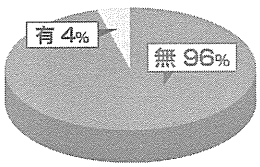
3 予防と治療

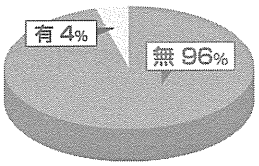
3 骨粗しょう症薬物療法

■骨粗しょう症の薬を服用している方の割合
（佐渡市2004）

背骨の骨折患者
（脊椎圧迫骨折）



脚の付け根の骨折患者
（大腿骨近位部骨折）



治療（薬剤服用）している方が少ない!!

「くすり」は続けて服用しましょう。

骨粗しょう症は骨折を起こします。
整形外科医（骨の専門家）とよく相談して、
適切な治療を長く続けて下さい。

骨粗しょう症による骨折

骨折調査のご協力をお願いします。

骨粗しょう症の予防、治療のさらなる充実のために
骨折された患者さんの調査を実施しています。

※調査にご協力いただきました患者様の個人情報は、
当研究のためだけに使用させていただきます。

参考

- 日本整形外科学会　http://www.joa.or.jp/jp/index.html
- 厚生労働省　http://www.mhlw.go.jp/topics/2006/11/tp1122-1.html
- FRAX　http://www.shef.ac.uk/FRAX

企画制作

新潟大学医学部　整形外科学教室（高齢者骨折パンフレット 2010年版）
厚生労働科学研究費補助金　長寿科学総合研究事業
「医療機関受診者を対象として高齢者骨折の実態調査に関する研究」
（札幌医科大学、横浜市立大学、鳥取大学、琉球大学との共同研究）

問い合わせ

資料２－３）

大腿骨近位部骨折
新潟県全県（250万総人口）疫学調査

経年推移（JBMM 川嶋1987,堂前1991,伊賀1999,森田2002,遠藤栄2004）

	1985	'87	'89	'94	'99	'04
骨折数	677	773	996	1468	1697	2421
男女比	1:2.7	1:2.4	1:2.8	1:2.9	1:3.2	1:3.6
平均年齢（歳）						
男 性	67.5	70.4	71.4	74.4	75.5	77.8
女 性	76.2	76.9	77.7	80.9	80.5	83.3
発生率	27.3	31.2	40.1	59.1	68.2	98.8
（100,000人人口／年）						
高齢化率(%)	12.9	13.7	14.2	17.3	20.7	23.2

既報の文献より一覧としてまとめたものである。

骨粗鬆症関連骨折

ひとつの地域における同一期間での全数調査

●新潟県佐渡市
（全人口70,011人
65歳以上人口23,787人
高齢化率＝34.0%）

●2004年1月1日～12月31日、
佐渡病院、関連施設との共同研究

骨粗鬆症関連骨折の1年間での発生数、発生率

	発生数（人／年）(男性, 女性)	発生率（人口10万対）	受傷年齢平均(歳)
脊椎	163 (45, 118)	232.8	77.7±11.8
大腿骨近位	85 (20, 65)	121.4	81.4±11.0
上腕骨近位端	26 (3, 23)	37.1	75.7±16.2
橈骨遠位端	76 (18, 57) *不明1	108.6	60.2±24.6
合計	350 (86, 263)	499.9	

（人口200人に　1骨折）

JBMM Vol. 7, No. 2, August 1989

Epidemiology of the Femoral Neck Fracture in 1985, Niigata Prefecture, Japan

Tadashi Kawashima

ABSTRACT

The incidence of the femoral neck fractures in 1985 was studied in Niigata Prefecture, Japan, which is on the "Japan Sea" at the central area of the Main Island of Japan. The author visited all hospitals within Niigata Prefecture, to study radiographs and records of patients who sustained femoral neck fractures. On October 1, 1985, the population of Niigata Prefecture was 2,474,829 (1,202,873 males and 1,271,956 females). The population over 65 years of age was 319,305, 12.9% of the total population (129,252 males and 190,053 females).

During 1985, there were 677 fractures of femoral neck (183 males and 494 females, i.e. 1:2.7). Its incidence over 65 years of age was 9.3 in males and 23.9 females per 10,000 population/year. The ratio of cervical and trochanteric fractures was 231:446 (1:1.9), the latter amounting to two thirds of the femoral neck fractures.

The age specific incidence in Niigata Prefecture showed an exponential increase with increasing age like in Sweden or in the USA, but the age-adjusted incidence in Niigata Prefecture was one-fourth or one-fifth of that in those countries.

Introduction

Femoral neck fractures are closely related to senile osteopenia and impaired physical activity with aging. Studies of their incidence have been done in England[1,2], Sweden[3], Singapore[4], Hong Kong[5], Israel[6], South Africa[7], Yugoslavia[8] and the USA[9]. No similar study have been performed in Japan. Previous reports showed that the incidence of femoral neck fractures differed from country to country and among different races. Orientals and Negros are thought to have a low incidence of femoral neck fractures compared to Caucasians. However, several studies of the prevalence of osteoporosis in Japanese in Japan and Japanese born in Hawaii disclosed that both tended to have a lower bone mineral content[11,10], and a higher incidence of postmenopausal spinal osteoporosis[11] than Caucasians.

This article reports the incidence of femoral neck fractures which occurred in Niigata Prefecture, Japan in 1985 and the possible role of factors such as osteoporosis and physical activity, in the occurrence of these fractures.

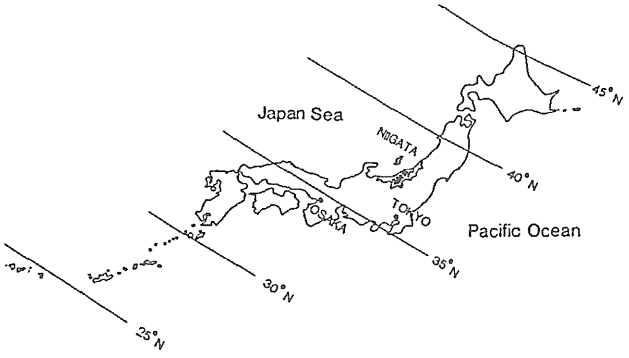
Materials and Methods

The survey was carried out in Niigata Prefecture, which is on the "Japan Sea" and located approximately in the center of the main island of Japan. The racial structure of people in Niigata Prefecture is almost exclusively Japanese. Since this area is bordered by mountains and sea, most residents tend to be treated in medical institutions within Niigata Prefecture. Most of these hospitals are affiliated with Niigata University School of Medicine, a fact which guaranteed the completeness of

Department of Orthopedic Surgery Niigata University School of Medicine Niigata City
Japan 951

this epidemiological study (**Fig.1**).

Figure.1 Location of Niigata Prefecture (shaded) on Honshu Island of Japan



All femoral neck fractures that occurred in residents in Niigata Prefecture from January 1 to December 31 in 1985 were collected from the 54 hospitals in this Prefecture, together with their x-rays and hospital records.

The data included patients' age, sex, date of injury, type of fracture, cause and location of the injury, preexisting diseases, history of other fractures, serological data, trabecular pattern of the opposite hip (according to Singh's grading system) and cortical index of the femoral shaft. The data were analyzed (χ^2 test, t-test) at the Medical Computer Center of Niigata University. Residents of Niigata Prefecture who sustained femoral neck fracture in 1985 and received treatment outside the Prefecture were included, but non-residents receiving treatment in Niigata Prefecture were excluded from this study. Three women who sustained fractures on both hips on separate occasions during this period were counted as 6 cases with 6 fractures.

Based on x-ray findings, femoral neck fractures were divided into 1) cervical fractures and 2) trochanteric fractures. Isolated fractures of the greater trochanter, subtrochanteric fractures and pathologic fractures were excluded from this study.

The severity of trauma was classified into the following 4 groups.

1. High energy trauma: injured in a major traffic accident, by fall from a height, by falling during sports activity, etc.
2. Medium energy trauma: falling down from a step, injured in a minor traffic accident, etc.
3. Low energy trauma: "Simple fall" due to slipping, tripping, stumbling, or due to dizziness.
4. Without obvious trauma: Spontaneous fracture, or fracture caused by minor force without fall.

Physical activity levels prior to the fracture were divided into 3 groups,

1. Completely independent: Those who were able to move around outside their home on their own accord without assistance.
2. Moderately dependent: Those who needed a cane during outside activity, or who remained in the vicinity of their homes.
3. Completely dependent: Those who were confined to their room, or bedridden.

Statistics

In Japan, a census takes place every 5 years. As of October 1, 1985, the population of Niigata Prefecture was 2,474,829 (1,202,873 males and 1,271,956 females). Residents defined as "elderly" with their ages over 65 years numbered 319,305 (129,252 males and 190,053 females).

Age specific incidences of femoral neck fracture were calculated from the corresponding population in Niigata Prefecture and expressed as fractures per 10,000 per annum for each sex and in 5 year age groups.

Results

1. Fracture incidence

During 1985, 677 femoral neck fractures occurred among ca. 2.5 million residents of Niigata Prefecture. All these fractures occurred in Japanese people. As shown in **Table.1** and **Figure.2**, the annual fracture rate per 10,000 population by sex and by age increased exponentially with increasing age from the 6th decade. The "elderly population" made up 83% (565 fractures) of the total fractures, and residents defined as the "advanced age group" their age being over 75 years made up 56% (377 fractures) of all the fractures. (**Table.1**)

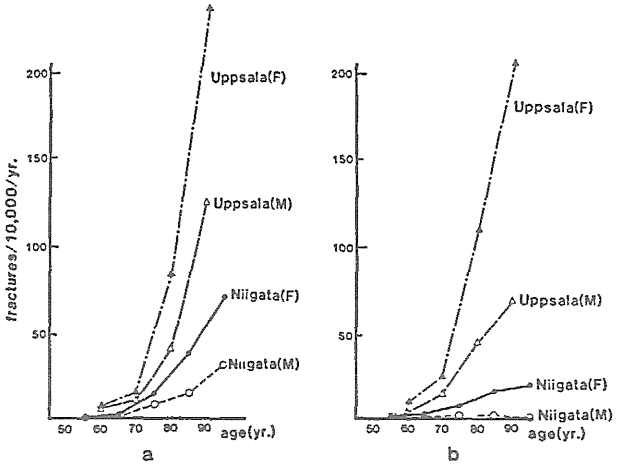
The crude incidence of all femoral neck fractures was 3.88 per 10,000 females per year, and 1.52 per 10,000 males per year. Of "elderly population", the incidence of female was 23.6 and that of males 9.3.

The female/male ratio based on the number of frac-

Table.1 Age-specific incidence rates of hip fractures and percentage of trochanteric fracture.
(Fracture rates are expressed as fractures per 10,000 population per annum in 5 year age groups)

Age	Male							Female						
	Cervical fractures		Trochanteric fractures		Both		Troch. fx.	Cervical fractures		Trochanteric fractures		Both		Troch. fx.
	Cases	Rate	Cases	Rate	Cases	Rate	%	Cases	Rate	Cases	Rate	Cases	Rate	%
-49	8	0.09	16	0.19	24	0.28	67%	7	0.08	3	0.04	10	0.12	30%
50-54	6	0.72	6	0.72	12	1.43	50%	7	0.79	2	0.23	9	1.02	22%
55-59	2	0.25	12	1.49	14	1.74	86%	11	1.27	3	0.35	14	1.62	21%
60-64	5	0.85	8	1.37	13	2.22	62%	11	1.44	5	0.65	16	2.09	31%
65-69	3	0.66	12	2.63	15	3.28	80%	23	3.77	23	3.77	46	7.53	50%
70-74	8	2.10	30	7.87	38	9.97	79%	38	7.12	51	9.55	89	16.67	57%
75-79	9	3.42	26	9.88	35	13.29	74%	30	7.54	80	20.09	110	27.63	73%
80-84	2	1.54	13	9.99	15	11.53	87%	32	14.12	70	30.89	102	45.02	69%
85-89	0	0	13	29.19	13	29.19	100%	23	25.07	48	52.31	71	77.38	70%
90-	0	0	4	31.42	4	31.42	100%	6	19.80	21	69.31	27	89.11	78%
Total	43	0.36	140	1.16	183	1.52	77%	188	1.48	306	2.41	494	3.88	62%
age over 65	22	1.71	98	7.62	120	9.33	82%	152	8.06	293	15.54	445	23.60	66%

Figure.2 Age-specific incidence of hip fractures of female and male residents of Niigata in 1985 and of Uppsala in 1980
a. Incidence of trochanteric fracture
b. Incidence of cervical fracture



tures was 494/183(2.70), also the female/male ratio based on the crude rates of fracture incidence was 3.88/1.52(2.55) (**Table.1**).

The ratio between cervical and trochanteric fractures was 231:446(1:1.9), with trochanteric fractures amounting to two thirds of the total number. The percentage of trochanteric fractures was higher in males (male: 77%, female: 62%), and it tended to increase with age in both sexes (**Table.1**). The average age of the patients with cervical fractures was 62.9 years in males, and 73.0 years in females, and that of patients with trochanteric fractures was 68.9 years in males, and 78.2 years in females. The average age of patients with trochanteric fractures was significantly higher than that of patients with cervical fracture in both sexes (male; $p < 0.05$, female $p < 0.01$). In either type of fracture, the average age of the females was significantly higher than the males (cervical fracture; $p < 0.01$, trochanteric fracture; $p < 0.01$).

When the rates for each sex were age-adjusted to the age distribution of the whole Japanese population in 1985, the age adjusted incidence in Japanese females became 3.05 and for Japanese males 1.26 per 10,000 per year, respectively. For comparison, the incidence of femoral neck fractures in other countries has been age adjusted to the Japanese population and is shown in **Table.2.**

2. Location at the time of injury

Of the 677 fractures, 77 occurred while the patient was hospitalized for other reasons, and 32 occurred in nursing homes. On the other hand, 418 patients were injured while being indoors and 254 patients consisting of 139 females and 115 males while being outdoors (unknown 5). Thus, 72% of the females and 38% of the males were injured indoors. For elderly patients, 75% of the females and 41% of males were injured indoors. (**Table.3**)

Table.2 Age-adjusted incidence rates of hip fractures from various studies.
(Different age distribution in different countries were adjusted to 10,000 Japanese population in 1985)
Rates are cases per 10,000 population per year.

			Female	Male
Uppsala (Sweden)	1980		15.36	4.87
	1965		13.29	3.20
Rochester (USA)	1965-1974		11.40	3.28
Jerusalem (Israel)	1957-1966	Europe America	8.58	3.68
		Asia Africa	6.13	3.79
Dundee Oxfork(UK)	1954-1958		5.43	2.08
Istra		Low Ca diet	4.43	3.59
Podravina (Yugoslavia)		High Ca diet	1.93	1.71
Hong Kong (China)	1965-1967		3.62	2.52
Singapore (Malaysia)	1955-1962		1.78	2.30
Johannesburg (South Africa)	1957-1963	Bantu	0.60	0.48
Niigata (Japan)	1985		3.05	1.26

3. Severity of trauma

The 674 cases in which causes of fractures were recorded, were divided into 4 groups (**Table.4**). Low energy trauma caused two thirds of them, 74% of females and 52% of males. The average age and sex ratio of each group showed that the lower the trauma energy was, the higher the age and female/male ratio.

As for the types of fracture, expressed by percentage of trochanteric fracture, there were no statistical differences between the "low", "medium" and "high" energy trauma groups. On the contrary, the "without obvious trauma" group, which had higher average age and sex ratio than the other three groups, had a low percentage of trochanteric fractures.

4. Ambulatory status

To minimize the errors from age and type of injury, 413 fractures of "low energy trauma" in patients over the age 65 were selected, and divided into 3 groups, according to the ambulatory status before the fracture

Table.3 Location at the time of injury (N=672)
* 418 patients were injured while being indoors, including 77 hospitalized cases and 32 cases in nursing home.

	Male			Female		
location	indoors		outdoors	indoors		outdoors
Age						
~64	20		44	20		28
65~74	18	(41%)	35	87	(75%)	43
75~	31		36	242		68
Total	69	(38%)	115	349	(72%)	139

Table.4 Cause of fracture in relation to sex, age and fracture type. (N=674)

Cause of fracture	Number of cases: Female cervical	Female trochanteric fx.	Male cervical	Male trochanteric fx.	mean age	sex ratio	trochanteric fx. %
High energy trauma	11	17	17	43	62.9 p<0.01	0.47	68% NS.
Medium energy trauma	14	35	4	20	70.3 p<0.01	2.04	75% NS.
Low energy trauma (simple fall)	120	244	21	75	76.2	3.79	69%
Without obvious trauma (spontaneous fx)	41	9	2	1	76.9	16.67	19%

Table.5 Ambulatory status of fracture cases in the elderly (over 65 years of age) caused by "low energy trauma" (N = 391)

Physical activity level	Number of cases: Female cervical fx.	Female Trochanteric fx.	Male cervical fx.	Male Trochanteric fx	Trochanteric fx. %	
Completely independent	49	104	6	22	70%	N.S.
Moderately dependent	39	94	6	32	74%	N.S.
Completely dependent	10	25	1	8	75%	

(Table.5). No information about physical activity prior to the accident was available for 22 cases. Only 153 of the 316 females, and 28 of the 75 males were independent.

Therefore, over a half of the fracture caused by "simple falls" among the elderly were associated with impaired physical activity. However, the ambulatory status did not affect the type of fracture.

5. Preexisting diseases (Table.6)

Major problems prior to injury which were possibly related to the fracture were divided into 2 groups: i.e., diseases affecting ambulatory status, and osteopenia.

Table.6 Preexisting diseases

A. Preexisting diseases affecting ambulatory status	
Neurologic paresis	123
Cerebro vascular disease	93
Parkinson's disease	12
Poliomyelitis	2
Cervical spondylotic myelopathy (post op.)	2
Others	14
Rheumatoid arthritis	14
Artificial limb	1
Short leg cast (ankle Fx.)	1
Severe visual disorder	11
B. Preexisting diseases affecting osteopenia	
Diabetes mellitus	56
Gasterectomy	34
Renal failure	14
Steroid	8
Anti-epileptic drugs	3

a. Preexisting diseases affecting ambulatory status

There were 123 patients with various kinds and different degrees of neurologic disorders. These were 93 patients with cerebrovascular disease, 12 with Parkinson's disease, 2 with paresis due to poliomyelitis, 2 who had surgery for cervical spondylotic myelopathy, and 14 with other neuromuscular problems such as cerebral palsy, brain tumor, cerebellar ataxia, muscular dystrophy, etc.

Furthermore there were 14 patients with rheumatoid arthritis including one patient with bilateral total knee replacements. One patient had an artificial limb after mid thigh amputation, and another had a short leg cast for an ankle fracture. Also, 11 patients had severe visual disorders.

A total of 150 preexisting disorders that were related to the patient's ambulatory status prior to injury, were noted in 142 patients, and trochanteric fracture occurred in 66% of this group. Of 87 patients with hemiplegics, fracture occurred in their hemiplegic side in 79 patients and the percentage of trochanteric fracture was 71% in hemiplegics.

b. Preexisting diseases affecting osteopenia

There were 56 patients with diabetes, 34 who had gasterectomy, 14 with chronic renal failure (5 of them undergoing hemodialysis), 8 patients being treated with steroids and 3 with antiepileptic drugs.

A total of 115 preexisting disorders related to osteopenia in 108 patients were noted, and trochanteric fractures amounted to 70% of the fractures in this group. No significant difference in the type of fracture was found that related to complications prior to injury of the patients in this series.

6. History of other fractures

A history of fractures prior to the hip fracture was found in 45 instances.

There were 15 cervical fractures, 7 trochanteric fractures, 4 supracondylar fractures of the femur, 10 humeral neck fracture, and 11 Colles' fractures. Of the 15 patients who had a previous cervical fracture, 9 had the same type of fracture, while all 7 patients who had a previous trochanteric fracture, suffered the same type of fracture on the opposite side.

7. Singh's index

Singh, et al.[13,14], classified trabecular patterns of the proximal femur into 7 grades. The author classified the non-injured hips with an A-P film taken with neutral position. In order to eliminate the factors of age and type of trauma, the author selected 413 cases of fractures due to "low energy trauma" (simple fall) in the elderly. Of the 295 cases available for grading, fewer than 30 % of the cases were graded lower than grade 3 (osteoporosis). The lower the Singh's index the higher the incidence of trochanteric fractures (Table.7).

8. Femoral cortical index (FCI)

To evaluate the cortical thickness from x-rays, the author measured femoral cortical index at a point 5 cm distal to the tip of the lesser trochanter as follows.

Table.7 Singh grades of fracture cases in the elderly (over 65 years of age) caused by "low energy trauma" (N = 295)
Note that the trochanteric fracture rate tended to increase with a decrease in grade.

Singh grade	Number of cases				Trochanteric fx. %	
	Female		Male			
	cervical fx.	trochanteric fx.	cervical fx.	trochanteric fx.	Female	Male
7	0	0	0	0	-	-
6	6	2	4	2	25%	33%
5	29	39	4	17	57%	81%
4	30	65	1	18	68%	95%
3	17	43	1	4	72%	80%
2	3	10	0	0	77%	-
1	0	0	0	0	-	-

$$FCI = \frac{\text{medial cortical width} + \text{lateral cortical width}}{\text{bone width}} \times 100$$

A total of 380 fractures was available for the group "over age 65" with "low energy trauma". Of 314, females 218 with trochanteric fracture had FCI of 34.8 ± 7.6 (mean ±SD) and 96 with cervical fracture had FCI of 39.4 ± 8.7.

Fifty-four male patients with trochanteric fractures and 12 with cervical fractures had FCI of 41.8 ± 7.2 and 45.1 ± 5.9, respectively. The FCI in trochanteric fractures was smaller than in cervical fractures in both sexes, but a statistically significant difference was found only in females ($p < 0.001$).

Disucussion

In contrast to the epidemiological studies of fractures of the proximal femur in other countries, the author found a significantly lowerincidence in Niigata, Japan (Table.2). As in other countries, the age-specific incidence of the fracture in Niigata showed an exponential increase with aging, but the incidence curve of Japanese was shifted to the right by more than 10 years from the incidence curve of Uppsala, Sweden[3] (Fig.2).

The female/male ratio of age-adjusted incidence of the Niigata residents, i.e., 2.43, showed some similarity to the results from Europe (Uppsala 3.15, Dundee-Oxford 2.61) and the USA (Rochester 3.48). There was a preponderance of fractures in females with approximately three times as many as that of males in these countries. (Table.2). It has been widely accepted that the non-white populations have lower incidence of hip fractures and also a preponderance in males. For example females had slightly lower fracture rate than male in Singapore (sex ratio = 0.77), and less than twice as many fractures as males in Yugoslavia (Istra 1.23, Podravina 1.13), in Hong Kong (1.44), Bantu population in South Africa (1.25) and Asia African group in Jerusalem (1.62).

The author observed differences in the etiological factors of fractures between males and females. As to the location at the time of injury and severity of trauma by sex, females tended to be injured indoors by a simple fall whereas males tended to be injured outdoors by trauma more severe than a simple fall. Thus, the author speculates that the differences in sex ratio among countries are not only due to racial or genetic factors but also to different environmental and socioeconomic factors which tend to increase the incidence of higher energy trauma in males.

Why was the fracture incidence low in Japan?

It has been thought that at least three factors may contribute to differences in fracture incidence; namely 1. senile osteoporosis, 2. osteomalacia and 3. increase of falls due to impaired physical activity.

The relation between osteoporosis and hip fractures has been a subject of keen interest. Several biomechanical studies showed a correlation between strength of neck of femur and bone density[15,16]. More over the measurement of bone mass by various methods disclosed that it was lower in patients with hip fractures than in control groups[17].

Several papers which dealt with the measurement of bone mass suggested that the bone mass in Japanese people was in general lower than in Caucasians, probably due to genetic factors. Garn found that cortical bone mass of metacarpals in persons of Chinese and Japanese descent, whether American-born or not was lower than in Americans of European descent[11]. Yano found that the Japanese in Hawaii had lower bone

mineral content of the radius, as compared with caucasian Americans[10]. Norimatsu also reported that the Japanese in Okinawa had lower bone mineral content of the femoral neck than white Americans[18]. Furthermore, calcium intake which thought to be a major nutritional determinant of bone mass had been lower in Japan. The average calcium intake among Japanese has increased since the early 1940s but it is still only 550 mg per day according to "Present Nutritional State of the Nation in 1985", which is considerably lower than that among Americans.

Therefore, the low incidence of fracture of femoral neck in Japan suggests that the prevalence of osteoporosis may not be directly related to fracture incidence and that some other factors such as the person's size or weight may play an important role given the fact that Japanese are smaller and less heavy than Americans or Europeans.

Another possible factor affecting hip fracture rate is osteomalacia. In England, histologic evidence of osteomalacia was observed in 37% of the fracture patients and the incidence of osteomalacia increased from February to April. Aaron pointed out the relation between daylight exposure and osteomalacia and hip fractures from this observation[19,20], whereas Evans found no evidence of osteomalacia among fracture patients in Australia[21].

Osteomalacia may play an important role in countries situated at high latitude. Although Niigata is situated near latitude 38 N (Fig.1), there was no serologic or radiologic evidence of osteomalacia among fracture patients, except for a few cases of renal osteodystrophy. Therefore, a low incidence of osteomalacia could be a reason for the low rates of fractures of the proximal femur in this study.

Physical activity is an important factor in the incidence of hip fracture.

It not only influences the peak skeletal bone mass at maturity and speed of bone loss thereafter, but may also be related to the risk of falling in the elderly. Also Japanese customs in activities of daily living, such as squatting and sitting on the "tatami" mattress may contribute to the muscular strength of the hip joint.

This study revealed that a half of the patients had an impairment of physical activity, which was often complicated by accumulation of different diseases. Johnell[22] also found that a history of falling was more common among patients with hip fracture than among control subjects, and Abdon[23] found that more than one third of patients with fracutures had occult arrythmias severe enough to cause dizzy spells. Hansson[24] found a high incidence of hip fractures among patients in mental hospitals. Therefore, when assessing fracture risk in an individual person, multiple factors must be considered. One is an osseous factor which includes both quality and quantity of bone and the others are non-osseous factors which increase the risk of accidental falls.

Hip fractures can be divided into cervical (intracapsular) fracture and trochanteric (extracapsular) fracture. There are several studies of the factors determining the type of fracture. Dretakis[25] reported that the percentage of trochanteric fracture was lower in patients with advanced osteoporosis. On the other hand Pogrund[26] reported predominance of trochanteric fracture among osteoporotic patients. The present study suggest that the percentage of trochanteric fractures tends to increase with age and with the progress of cortical and trabecular osteopenia but that it is not related to the ambulatory status nor to the intensity of trauma. Exceptionally spontaneous fractures occurred at the level of subcapital area among older females. The author speculates that osteomalacia or other unknown qualitative deterioration of bone may play an important role in these spontaneous cervical fractures and may affect the overall incidence of cervical fracture.

The author concludes that the incidence of the femoral neck fractures depends on many, often interrelated factors affecting an elderly population; furthermore the Japanese elderly people are 10 years younger with respect to hip fractures than Euro-Americans. Further world wide epidemiologic studies of fracture of the proximal femur using standardized methods are needed for a better understanding of the factors leading to this devastating fracture.

Acknowledgments

The author wishes to express his gratitude to Prof. T. Tajima for his guidance and to Ass. Prof. H.

Takahashi for his encouragement and interest.
The author also thanks Dr. H.M. Frost, Dr. J.J.B. Anderson and Prof. H.K. Uhthoff for their freely given advice. Also the long suffering Miss S. Goto for the preparation of the manuscript.

References

1. Knowelden, J., Buhr, A.J. and Dumbar, O.: Incidence of fractures in persons over 35 years of age, A report to the M.R.C. working party on fractures in the elderly. Brit. J. Prev. Soc. Med. 18:130-141, 1964.
2. Stewart, I.M.: Fractures of neck of femur, incidence and implication. Br. Med. J. 1:698-701, 1955.
3. Elabdien, B.S.Z., Olerud, S. Karlström, G. and Smedby, B.: Rising incidence of hip fracture in Uppsala, 1965-1980. Acta Orthop. Scand. 55:284-289, 1984.
4. Wong, P.C.: Fracture epidemiology in a mixed southeastern asian community (Singapore), Clin. Orthop. 45:55-61, 1966.
5. Chalmer, J. and Ho, K.C.: Geographycal variation in senile osteoporosis. The association with physical activity. J. Bone Joint Surg. 52B:667-675, 1970.
6. Levine, S., Mankin, M., Menczel, J., Robin, G.M., Naor, E. and Steinberg, R.: Incidence of fractures of the proximal end of the femur in Jerusalem. J. Bone Joint Surg. 52-A:1193-1202, 1970.
7. Solomon, L.: Osteoporosis and fracture of the femoral neck in the South Africa Bantu. J. Bone Joint Surg. 50B:2-13, 1968.
8. Matkovic, V., Kostial, K., Simonovic, I., Buzina, R., Brodvec, A. and Nordin, B.E.C: Bone status and fracture rates in two regions of Yugoslavia. Am. J. Clin. Nutr. 32:540-549, 1979.
9. Gallagher, J.C., Melton, L.J., Riggs, B.L. and Bergstrath, E.: Epidemiology of fractures of the proximal femur in Rochester, Minnesota. Clin. Orthop. 150:163-171, 1980.
10. Yano, K., Wasnich, R.D., Vogel, J.M. and Heilbran, L.K.: Bone measurements among middle-aged and elderly Japanese residents in Hawaii, Am. J. Epidemiology 119:751-764, 1984.
11. Garn, S.M., Pao, E.M. and Rihl, M.E.: Compact bone in Chinese and Japanese, Science 143:1439-1440, 1964.
12. Nordin, B.E.C.: International patterns of osteoporosis, Clin. Orthop. 45:17-30, 1966.
13. Singh, M., Nagrath, A.R. and Maini, P.S.: Changes in trabecular pattern of the upper end of the femur as an index of osteoporosis, J. Bone Joint Surg. 52-A:457-467, 1970.
14. Singh, M., Riggs, B.L., Beabout, J.W. and Jowsey, J.: Femoral trabecular index for evaluation of spinal osteoporosis, Ann. Intern. Med. 77:63-67, 1972.
15. Dalen, N., Helström, L.G. and Jacobson, B.: Bone mineral content and mechanical strength of the femoral neck, Acta Orthop. Scand. 47:503, 1976.
16. Leichter, I., Margulies, J.Y. Weinreb, A., Mizrahi, J., Robin, G.C., Conforty, B., Mankin, M.: The relationship between bone density, mineral content, and mechanical strength in femoral neck, Clin. Orthop. 163:272-281, 1982.
17. Bohr, H. and Schaadt, O.: Bone mineral content of femoral bone and the lumbar spine measured in women with fracture of the femoral neck by dual photon absorptiometry. Clin. Orthop. 179:240-245, 1983.
18. Norimatsu, H., Mori, S., Uesato, T. and Katsuyama, N.: Bone mineral density of the spine and proximal femur in normal and osteoporotic subjects in Japan. Bone and Mineral. 5:213-222, 1989.
19. Aaron, J.E., Gallagher, J.C., Anderson, J., Stasiak, L., Longton, E.B., Nordin, B.E.C. and Nicholoson, M.: Frequency of osteomalacia and osteoporosis in fractures of the proximal femur. Lancet 1, 229-233, 1974.
20. Aaron, J.E., Gallagher, J.C. and Nordin, B.E.C.: Seasonal variation of histological osteomalacia in femoral neck fracture. Lancet 2, 84-85, 1974.
21. Evans, R.A., Ashwell, J.R. and Dunstan, C.R.: Lack of metabolic bone disease in patients with fracture of the femoral neck, Aust. N.Z.J.Med. 11:158-161, 1981.
22. Johnell, O. and Nilsson, B.E.: Hip fracture and

accident diposition, Acta orthop. Scand. 56:302-304, 1985.

23. Abdon, N.J. and Nilsson, B.E.: Episodic cardiac arrhythmia and femoral neck fracture, Acta Med. Scand. 208, 73-79, 1980.
24. Hansson, L.I., Ceder, L., Svensson, K. and Throngren, K.G.: Incidence of fractures of the distal radius and proximal femur, Comparison of patients in a mental hospital and the general population, Acta Orthop. Scand. 53:721-726, 1982.
25. Dretakis, E.K. and Christodoulou, N.A.: Significance of endogenic factors in the location of fractures of the proximal femur, Acta Orthop. Scand. 54, 198-203, 1983.
26. Pogrund, H., Makin, M., Robin, G., Menczel, J. and Steinberg, R.: Osteoporosis in patients with fractured femoral neck in Jerusalem, Clin. Orthop. 124:165-172, 1977.

JBMM Vol. 9, Supplement, August 1991

Epidemiology of Femoral Neck Fractures in 1989, Niigata Prefecture, Japan

— A Comparison with the Incidence in 1985 and 1987 —

Yoichiro Dohmae, Hideaki Takahashi, Tadashi Kawashima
Tatsuhiko Tanizawa and Saburo Nishida

ABSTRACT

The incidence of the femoral neck fractures in 1989 was studied in Niigata Prefecture, which has a population of 2,481,441 (1,204,349 males and 12,277,092 females) as of January 1, 1989. The population over 65 years of age was 352,003, 12.5% of the total population (139,518 males and 212,485 females).

The authors visited all hospitals in Niigata Prefecture to study roentgenograms and records of patients. In order to cover possible neglected patients, questionnaires were sent to nursing homes and mental hospitals.

During 1989, there were 996 femoral neck fractures (259 males and 737 females, i.e., 1:2.85) the ratio of cervical and trochanteric fractures was 327:667 (1:2.04). The average age of these patients was 71.7 years for males and 77.7 years for females. The incidence over 65 years of age was 14.2 in males and 31.2 in females and that over 85 was 49.8 in males and 108 in females per 10,000 population per year.

Key Words

Epidemiology, Femoral neck fracture, Japan

Introduction

The incidence of femoral neck fracture, closely related to senile osteopenia, has been studied in Japan and other countries during the last several years.

In 1985 and '87, Kawashima[1] and Dohmae reported the incidence of femoral neck fracture in Niigata prefecture, Japan which was much lower than in North America and Europe[2-4]. In this paper, we report the incidence in 1989 compared with that in 1985 and '87.

Department of Orthopedic Surgery, Niigata University School of Medicine, Niigata, 951 Japan

Materials and Methods

This study was carried out in Niigata Prefecture which is located approximately in the center of the main island of Japan. Information concerning all femoral neck fractures that occurred in residents in Niigata Prefecture from January 1 to December 31 in 1989 was collected from 65 hospitals in this prefecture together with their X-rays. The medical records and roentgenograms of all patients with a diagnosis of femoral neck fracture were reviewed by the author and co-authors, excluding subtrochanteric or pathological fractures. The patients from the other prefectures and / or under the age of twenty were excluded from this study.

Basic demographic informations, such as the patients' age, sex, and type of femoral neck frac-

ture were included in this study.

The data was analyzed using the X^2-test and t-test at the Medical Computer Center of Niigata University. The residents of Niigata Prefecture who had sustained femoral neck fractures in 1989 and received treatment outside of this prefecture were included in this study also previous studies performed in 1985 and '87. In order to cover possible neglected patients with femoral neck fracture, the questionnaires were sent to 50 nursing homes and 23 mental hospitals without an orthopedic department in which femoral neck fractures might occur.

Statistics

In Niigata Prefecture, the prefectural office takes a census every year. As of January 1, 1989, the population of Niigata Prefecture was 2,481,441 (1,204,349 males and 1,277,092 females). Residents defined as "elderly" (over 65 years) numbered 352,003 (139,518 males and 212,485 females).

Results

1. Incidence of fractures

In Niigata Prefecture, femoral neck fractures occurred in 996 cases. As shown in **Table 1.** and **Fig.1**, the incidence of fractures per 10,000 per year increased exponentially with increasing age from the 6th decade in both sexes. And that of males was slightly greater than that of females under the age of 55. After 55 the relationship reversed and more females developed hip fractures. In the "elderly population", 86.5% (861 fractures) occurred in all fractures, and residents defined as the "abvanced age group" (over 75 years) had 66.6% (663 fractures) of all the fractures. The crude incidence of all femoral neck fractures was 2.98 per 10,000 per year in males and 8.27 in females. Of "elderly population" the incidence of male was 14.2 and that of female 31.2. However, the incidence in patients over 85 years of age increased to 49.8 in males, and 108 in females. The female/male ratio based on the number of fractures was 773/259 (2.85) also, the ratio based on the crude incidence was 3.47/2.15 (1.61) (**Table 1**).

Concerning the type of femoral neck fracture, there were 667 (67%) trochanteric fractures and 327 (33%) cervical neck fractures. Trochanteric fracture was observed twice as many times as cervical neck fracture. The percentage of trochanteric fracture was higher in males, 78%, than in females, 63%.

The average age of patients with cervical neck fracture was 64.8 years in males, and 73.6 years in females and that of patients with trochanteric fracture was 72.8 years in males and 78.7 years in females. The average age of patients with trochanteric fracture was significantly higher than that of patients with cervical neck fracture in both sexes ($p<0.01$). Also in both type of fractures the average age of females was sighnificant higher than that of males ($p<0.01$).

Table 1. Age-specific incidence rates of hip fracture and percentage of trochanteric fracture in 1989. (Fracture rates are expressed as fractures per 10,000 population per annum as estimated over in 5 year age group)

Age	Male							Female						
	Cervical fractures cases	Rate	Trochanteric fractures cases	Rate	Both cases	Rate	Troch. fx %	Cervical fractures cases	Rate	Trochanteric fractures cases	Rate	Both cases	Rate	Troch. fx %
−49	8		17		25		68	7		3		10		30
50−54	1	0.31	9	2.79	10	3.11	90	5	9.59	1	0.12	6	0.71	17
55−59	2	0.40	4	0.80	6	1.20	67	14	1.59	8	0.90	22	2.50	36
60−64	4	0.54	16	2.16	20	2.71	80	24	2.67	12	1.33	36	4.01	33
65−69	8	1.63	15	3.07	23	4.72	65	24	3.44	27	3.86	51	7.32	53
70−74	6	1.55	28	7.25	34	8.80	82	33	6.09	57	10.51	90	16.59	63
75−79	14	4.79	38	13.01	52	17.80	73	50	10.97	115	25.23	165	36.12	70
80−84	9	5.80	43	27.70	52	33.51	83	70	41.88	113	25.72	183	67.60	62
85−	5	6.73	32	43.07	37	49.82	86	43	26.69	131	81.31	174	108.0	75
Total	57	0.66	202	2.32	259	2.98	78	270	3.03	467	5.24	737	8.27	63
age over 65	42	3.01	156	11.18	198	14.20	79	237	11.15	446	20.99	663	31.20	67

Answers to questionnaires were obtained from 16 (70%) of 23 mental hospitals and 46 (92%) of 50 nursing homes. Femoral neck fractures were suspected in 44 patients in mental hospital and 92 patients in nursing homes. Of 136 patients 116 were transferred to the hospital with an orthopedic department and diagnosed as femoral neck fracture, and were already included and duly checked in the fractures previously mentioned. Twenty patients were suspected femoral neck fractures but not transferred to hospitals, because of mental problems and general poor conditions. These possible neglected hip fractures corresponded to about only 2% (20/996 cases) of total femoral neck fractures in Niigata Prefecture.

2. Comparison of the incidence in 1985, 1987 and 1989.

As shown in **Table 2**, the total number of the fractures increased 319 from 1985 to 1989. There was a minor difference in the population pyramid by age and sex in 1985 and that in 1989. The population over 55 years increased, and that under 40 years decreased in both sexes in 1989 in comparison with the population in 1985 (**Fig.2**).

In 1989, the expected number of femoral neck fractures was caluculated from the adjusted population of 1989 to 1985. The expected number of trochanteric fracture were 176 in males, 359 in females, and that of expected cervical neck fractures was 47 in males, and 266 in females. The expected number compared statistically with the observed number in 1989 using the X^2-test. There was quite a difference in only trochanteric fracture of females, however no significant differences in the others, i.e. only trochanteric fractures in females increased (**Table 3**).

The average age of patients with fractures is increasing in both sexes, however there were no significant differences among the three years and the cervical neck fracture/trochanteric fracture ratio showed the same trend (**Table 2**).

The crude incidence of fractures was not of a significant difference for every 2 year interval. In the elderly (age over 65 years), the incidence of fracture rose from 9.33 in 1985, to 14.2 in 1989 in males, and from 23.60 to 31.20 in females, and the incidence in patients over the age of 85 also rose

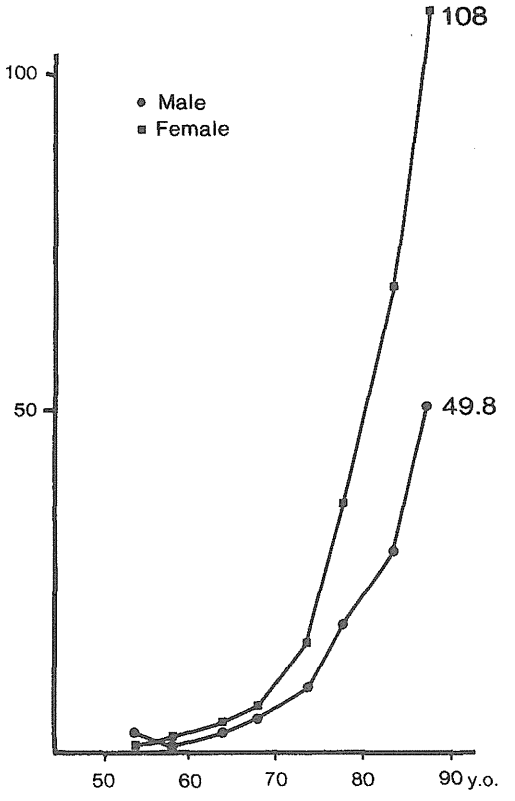


Fig. 1 Age-apecific incidence of hip fractures of female and male residents of Niigata in 1989 Fracture incidence with patients over 85 years was 49.7 in males and 108 in females.

Table 2. The summary of femoral neck fractures for every 2 year internal

		1985	'87	'89
Cases		677	773	996
Ave. Age	M	67.5	70.4	71.7
	F	76.2	76.9	77.7
Cerv./Troch. fx		1 : 1.9	1 : 2	1 : 2
M/F		1 : 2.7	1 : 2.4	1 : 2.8

Table 3. Statisticaly analysis between the number in 1985 and expected number in 1989 with adjusting population from 1989 to 1985.

		1985	1989 (Exp. No.)	X^2
Cervical fx	M	35	47	N.S.
	F	181	266	N.S.
Trochanteric fx	M	124	176	N.S.
	F	303	359	$p<0.01$

significantly from 29.7 in 1985, to 49.5 in 1989 in males, and from 80.3 to 108 in females (**Table 1**).

3. Femoral neck fracture without trauma

Since it was difficult to determine the cause of fractures, only the patients without obvious trauma were investigated for every 2 year interval. In the trochanteric fracture group, there were only 2 cases with trauma (2/503:0.4%) in males, and 7 cases (7/1122:0.6%) in females. In the cervical neck fracture group there was one case (1/167:0.6%) in males, and 98 cases (98/646:15.2%) in females. The extremely higher percentage of the patient without obvious trauma was indicated only in the cervical neck fracture group in females in comparison with the other groups.

Ambulatory status before injury was also observed in these two groups. All cases of cervical neck fracture was ambulatory without support except one patient; in contrast, 7 cases of 9 trochanteric fractures were bedridden, and were diagnosed for when their mal-positions on the bed.

In the cervical neck fracture group, the average age of the patients without trauma (78.6 years) was higher than that of patients with trauma (74.8 years) ($p<0.05$).

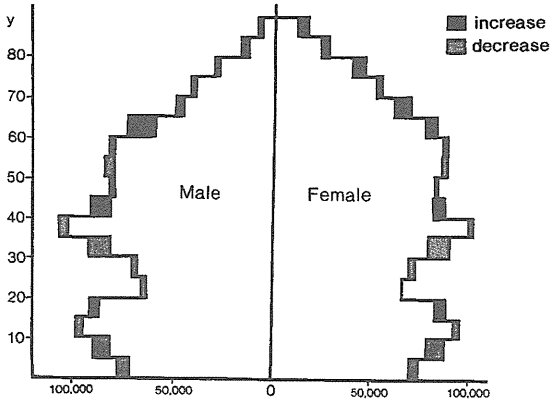


Fig. 2 The change of populationpyramid between 1985 and 1989.

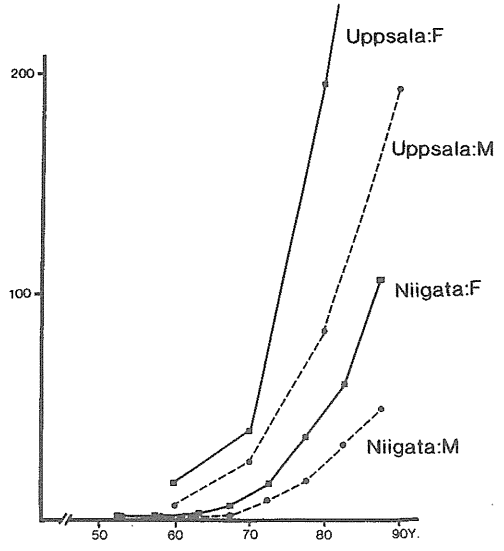


Fig. 3 Age-specific incidence of hip fractures of male and female residents of Niigata in 1989, compared with Uppsala in 1980.

Discussion

The incidence of femoral neck fracture in Niigata Prefecture was still lower than that in Caucasian populations. The age-specific incidence of fracture in Niigata showed an exponential increase with aging, but the incidence curve of Niigata in 1989 shifted to the right by more than 10 years from the incidence curve of Uppsala (Sweden) concerning both sexes (**Fig.3**). The incidences of fracture reported from the other areas of Japan (Wakayama[5], Tottiri[6] were of the same trend as that in Niigata. Kawashima has already discussed why the fracture incidence is low in Japan.

How is the future trend of hip fracture incidence in Japan ? After five years of observation, there is no doubt that the number of fractures has been increasing. In order to compare the incidence in 1985 and in 1989, the following corrections were made. Fractures treated in the 3 hospitals where general surgeons managed fractures were deducted, but fractures treated in newly opened hospital after 1986 were counted. Because the number of trochanteric fracture increased in female excluding neglected fractures in 1989 and also the natural increase of population over 55 years, an increase is judging by the change of the population pyramid from 1985 to 1989. The crude incidence of fracture was not of a significant difference among the three years, but the fracture incidence for patients above the age of 65 years rose from 9.3 to 14.2 in males, and from 23.4 to 31.2 in females, and also the incidence for patients of 85

years significantly rose from 1985 to 1989 (from 29.7 to 49.8 in males, and from 80.3 to 108.0 in females). On the other hand, the fracture incidence is affected by many factors, such as osteopenia, osteomalacia, physical activities and so on which have already been mentioned by Kawashima. Since it is impossible to predict changes of these factors from only this epidemiologic study, the trend of fracture incidence is uncertain. Further epidemiologic studies of femoral neck fracture are needed.

Acknowledgements

The author thanks Miss R. Nakazawa for the preparation of this manuscript.

References

1. Kawashima, T. : Epidemiology of the Femoral Neck Fracture in 1985, Niigata Prefecture, Japan. J. Bone Mineral Metab. 7:118-126, 1989.
2. Elabdien, B.S.Z., Olerud, S., Karlstrom, G. and Smedby, B. : Rising incidence of hip fracture in Uppsala, 1965-1980. Acta Orthop. Scand. 55:284-289, 1984.
3. Gallagher, J.C., Melton, L.J., Riggs, B.L. and Bergstrath, E. : Epidemiology of fracutre of the proximal femur in Rochester, Minnesota. Clin. Orthop. 150:163-171, 1980.
4. Stoff, BHB, S., Gray, D.H., Stevenson, W. : The incidence of femoral neck fracture in New Zealand. New Zealand Med. J. 9:6-9, 1980.
5. Yamamoto, K., Ogino, H., Nakamura, T., Nose, T. and Oshiro, H. : Epidemiology of femoral neck fracture in Tottori Prefecture. Silver Science Research, Report of 1989.:94-95, 1989. (in Japanese)
6. Hashimoto, T., Tamaki, T., Danjoh, S., Kinoshita, H., and Kasamatsu, T.: Epidemiology of femoral neck fracture in Wakayama Prefecture. Silver Science, Report of 1990. : 129-130, 1990. (in Japanese)

J Bone Miner Metab (1999) 17:224–231

Journal of
Bone and
Mineral
Metabolism

Increase in the incidence of cervical and trochanteric fractures of the proximal femur in Niigata Prefecture, Japan

Toshiroh Iga, Yoichiro Dohmae, Naoto Endo, and Hideaki E. Takahashi

Department of Orthopedic Surgery, Niigata University School of Medicine, 1-757 Asahi-machi, Niigata 951-8510, Japan

Abstract: This study aimed to determine the incidence of cervical and trochanteric fractures of the proximal femur in 1994 in Niigata Prefecture, Japan, and to compare this incidence with those previously reported in Niigata in 1985, 1987, and 1989. We visited all hospitals within Niigata Prefecture having an orthopedic department and reviewed the medical records and radiographs of all patients who sustained such fractures in 1994. The population of Niigata Prefecture was determined in 1994 to be 2483879 (1205151 males and 1278728 females). The population over 65 years of age was 428795 (172788 males and 256007 females), representing 17.3% of the total population. In 1994, there were 1468 cervical or trochanteric fractures in 378 males and 1090 females, with a male-to-female ratio of 1:2.9. The incidence of these fractures in persons over 65 years of age was 304 fractures per 100000 population per year. Of 528 cervical and 940 trochanteric fractures, the latter accounted for 64% of the total number. The age-specific incidence of the fractures in Niigata exhibited an exponential increase with age, similar to those reported in Sweden and the United States. However, the incidence was lower than in those countries. When comparing the number of cervical and trochanteric fractures in 1994 with the numbers reported in 1985, 1987, and 1989, it is evident that the overall number and incidence of these fractures has been increasing over this period. Even if the difference of the age-specific population among these years is adjusted, the fractures have been increasing.

Key words: epidemiology, cervical femoral fracture, trochanteric femoral fracture, hip fracture, femoral neck fracture, Niigata, Japan

Offprint requests to: T. Iga
Received: Dec. 27, 1996 / Accepted: Jan. 14, 1999

Introduction

Hip fractures are related to senile osteoporosis and impaired physical activity, which accompanies aging [1]. Studies have shown that the incidence of hip fractures differs from country to country and among different races [2–4].

Orientals and Africans are thought to have a lower incidence of hip fractures, compared with Caucasians [4–7]. However, several studies of the prevalence of osteoporosis reported that the Japanese tend to have a lower bone mineral content and a higher incidence of postmenopausal spinal osteoporosis than Caucasians [8,9]. Kawashima [2] reported the first study of the incidence of hip fractures in Niigata Prefecture, Japan. He found that the incidence of hip fractures in Niigata was lower than the incidence reported for Caucasians. Recently, similar studies in Japan have also reported that the incidence of hip fractures was lower than that of Caucasians [3,10–12].

The goals of this study were to determine the incidence of cervical and trochanteric fractures of the proximal femur that occurred in 1994 in Niigata Prefecture, Japan, and to document the change in the incidence of these fractures from 1985 to the present.

Subjects and methods

This study was carried out in Niigata Prefecture, which is located in the middle of the main island of Japan, on the Sea of Japan (Fig. 1). The center of the region is located at 38° north latitude and 139° east longitude. The area of Niigata Prefecture is approximately 12580 square kilometers. The racial structure of the people in Niigata Prefecture is almost exclusively Oriental Japanese. Because this region is bounded by mountains and sea, most residents are treated in medical institutions within Niigata Prefecture.

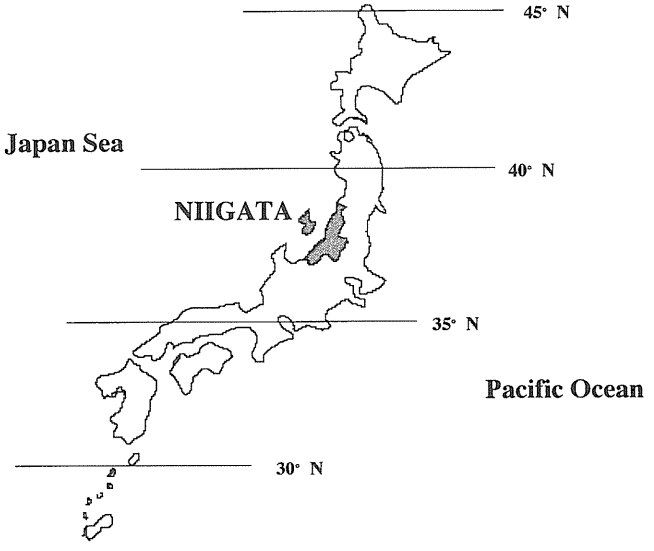


Fig. 1. Location of Niigata Prefecture, Japan

Number of hip fractures in 1994

The medical records and radiographs of all residents of Niigata Prefecture who were diagnosed as having a hip fracture from January 1 to December 31, 1994, were collected by the authors from 69 hospitals in the prefecture. Basic demographic information such as patient sex and age and the type of hip fracture were recorded. Patients with isolated fractures of the greater trochanter, subtrochanteric fractures, and pathological fractures were excluded from the study. Patients from other prefectures were also excluded, as well as those under 20 years of age. All hip fractures were classified as either being cervical or trochanteric. Fractures at the level of the base of the neck were included in the trochanteric category. The residents of Niigata Prefecture who sustained cervical or trochanteric fractures in 1994 were included in the study.

Change in the incidence of fractures from 1985 to 1994

All patients with fractures in this study were classified according to the patient's age (5-year intervals), sex (male or female), and type of fracture (cervical or trochanteric). The incidence or rate of the cervical or trochanteric fractures in each age interval in each study year was calculated as the number of fractures per 100000 population per year.

Studies of the incidence of hip fractures in Niigata Prefecture have been previously performed in 1985, 1987, and 1989 [2,3]. To compare the incidence of the cervical or trochanteric fractures in the individual and combined 5-year age groups among the 4 study years, a standard or "reference" study year was chosen, for example, 1985. The number of fractures "expected" to occur in each age interval in a "particular" study year, for example, 1994, was compared with the number that was actually "observed" in 1994. The expected number of fractures (En) was computed by taking the product of the incidence of fractures in the reference study year, 1985 (In), and the population in the particular study year, 1994 (Pn), and then dividing by 100000:

$$En = In \times Pn/100000$$
$$E_{total} = \Sigma En$$

The expected number of fractures refers to the number of fractures that would be expected to occur in 1994, based on the incidence previously recorded in 1985 and the current population in 1994. In other words, the expected number of fractures refers to the number expected to occur, assuming that the incidences are the same in the reference year and the particular study year, with the differences in the age-related population pyramid between the 2 years being taken into account. If the expected number of fractures in the particular study year was larger than the observed number, the incidence in the particular study year would be lower than the incidence in the reference year. Also, if the expected number of fractures in the particular study year was lower than the observed number, the incidence in the particular study year would be higher than that in the reference year. The expected numbers of males and females with cervical or trochanteric fractures in each of the age intervals were calculated with these procedures. Comparisons were made using different combinations of reference and particular study years. The differences between the expected and the observed numbers of fractures were compared using chi-square analysis. An alpha level of 0.05 was considered significant.

The prefectural office in Niigata collects census data each year. As of October 1994, the population of Niigata Prefecture was 2483879 (1205151 males and 1278728 females). The population of residents over 65 years of age was 428795 (172788 males and 256007 females), or 17.3% of the total population. The total population of Niigata Prefecture in each study year, as well as the elderly population over 65 years of age, is shown in Table 1.

Results

Number of hip fractures in 1994

In Niigata Prefecture, a total of 1468 cervical or trochanteric fractures of the proximal femur occurred in 1994 (378 males and 1090 females), with a male-to-female ratio of 1:2.9 (Tables 2, 3; Fig. 2). The combined number of cervical and trochanteric fractures per 100000 population per year increased exponentially in

Table 1. Relevant populations in Niigata Prefecture during the 4 years of the study

Year	Total population	Population over 65 years of age	Percentage of population over 65 years of age
1985	2476383	319305	12.9
1987	2480846	340944	13.7
1989	2482223	352003	14.2
1994	2483879	428795	17.3

Table 2. Summary of cervical and trochanteric fractures in the proximal femur in Niigata Prefecture, Japan, 1994

	Number	incidence (number of fractures /100000 population/year)
Total number of fractures	1468	59.1
Gender		
Male	378	31.4
Female	1090	85.2
Type of fracture		
Cervical	528	21.3
Trochanteric	940	37.9
Cervical-to-trochanteric ratio	1:1.8	
Male-to-female ratio	1:2.9	

Table 3. Age-specific number and incidence of cervical and trochanteric fractures of the proximal femur in 1994

	Males		Females		Total	
Age (years)	Number	Incidence	Number	Incidence	Number	Incidence
0–49	22	2.8	21	2.7	43	2.7
50–54	14	17.5	10	12.3	24	14.9
55–59	20	25.9	17	20.3	37	23.0
60–64	23	29.5	39	45.2	62	37.8
65–69	36	52.8	62	76.6	98	65.7
70–74	44	101.7	129	196.1	173	158.6
75–79	62	199.6	192	394.3	254	318.5
80–84	90	455.9	290	792.4	380	674.4
85+	67	635.4	330	1373.9	397	1148.6
Total	378	31.4	1090	85.2	1468	59.1
Over 65	299	173.0	1003	397.0	1302	303.6
%	79.1		92.0		88.7	
Over 75	219	357.0	812	742.8	1031	604.1
%	57.9		74.5		70.2	

both sexes with increasing age from the sixth decade of life. Eighty-nine percent of all cervical or trochanteric fractures (1302) occurred in the "elderly population", persons more than 65 years of age; 70% of all fractures (1031) occurred in the "advanced age group," those over 75 years of age.

The overall incidence of the combined number of cervical and trochanteric fractures was 31.1 per 100000 population per year for males, and 85.5 for females (Tables 2 and 3). The incidence of the combined number of cervical and trochanteric fractures in those over 65 years of age was 173.0 for malesand 397.0 for females. The incidence in those more than 85 years of age increased to 635.4 for malesand 1373.9 for females. There were 940 trochanteric fractures (64.0%) and 528 cervical fractures (36.0%) (Table 2). The percentage of trochanteric fractures was higher in males (70.9%) than in females (61.9%).

The average age of the patients with cervical fractures was 71.7 years for malesand 75.1 years for females. The average age of the patients with trochanteric fractures was 74.4 years for males and 80.9 years for females. The average age of the patients of both sexes with trochanteric fractures was significantly higher than the age of