department of orthopedic surgery or general surgery during the observation period, and survey registration was performed each year in all these hospitals by the doctors and the staff of each hospital according to hospital records. Registration information included name, gender, age, place of residence, date of the fracture, type of fracture (neck or trochanteric) and the treatment. Patients residing in other prefectures were excluded. Duplication of cases was checked by the patients' names and addresses. Completion of registration was confirmed by interviewing doctors or making telephone calls, and investigators were sent from Tottori University to hospitals, if necessary, to complete the registrations.

To compare data with those reported before, we investigated the methods of collection at the three hospitals with the most patients (top three), which cover one-third of the total patients in this prefecture. We confirmed that the methods of registration of patients with hip fracture were consistent from 1986 to 1988, from 1992 to 1994, and from 1988 to 2001 at those three hospitals. All patients' data were collected based on hospital records including surgical records. The number of patients increased consistently from 1986 to 2001 and the increases were 3.0-fold (22 and 67), 4.0-fold (19 and 76), and 4.5-fold (21 and 95), respectively, at the three hospitals.

Calculation of the incidence

The patients were divided into groups according to age (subdivided into 5-year increments), gender, and fracture type. The age- and gender-specific incidence rates (per 100,000 person-years) were calculated based on the population of Tottori Prefecture in each year. A national census is undertaken on October 1 every 5 years in Japan, and it was performed in 2000 during the observation period. The age- and gender-specific population for each survey year was estimated by the Bureau of Statistics of the Tottori Prefecture government according to its resident registration records.

Statistical methods

To determine the recent incidence trend, a test of trends of proportions in quantitatively ordered samples was used to analyze the changes of incidence [14]. The age- and gender-specific incidence rates (per 100,000 person-years) during 1986–1988 and 1992–1994, which we reported before [2], were used for this analysis. The expected number of patients, age-adjusted to the population structure of 1986 in Tottori Prefecture (35 years and over), was calculated from the age- and gender-specific incidence rates in each observation year. Then, the values of the chi-square for overall and slope were examined.

The monthly variation in the number of patients was tested by the Friedman test.

$p < 0.05$ was regarded as significant.

Results

Number of patients

Registration was performed in all hospitals during the whole observation period; as a result, this survey covered all patients with the studied fractures. The survey found 604 (114 men and 490 women), 671 (130 men and 541 women), 710 (150 men and 560 women), 729 (150 men and 579 women) patients, in 1998, 1999, 2000, and 2001, respectively.

Dividing into the fracture types, there were 228 neck and 362 trochanteric (undetermined 14), 243 neck and 416 trochanteric (undetermined 12), 259 neck and 422 trochanteric (undetermined 29), and 293 neck and 428 trochanteric (undetermined 8), in 1998, 1999, 2000, and 2001, respectively. Concerning the fracture site, there was no significant difference between the numbers of fractures on the right or left (by chi-square test).

Age- and gender-specific incidence

The age- and gender-specific incidences (per 100,000 person-years) for both genders increased exponentially after 70 years of age (Table 1, Fig. 1). Dividing into the fracture types, those for neck fractures averaged for 4 years (from 1998 to 2001) were 42.0 for men and 123.4 for women, 78.8 and 209.6, 169.7 and 413.4, and 213.0 and 625.2, in the age groups of 70–74, 75–79, 80–84, and over 84, respectively (Table 2). Those for trochanteric fractures were 64.4 for men and 122.1 for women, 122.7 and 287.5, 262.1 and 671.1, and 560.4 and 1,388.2, respectively.

The recent incidence trend

The age- and gender-specific incidence rates between 1986 and 2001, averaged for 3-year or 4-year observation periods, increased among patients 80 years old and over for both genders (Fig. 1). The expected numbers of patients in 1992 were 1.39 and 1.34 times those in 1986 for men and women, respectively; those in 1998 were 1.23 and 1.42 times, and those in 2001 were 1.61 and 1.48 times those in 1986, for men and women, respectively (Table 3). The trend test for the increase in the incidence rates in each year showed a significant increase with time for both genders. (The time-trend data analysis reported in Table 3 is based on individual year data and not on 3-year or 4-year observation periods as in Fig. 1.)

Dividing into the fracture types, the age- and gender-specific incidence rates between 1986 and 2001 averaged for 3-year or 4-year observation periods increased with time for both neck and trochanteric fractures in both genders (Table 2). The expected numbers of patients for

Table 1 Age- and gender-specific incidence of hip fracture in Tottori Prefecture, Japan. Data are incidence rates per 100,000 person-years

Age group	Men				Women				Average	
(year)	1998	1999	2000	2001	1998	1999	2000	2001	Men	Women
35–39	0	0	5.8	6.1	0	0	0	0	3.0	0
40–44	4.8	5.0	10.2	26.4	0	0	10.2	10.5	11.6	5.2
45–49	11.9	4.2	8.7	9.0	8.2	21.7	4.5	9.3	8.5	10.9
50–54	14.2	4.4	24.4	33.8	14.4	13.5	8.3	7.8	19.2	11.0
55–59	34.3	32.6	21.6	63.0	26.1	76.1	15.4	27.5	37.9	36.3
60–64	28.0	58.4	41.4	47.4	72.3	25.1	72.1	52.0	43.8	55.4
65–69	61.4	118.7	91.4	62.8	171.7	98.6	108.7	129.0	83.6	127.0
70–74	93.2	122.7	95.8	120.3	244.2	165.7	268.0	318.4	108.0	249.1
75–79	140.4	212.0	330.7	152.9	467.5	435.4	566.2	554.2	209.0	505.8
80–84	352.3	321.0	505.5	617.8	1,015.6	1,337.2	1,087.7	1,021.2	449.1	1,115.4
85-	1,003.7	719.1	774.5	622.9	1,932.8	2,224.5	2,108.9	1,999.5	780.0	2,066.4

each fracture type for women in 1992 were 1.32 and 1.34 times those in 1986 for neck and trochanteric fractures, respectively. Those in 1998 were 1.39 and 1.42 times those in 1986, and those in 2001 were 1.48 and 1.49 times those in 1986 (Table 3) for neck and trochanteric fractures, respectively. The trend test showed a significant increase with time for women in both fracture types but no significant increase for men.

Monthly variation

The highest number of fractures occurred in October; the second-highest number occurred in January. The lowest number of fractures occurred in July and the second-lowest occurred in June (Fig. 2). There was a significant monthly variation ($p < 0.05$, by Friedman test).

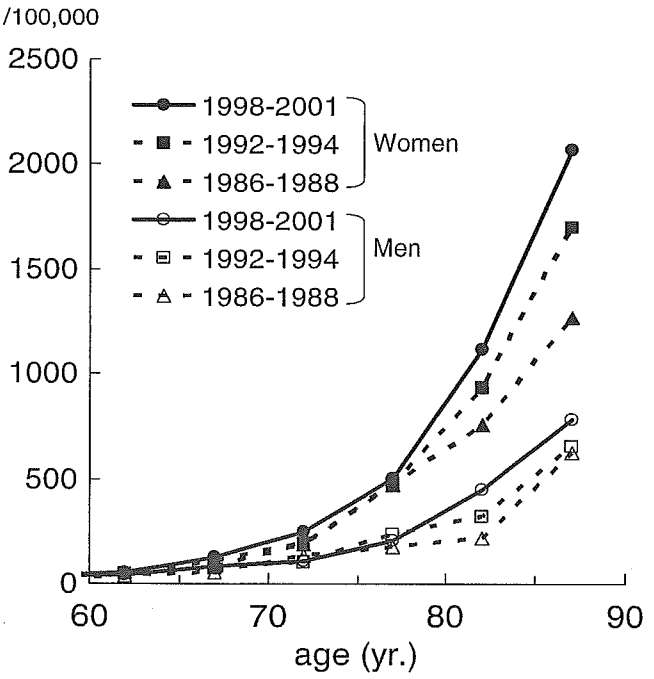

Fig. 1 The age- and gender-specific incidence rates (per 100,000 person-years) of hip fracture between 1986 and 2001 (The incidence rates during 1986–88 and 1992–94, which we reported before (Hagino H, 1999), were used for comparison)

Discussion

This study demonstrated that the age-adjusted incidence rates of hip fracture for both genders from 1998 to 2001 were significantly higher than those from 1986 to 1988 or those from 1992 to 1994 in Tottori Prefecture. Comparing the recent data concerning the incidence of hip fractures within Japan [15,16], the incidence rates were similar to our results, suggesting that the incidences in this study properly represent the Japanese population.

The secular trends in the incidence of hip fractures are variable between observation periods or geographic areas according to previous studies. Epidemiological surveys before 1990 in Europe in most cases showed that the incidence of hip fractures was increasing [17–21]; however, data in the 1990s from Northern Europe [22–24], North America [25], and Australia [26] indicated that the increase had leveled off or stopped. In East Germany, a steep increase since reunification was reported in the incidence of hip fracture, suggesting a significant influence of Western lifestyle on hip fracture incidence [27].

Most reports from the Asian area indicated an increase in the incidence of hip fracture with time [2, 16, 28,29]. In Singapore hip fracture rates from 1991 to 1998 for women were five times higher than corresponding rates in the 1960s [8], and in Hong Kong those for women 80 years old and over in 1995 were three times higher than corresponding rates in the 1960s. However, the trends of the last decade in these two areas are different from those before [30]. The increases were only 1.1 times in Singapore in the 1990s and 1.4 times in Hong Kong from 1985 to 1995. The increase in the incidence rate in our observations, which was 1.4 times from 1986 to 1998 (Table 2), were very close to these findings. From these points of view, the age-specific incidences of hip fracture among developed and urbanized Asian

Table 2 Age- and gender-specific incidence of neck and trochanteric fracture in Tottori Prefecture, Japan. Data are incidence rates per 100,000 person-years. Incidence rates for 1986–88 and 1992–94 were reported earlier (Hagino H, 1999)

Age group	Men						Women					
	Neck			Trochanter			Neck			Trochanter		
(years)	1986–1988	1992–1994	1998–2001	1986–1988	1992–1994	1998–2001	1986–1988	1992–1994	1998–2001	1986–1988	1992–1994	1998–2001
35–39	0	1.7	3.0	6.4	0	0	0	0	0	0	1.6	0
40–44	5.0	1.4	6.6	7.9	7.7	3.8	0	1.4	5.2	1.6	1.4	0
45–49	1.8	4.7	3.2	3.6	4.9	5.3	1.7	4.8	7.7	1.7	1.5	1.0
50–54	8.4	3.5	7.2	10.1	11.0	10.8	7.8	3.5	6.6	6.1	6.9	4.4
55–59	11.5	12.3	19.7	14.8	18.2	18.1	16.3	27.5	23.3	7.4	9.7	12.9
60–64	17.0	20.9	20.4	15.0	29.6	23.4	26.6	25.8	37.6	25.0	24.2	16.5
65–69	26.1	28.1	29.8	22.9	49.6	52.4	42.3	80.9	62.4	34.4	26.8	63.5
70–74	64.1	28.9	42.0	67.4	71.9	64.4	95.5	109.4	123.4	93.1	85.4	122.1
75–79	54.9	96.7	78.8	115.1	134.8	122.7	219.4	206.7	209.6	237.8	268.0	287.5
80–84	67.7	125.0	169.7	151.5	197.8	262.1	310.7	311.5	413.4	436.1	611.8	671.1
85-	132.9	198.7	213.0	489.3	445.2	560.4	338.9	489.6	625.2	881.7	1,191.9	1,388.2

areas seem to have leveled off in the last decade, although small increases still exist.

The increase in risk factors of fractures might contribute to the increase in fracture incidence. Two studies were performed to elucidate risk factors for hip fracture among the Japanese population [13,31]. In one of them [13], a case-control study on hip fracture was performed and found that some Westernized lifestyle characteristics such as sleeping in a (Western-type) bed increased the risk of hip fractures, and traditional Japanese lifestyle factors such as drinking Japanese tea were effective in preventing hip fractures. Recently, we reported that one of the significant preventive factors for distal radius fractures among Japanese was the use of a futon (as opposed to bed use), and we speculated that futon use maintains physical activity resulting in a reduced risk of falls [32]. The decrease in physical activity of a Westernized lifestyle is one of the possible explanations for the increase in fracture incidence among Japanese. Another explanation might be a greater proportion of seniors with poor health because of other conditions under treatment, with the result that people are living longer at a time when their bones are considerably weakened [2].

Several studies have demonstrated seasonality in hip fractures [33–36], while another failed to find it [37]. In the previous studies which found seasonal variation, the incidence of hip fracture was higher in the winter than the summer period. A nationwide survey in Japan also found that the number of patients per month was highest in January and lowest in June or July, showing a significant monthly variation [38]. Although our previous study failed to find such a variation [2], there was a significant monthly variation in the number of hip fracture patients in the present study, with a lower incidence during the summer months than during winter months, supporting previous studies. Since about 70% of patients sustained fractures indoors [38], weather conditions such as ice or snow have only little impact on fracture occurrence. It is possible that elderly patients have poorer coordination in winter and are clumsier due to extra layers of clothing, which may lead to falls [36]. Cold weather is associated with lower blood pressure, which also increases the risk of falls [34]. A low level of vitamin D in winter may cause the higher incidence of fracture, since the low vitamin D level in winter results in not only diminished bone mineral density but also diminished muscle strength, increasing falls [39].

Our study has limitations concerning data collection. All hospitals but one in Tottori Prefecture that have a department of orthopedic surgery or general surgery have doctors related to Tottori University, and this circumstance affects the validity of the survey. To compare the present data with those reported before, we checked on the methods of collection at the top three hospitals in terms of patient numbers and found the method of registration was consistent during the observation periods. We also observed steady increases in the number of registered patients in these hospitals. It is most likely that the incidences each year were

Table 3 Test of trends of proportions in number of patients with hip fractures per annum (35 years and over). Data are the expected number of patients adjusted for the age- and gender-specific incidence in each year, adjusted by the population structure of 1986. Population ages 35 and over was 154,774 for men and 183,157 for women in 1986. Incidence rates for 1986–88 and 1992–94 were reported earlier (Hagino H, 1999)

	All hip fractures		Neck fractures		Trochanteric fractures	
	Men	Women	Men	Women	Men	Women
1986	63.0	209.0	22.0	87.0	39.0	119.0
1987	68.5	205.6	25.1	86.4	43.4	116.4
1988	85.1	245.4	32.3	102.5	51.0	133.9
1992	87.4	281.1	34.9	114.9	51.5	159.8
1993	71.0	237.7	22.2	100.8	48.1	136.2
1994	88.4	265.9	32.5	109.3	55.9	156.0
1998	77.3	295.9	29.1	121.2	45.8	169.3
1999	86.0	307.3	32.1	121.0	53.2	180.3
2000	99.2	309.8	31.8	124.2	62.7	173.0
2001	101.3	309.1	47.7	129.0	52.9	176.9
$\chi 2$ overall	17.4	55.3	16.1	18.8	8.0	34.0
	<0.05	<0.001	n.s.	<0.05	n.s.	<0.001
$\chi 2$ slope	9.5	48.1	5.9	16.5	3.5	30.2
	<0.01	<0.001	<0.05	<0.001	n.s.	<0.001

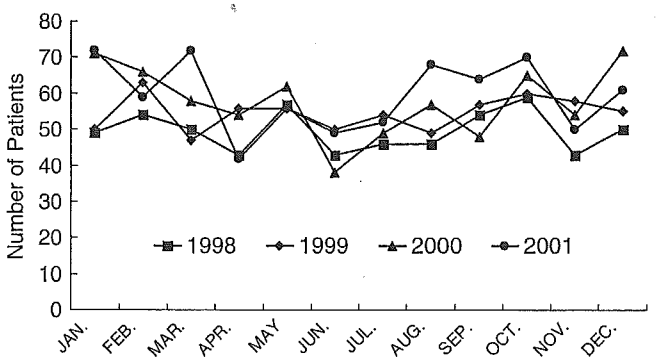

Fig. 2 Monthly variation in number of patients with hip fractures

comparable; however, data collection bias based on hospital records in each hospital cannot be discounted. Furthermore, hip fracture patients resident in Tottori Prefecture and treated outside this Prefecture could have missed the registration. From the geographical features of Tottori Prefecture, all patients with hip fracture must be treated at a hospital within the Prefecture, but those who were injured outside the Prefecture may have missed registration, although the number of such patients would be very small.

In conclusion, the incidence rates of hip fracture from 1998 to 2001 increased compared with those from 1986 to 1988 or from 1992 to 1994. It is estimated that the population aged 65 years and over will account for 23% of the total population in Japan in 2010, rising to 30% in 2030. Based on the age- and gender-specific incidence observed in the current study, the total number of hip fracture patients in Japan is forecast to be 153,000 per year in 2010, and 238,000 in 2030. Strategies including prevention and treatment of osteoporosis and prevention of falling, and maintenance of physical activities among the elderly by changing lifestyle will be extremely important in order to reduce the social burden of hip fractures in the future.

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第24回日本老年学会総会記録
〈シンポジウムIII：骨粗鬆症のすべて〉

2. 骨粗鬆症とは？（疫学からみた重要性）

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2. 骨粗鬆症とは？（疫学からみた重要性）

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Key words：骨粗鬆症，疫学，大腿骨近位部骨折，脊椎骨折，発生率

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はじめに

骨粗鬆症は，骨量の低下や骨の微細構造の悪化が原因で骨が脆弱となって，骨折の危険性が高い状態と定義される．現在，わが国で約1,000万人と考えられている骨粗鬆症患者のうち，実際に治療が行われているのはごく一部である．これは骨粗鬆症について，患者側も治療する医師も，その必要性を十分に認識していないことが原因している．「骨を折っただけで済んで助かった」とはよく聞くせりふであるが，「心筋梗塞だけで済んだ」とか「脳卒中だけで助かった」いうせりふは見つからない．これは一般に患者・医師とも，生命予後に直接的に関与する疾患に対してより敏感で，その治療が重要と感じるためである．しかしながら，骨粗鬆症によって引き起こされる骨折は身体機能を著しく悪化させ，生命予後にも大きく影響を及ぼすため，その予防と治療の必要性はきわめて高い．そしてこれらの骨折患者数は今後急速に増加すると予想されている．

骨粗鬆症は沈黙の疾患

骨粗鬆症は「沈黙の疾患」と呼ばれ，骨量減少のみでは臨床症状が現れることはない．しかしながら，ひとたび骨折を発症すると，著しい疼痛をもたらし日常生活動作を制限する．脊椎骨折や大腿骨近位部骨折は，加齢に伴い骨粗鬆症が進展すると発生頻度が増加することがよく知られている．

骨粗鬆症で発生する骨折は？

いかなる骨折が骨粗鬆症と関係あるかを明らかとするため，Stoneらは65歳以上の9,483人の集団を対象に，骨量測定した後，平均10.4年間にわたって追跡し，その後に発生した骨折を検討している[1)]．その結果，骨量の減少と有意な関係があったのは大腿骨近位部骨折，脊椎椎体骨折の他，上腕骨骨折，骨盤骨折，手関節部骨折，肋骨骨折，下腿骨折などであった（表1）．患者数はこれらの骨折のうち脊椎骨折，大腿骨近位部骨折，手関節部骨折（橈骨遠位端骨折），上腕骨近位端骨折が多い．

表1　骨密度と骨折リスクの関係

骨折部位	骨量測定部位			
	橈骨遠位	踵骨	脊椎	大腿骨頸部
大腿骨頸部	1.54	1.71	1.49	2.37
手関節	1.88	1.71	1.62	1.67
脊椎	1.73	1.79	2.06	1.93
上腕骨	1.97	1.82	1.78	2.01
肋骨	1.43	1.59	1.42	1.56

文献1より引用・改変
値は骨密度が1SD低下した場合の骨折発生の相対危険度を示す．
例えば，大腿骨頸部の骨密度が1SD低下すれば，大腿骨頸部骨折の発生リスクが2.37倍高くなることを意味する．

また疫学的検討から，骨折の既往があると，新規の脊椎骨折発生率が上昇することが知られていて，既に骨折を有する例ではそうでない例に比べて，年齢や骨密度が同じであっても，その後に骨折が2～5倍程度も発生しやすい（表2）[2)]．

骨粗鬆症性骨折の発生率と予後

1）脊椎骨折

本骨折は発症後に強い背部痛を主訴として受診する症例と，疼痛が軽微で，患者本人も骨折発症を自覚することなく経過する場合がある．したがって発生率の調査は困難で，これまでは主に有病率が調査されていた．わが国では広島，山梨，和歌山での有病率が調査され，60

What is osteoporosis?　—Its significance from epidemiological point of view—

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表2　骨折の有無による骨折発生の危険度

骨折部位	手関節	椎体	大腿骨頚部	全て
手関節	3.3（2.0，5.3）	1.7（1.4，2.1）	1.9（1.6，2.2）	2.4（1.7，3.4）
椎体	1.4（1.2，1.7）	4.4（3.6，5.4）	2.3（2.0，2.8）	1.8（1.7，1.9）
大腿骨頚部	—	2.5（1.8，3.5）	2.3（1.5，3.7）	1.9（NA）
その他	1.8（1.3，2.4）	1.9（1.3，2.8）	2.0（1.7，2.3）	1.9（1.3，2.7）

文献2より引用　　相対危険（95%信頼区間）

既に骨折を有する例ではそうでない例に比べて，年齢や骨密度が同じであっても，その後に骨折が2～5倍程度も発生しやすい

歳代で7.6～14%，70歳代で37～45%と報告されている[3)~5)]．また椎体別では第6～8胸椎と，胸腰椎移行部に多発することが知られている．

最近，広島における前向き疫学研究による調査結果が報告された．それによれば脊椎骨折の発生率は加齢とともに上昇し，女性では75歳代で人口10万当たり年間約3,000に達する[6)]．この結果を欧州での調査結果と比較すると，日本人における発生率は欧州白人よりも高値である[7)8)]．

脊椎骨折の臥床期間は骨折数が多くなるほど長くなる．脊椎骨折の無い高齢者で，1日以上臥床するのは4%程度，1週間以上活動が制限されるのが13%程度であるのに対して，1つでも脊椎骨折を生じるとそれぞれ19%，36%，骨折が2カ所以上になると，42%，69%と高くなる[9)]．

脊椎骨折は生命予後を低下させ，少なくとも1椎体の骨折が発生した女性では，椎体骨折のない女性に比べて，死亡率が32%高まる[10)]．

2）大腿骨近位部骨折

日本整形外科学会が行った平成10年から12年までに全国で発生した110,747例の集計結果では，年齢階級別の全患者数は80～84歳が最多で，80歳代が全体の半分を占める（図1）[11)]．大腿骨近位部骨折の発生率は50歳以下では男女とも人口10万人当り10以下でその発生はごく少なく，60歳以上で徐々に発生率が増加し，70歳以降に指数関数的に上昇する[12)~14)]．骨折型別の発生率は，70歳代前半までは頸部（内側）骨折の発生率が転子部（外側）骨折よりも高値であるが，70歳代後半から転子部（外側）骨折の方が高値となる[14)]．

国別の発生率を比較すると，上述のわが国における発生率は北欧や米国での発生率の1/2～1/3である[14)]．アジア人での発生率は，北欧や米国の白人より明らかに低値で，米国内でもアジア系民族では白人より発生率が低い．このように地域や人種によって発生率にばらつきがあり，Lauは近代化と都市化が進んだ地域ほど発生率が高いことを指摘している[15)]．

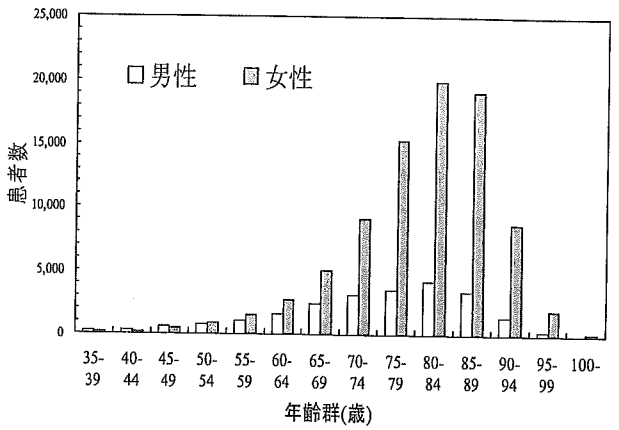

図1　大腿骨近位部骨折の年齢階級別患者数（文献11より引用）

最近報告された全国調査結果によれば1987～2002年の間，わが国の発生率は上昇が続いている[12)]．鳥取県での調査では，1986～88年と1992～94年の発生率を比較したところ，80歳以上の女性での経年的な上昇が著しく[14)]，その後の調査でも同様の傾向が観察されている[16)]．また他のアジアの国々でも発生率上昇が続いている．一方，北欧や北米では以前には発生率上昇の傾向が見られたが，近年では変化がないという報告が多い[17)]．

このように地域や人種によって発生率やその推移にばらつきがあり，都市化が進んだ地域ほど発生率が高い．発生率の推移に影響する重要な要因として，身体活動性の低下，飲酒量や催眠鎮静剤の服用頻度の増加があげられ，これらは骨脆弱化の進展や転倒の危険性を高め，骨折発生率上昇の一因となる．

本骨折症例のうち退院時歩行可能者の割合は全体で60～80%程度，85歳または90歳以上の超高齢骨折患者では約40～60%程度である[18)]．骨折後の歩行能力には，年齢，受傷前の歩行能力，痴呆の有無，骨折型（内側骨折の方が良好）が影響を及ぼす．本骨折患者の受傷1年後の生存率は約80～90%である[18)]．受傷後3カ月から半年までの死亡率が高く，それ以後は一般人口の生存率と変わらなくなる．90歳以上の超高齢者では生存率は

さらに低下し，1年後生存率は70％程度である．生命予後に影響を与える因子として，年齢，性別（女性の方が良好），痴呆の有無，合併症の有無，退院時の歩行能力が挙げられる．

結　語

わが国の人口は今後も高齢化が進み，老年人口（65歳以上）のピークは2043年頃と推測され，大腿骨近位部骨折患者数も2040年頃まで増加の一途をたどることが予想される．現在の年齢階級別発生率と将来人口推計に基づくと，現在年間約12万例発生している患者数が，2030年には2倍以上となると予測される．これに発生率の上昇が加われば，患者数の増加に拍車がかかるのは必至である．脊椎骨折もまた後期高齢者での発生率が高いため，今後，急速に患者数が増加すると予想される．骨粗鬆症の予防に力を入れると同時に，骨粗鬆症の適切な診断と骨折予防効果を有する薬剤による治療を行うことで，患者数の増加が抑制を図ることが，社会的な急務である．

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