (10). Due to the high consumption of calcium rich foodstuffs, such as milk and milk products, the mean daily calcium intake in the Nordic countries is higher than the recommendation for almost all age-groups, i.e. 900–1,200 mg/day for women and 900–1,400 mg/day for men (NNR) (10). In contrast, much of the world's population has a calcium intake <500 mg/day (10), e.g. the intake in Japan is 400–500 mg/day due to a diet of mainly soybean, small fish with bone and vegetables (19). The calcium intake is even lower in other Asian countries and in Africa. Paradoxically, the highest incidence of osteoporotic fractures is found in developed countries with the highest calcium intake, arguing in favour of a more complex correlation to fractures than calcium intake alone.

According to the findings of our study, the mean calcium intake of patients with a hip fracture was sufficient, whereas more than one-third of the patients had a suboptimal intake. Since 1980, several studies have asserted that calcium intake via food and supplement was the best way to prevent and treat osteoporosis and hip fracture. However, the results are conflicting (14, 16, 20, 21). For example, calcium supplementation alone has been reported to have a small positive effect on bone density (22). On the other hand, calcium supplementation was recently shown unlikely to be able to substantially reduce the fracture risk (23, 24). There are Dutch results suggesting an increased risk of osteoporotic fractures in old age with a high life time calcium intake (2).

Surprisingly, in our study there was a trend toward a decreased calcium intake during the years 2002–2005. We do not have specific explanations for this finding, but one possible explanation could be the coincidental mass-medial warnings occurring at this time concerning milk consumption and its relation to atherosclerosis and cardiovascular disease. Moreover, there were discussions of studies on osteoporotic hip fractures in postmenopausal women reporting that neither milk nor a high calcium diet appeared to reduce the risk of fracture (2, 24). In countries such as the US, Italy, and Sweden, it has been suggested that there is almost no correlation between calcium intake and osteoporotic hip fracture (14, 20, 25). In the previously mentioned Dutch study, it was suggested that calcium might inhibit osteoblast activity in bone tissue (2).

A drawback of this study was that the levels of 25-OH-vitamin D were not measured, which is important in calcium absorption. However, the effectiveness of vitamin D alone in fracture prevention is unclear (26). One study reports no association with fracture risk (14), while others show a sustained effect on fewer hip fractures in institutionalised, frail, older people in combination with calcium supplements (27). Another study shows a reduced risk of hip fractures and other non-vertebral fractures among elderly women with such a combination therapy (28), as well as a study on elderly community dwelling residents (29). Furthermore, we did not have a matched control group to compare calcium intake. However, we were interested in the hip fracture patients' calcium intake and the relation to RDI. A French study on institutionalized geriatric patients showed a mean calcium intake of 670 ± 258 mg/day (30). The use of a FFQ as the only measure of calcium intake is a weakness of the study. This technique was validated by Michaelsson et al. (14)

Conclusion

This study of patients with hip fracture showed that the mean calcium intake was well above the daily recommended intake regardless of gender, despite the general dominant incidence of osteoporotic hip fracture in women. However, more than one-third of the patients had an intake below the recommended level. There was no significant correlation between dietary calcium intake and age, gender or nutritional status. Further studies are suggested in order to seek mechanistic explanations for the paradox that subjects with sufficient or even high calcium intake still have a high incidence of hip fractures.

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