Table 1. Questionnaire items

1. Trends in medical care for spine fractures in the elderly
   (1) Mean percentage of spine fractures patients who were hospitalized
   (2) Use of critical paths for the treatment of spine fractures
   (3) Imaging tests used regularly (*multiple responses are allowed*)
   Which test is most trusted in determining a diagnosis of fracture?
   (4) Open surgery and vertebroplasty performed
   (5) External fixation used regularly (*multiple responses are allowed*)
   Which method is used most often? Which method is never used?
   (6) Analgesic treatment used regularly (*multiple responses are allowed*)
   Which method is used most often? Which method is used when pain is strongest?
   (7) Rehabilitation practices used regularly (*multiple responses are allowed*)
2. Number of patients under hospitalization on the day of the response
   (1) Number of patients hospitalized for orthopedic diseases
   (2) Number of hospitalized spine fracture patients 65 years or older
   (3) Number among them receiving conservative treatment
3. Number of surgeries for patients with spinal fractures in 2005
   (1) Number of vertebroplasties using bone cement, materials other than bone cement, or other methods
   (2) Number of open surgeries using a posterior procedure, anterior procedure, or combined anterior and posterior procedure

This survey was limited to spine fracture patients ≥65 years of age who had acute pain or other clinical symptoms. Patients with asymptomatic morphological fractures were excluded

Materials and methods

A questionnaire survey of medical institutions was conducted by mail. In Japan, nearly all doctors who perform orthopedic treatment belong to the JOA, and the hospitals where these doctors work are broadly classified as JOA-authorized hospitals and Japanese Clinical Orthopaedic Association (JCOA) hospitals. The former are relatively large hospitals certified as postgraduate clinical training hospitals, and the latter are small hospitals with up to 19 beds. As of 2006, there were 2229 JOA-authorized hospitals and 1279 JCOA hospitals. All these hospitals have been targeted for annual surveys of the incidence of hip fractures by the JOA since 1997. From among these 3509 institutions, 1200 hospitals were randomly selected for the current survey with consideration of type of hospital and region. In this survey, the regions were the 47 prefectures of Japan. Before selecting the subject institutions, a letter was sent to the president of the JOA requesting permission to use the directory of the JOA and digital data from the list of printed address labels; the permission was granted. In addition, we obtained agreement from our institutional review board to publish this article.

Questionnaires were mailed to the chiefs of the departments of orthopedic surgery in the selected hospitals by the end of July 2006; and responses received by the end of September 2006 were analyzed. Spine fractures included in the survey were limited to those accompanied by acute pain in elderly (defined here as ≥65 years of age) hospitalized patients. The questionnaire items are shown in Table 1.

The trends in medical care were summarized by the chief of surgery based on the regular treatment patterns. Responses for the number of hospitalized patients and surgeries were based on actual patient numbers.

Data handling and statistical analysis were performed using Dr.SPSS II (SPSS, Chicago, IL, USA). Associations between categorical variables were tested with chi-squared distribution, and differences between means for continuous variables were analyzed using the *t*-test. A P value of 0.05 (two-tailed) was used to define statistical significance.

Results

Responses were received from 473 hospitals in all regions, for an overall response rate of 39.4%. The number of responses and response rate by hospital were 308 hospitals (40.5%) among JOA-authorized hospitals and 155 hospitals (35.2%) among JCOA hospitals. The classification of 10 hospitals was unclear. Among the 473 hospitals from which responses were received, 22 no longer accepted inpatients, and 2 were pediatric hospitals. The analysis was thus conducted with the responses from the remaining 449 hospitals (valid response rate 37.4%).

First, the results with regard to trends in medical care for spine fractures were as follows. Hospitalization of patients diagnosed with spine fractures was done in 39.5% [standard deviation (SD) 32.3%] of cases. In a comparison of the two types of hospital, the percentage at JOA-authorized hospitals, at 42.0% (SD 33.2%), was higher than that at JCOA hospitals, which was 33.1% (SD 29.3%) ($P = 0.0108$).

In all, 449 hospitals responded concerning imaging tests, and the most common response for test regularly

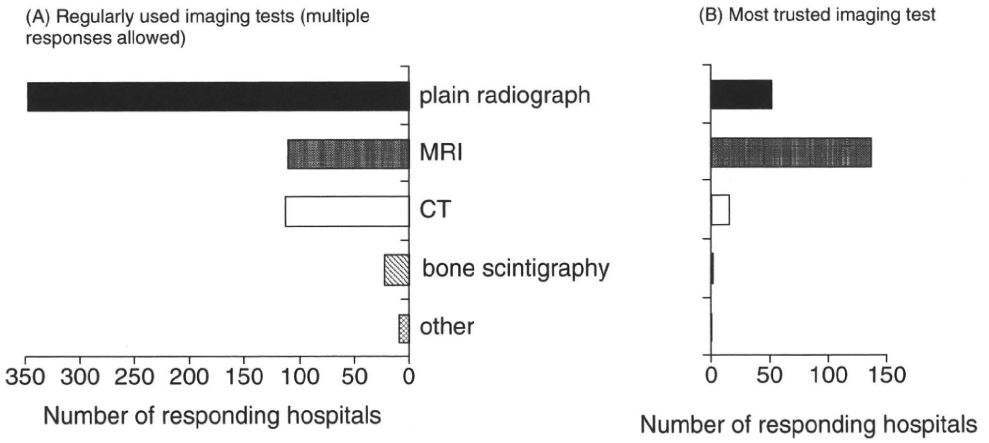

Fig. 1. Imaging tests for spine fractures. **A** Plain radiography was the imaging test most commonly used for diagnosing spine fractures in the elderly. **B** Among all imaging tests, magnetic resonance imaging (MRI) was the most trusted test in making a diagnosis

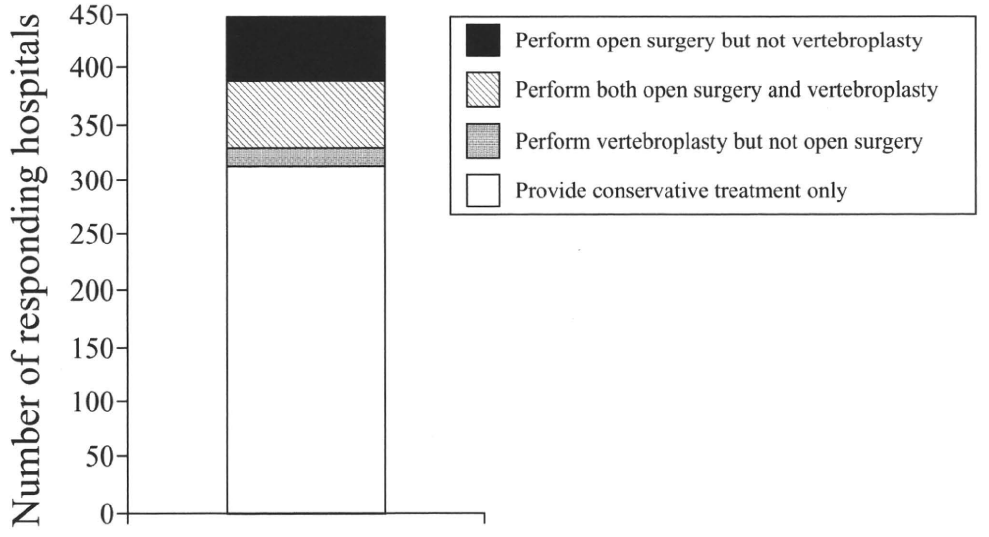

Fig. 2. Treatment for elderly spine fracture patients. In all, 69.7% of hospitals provided conservative treatment only, 3.8% performed vertebroplasty but not open surgery, 12.9% performed both open surgery and vertebroplasty, and 13.6% performed open surgery but not vertebroplasty

used was plain radiography. Next most common were computed tomography (CT) and magnetic resonance imaging (MRI), at 110 hospitals (24.5%) and 112 hospitals (24.9%), respectively. Bone scintigraphy was used at a fairly small number of hospitals (n = 23, 5.1%). In contrast, responses were received from 291 hospitals on the imaging test that was most trusted in determining a diagnosis of fracture, and the largest number, 211 hospitals (72.5%), responded that MRI was the most reliable. This was more than three times higher than plain radiography and far above CT and bone scintigraphy (Fig. 1).

Second, responses related to surgery were received from 449 hospitals. Open surgery was performed at 119 hospitals (26.5%) and not performed at 328 hospitals (73.1%). Vertebroplasty was conducted in orthopedic units of 73 hospitals (16.3%) and in a department other than orthopedics in 2 hospitals (0.4%). Vertebroplasty was not conducted in 372 hospitals (82.9%). A total of 136 hospitals (30.3%) conducted surgical treatment — either open surgery or vertebroplasty — and 313 hospitals (69.7%) did not. In all 58 hospitals responded that they performed both open surgery and vertebroplasty, 61 hospitals (13.6%) conducted open surgery but not vertebroplasty, and 17 hospitals (3.8%) did vertebroplasty but not open surgery (Fig. 2).

Responses were received from 449 hospitals with regard to treatment with a cast or brace, of which 430 hospitals (95.8%) used them and 18 hospitals (4.0%) did not. The most common responses were soft corsets and hard corsets at 202 hospitals (45.0%) and 189 hospitals (42.1%), respectively. These choices were followed by casts at 151 hospitals (33.6%) and lumbar support belts at 133 hospitals (29.6%). According to responses from 260 hospitals on the method that was used most often, 150 (57.7%) used soft corsets, and 51 (19.6%) used hard corsets. Casts were the most common method in only 30 (11.5%) cases and never used in 56 (12.5%).

Table 2. Number of hospitalized patients on the day of response

Parameter	All hospitals	JOA-authorized hospitals	JCOA hospitals	Hospitals of undetermined affiliation
Total hospitalized orthopedic patients[a]	14372 (32.8)	12658 (42.8)	1529 (11.6)	185 (18.5)
Hospitalized spine fracture patients age ≥65 years[a]	1403 (3.1)	1100 (3.7)	285 (1.9)	18 (1.8)
Hospitalized spine fracture patients who underwent conservative treatment[a]	1294 (3.1)	995 (3.4)	282 (1.8)	17 (1.7)
Spine fracture patients ≥65 years among all hospitalized orthopedic patients	13.5% ± 16.6%	19.6% ± 20.7%[b]	11.0% ± 14.1%	13.0% ± 13.1%
Spine fracture patients who received conservative treatment	91.9% ± 24.5%	89.2% ± 27.7%[c]	98.6% ± 10.7%	97.6% ± 5.8%

JOA, Japanese Orthopaedic Association; JCOA, Japanese Clinical Orthopaedic Association
[a] Numbers in parentheses represent the number of patients per hospital ± SD
[b] $P < 0.0001$ for JCOA hospitals
[c] $P = 0.0014$ for JCOA hospitals

Responses were received from 449 hospitals about pain relief. Methods normally used to relieve pain were, in order of frequency: antiinflammatory analgesic plaster in 308 (68.6%), calcitonin in 264 (58.8%), oral NSAIDs in 224 (49.9%), NSAID suppositories in169 (37.6%), local injections in 129 (28.7%), liniments in 96 (21.4%), nerve blocks in 35 (7.8%), and pentazocine in 19 (4.2%). No hospitals used narcotics. Responses regarding the pain relief method that was used most often were received from 345 hospitals. The choice here was oral NSAIDs in 191 (55.4%) followed by NSAID suppositories in 105 (30.4%), and calcitonin in 20 (5.8%). Responses were also received from 215 hospitals on the method used when pain was strongest. The most common response was overwhelmingly NSAID suppositories, in 162 (75.3%), followed by local injection in 17 (5.6%) and use of pentazocine in 13 (6.0%).

With regard to rehabilitation, responses were received from 449 hospitals. Normal practices were, in order of frequency, activities of daily living (ADL) training by a physical therapist in 301 (67.0%), physical therapy in 226 (50.3%), ADL training by someone other than a physical therapist in 94 (20.9%), no rehabilitation in 32 (7.1%), and "other" in 10 (2.2%).

The numbers of hospitalized patients on the day of the response (from 446 hospitals) were as follows. On the day of response, the total number of inpatients at orthopedic surgery hospitals was 14 372, for an average of 32.8 (SD 27.6) per hospital. The number of hospitalized spine fracture patients ≥65 years of age was 1403 on the day of response; this was an average of 3.1 (SD 3.3) per hospital, accounting for 13.5% of all orthopedic surgery patients. The number of these patients receiving conservative treatment was 1294, which accounted for 91.9% of hospitalized spine fracture patients. The remaining 109 (8.1%) were thought to be patients hospitalized for surgical treatment. A comparison between the two types of hospital regarding the number of inpatients on the day of response showed that the percentage of elderly spine fracture patients among all orthopedic surgery patients and the percentage of patients receiving conservative treatment were both higher at JCOA hospitals (Table 2).

Third, with regard to the surgeries performed in 2005, the number of open surgeries was reported to be 624 at 119 hospitals. They included 471 (75.7%) posterior surgeries, 100 (16.0%) anterior surgeries, 51 (8.2%) combined anterior and posterior surgeries, and 2 (0.3%) others. The respective average per hospital for hospitals that conducted open surgery was, in order, 4.0 (SD 9.0), 0.8 (SD 3.9), 0.4 (SD 1.3), and 0.0 (SD 0.2). The number of vertebroplasties performed was reported to be 257 at 75 hospitals. Bone cement was used in 88 surgeries (34.2%), materials other than bone cement were used in 155 (60.3%), and 14 vertebroplasties (5.4%) were listed as "other." The average per hospital performing vertebroplasty was 1.2 (SD 2.7), 2.1 (SD 2.8), and 0.2 (SD 0.8), respectively (Fig. 3).

Discussion

This study was the first nationwide survey to clarify the status of treatment for elderly patients with spine fractures in Japan. The percentage of spine fractures that are clinical fractures accompanied by pain is reported to be 23%–34%.[4,5] Moreover, not all patients with clinical fractures are hospitalized. Therefore, it is difficult to gain an overall understanding of the treatment status of spine fractures. For that reason, there have not been any rigorous national surveys.

The present survey also was limited to elderly hospitalized patients with spine fractures. To make the present survey as similar as possible to the hip fracture

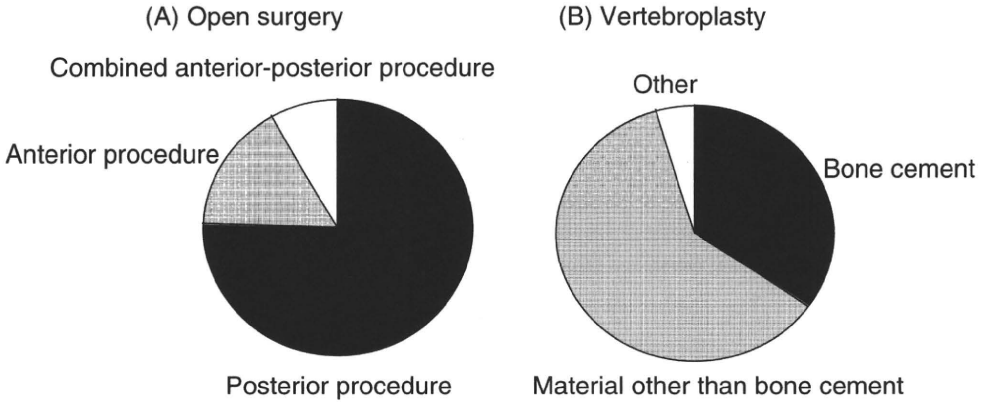

Fig. 3. Number of surgeries performed in elderly spine fracture patients in 2005. **A** The number of open surgeries was reported to be 624. **B** The number of vertebroplasties was reported to be 257

surveys, 1200 hospitals were selected randomly with consideration of type of hospital and the 47 prefectures in Japan, accounting for about one-third of the hospitals in the 2006 register. The response rates in the hip fracture surveys from JOA-authorized hospitals were 53.7%, 55.6%, and 46.0%, in 1998, 1999, and 2000, respectively; and those from JCOA hospitals were 40.5%, 54.5%, and 48.5%, respectively.[1] The response rates in the current investigation were slightly lower than those for hip fractures stated above. Possible reasons for this are the short survey period of 2 months, and the effect from not sending up a follow-up reminder. However, the difference was not large, and the results of the analysis from the present responses are considered to have reliability comparable to that of the hip fracture surveys.

The period of hospitalization for spine fracture patients is long. In Canada, of 18 health conditions, spine fractures were among the top three in accounting for length of hospital stay, along with hip fractures and mental disorders.[6] However, the percentage of spine fracture patients with symptoms who are hospitalized for treatment may vary considerably according to age, sex, or differences in medical practices or circumstances by country; for example, the difference in medical insurance systems must affect the treatment of the spine fractures, although much remains unclear.

According to the present survey, Japanese orthopedic surgeons hospitalize 39.5% of the elderly spine fracture patients who they examine. In a national survey in Spain, which was the only nationwide survey in America and European countries, it was found from the 2002 National Hospital Discharge Register that identified cases with spine fractures attributable to osteoporosis amounted to a hospitalization rate of 2.76 cases per 10 000 population aged >30 years, and these cases represented 0.15% of all hospital admissions nationwide.[7] However, it is difficult to compare this rate with our results.

It is not easy to diagnose accurately, using plain radiography, new spine fractures that occur with osteoporosis. According to our earlier study, in which we examined the diagnostic rate with plain radiography for new fractures in the elderly spine, the correct diagnosis rate by five orthopedic surgeons and two radiologists, with MRI diagnosis as the standard, was only 25%.[8] The same trend was observed in the present survey, in which 72.5% of hospitals said MRI was the most reliable for making diagnoses.

With regard to surgery, 30.3% of hospitals responded that they performed surgery for elderly spine fracture patients. Of the 1403 elderly spine fracture patients who were under hospitalization on the day of response, 109 (7.8%) were surgical patients, but this rate was clearly higher than the low rate of 1.5% reported in the other surveys.[6,7] In Japan, the material used for vertebroplasty is bone cement in a small number of cases, with the mainstream choice still being other materials (e.g., calcium phosphate paste, hydroxyapatite granules). Although surgery for elderly spine fracture patients should be as minimally invasive as possible,[9,10] the number of hospitals that perform vertebroplasty and the actual number of cases is still rather low, with a background reason being that the Japanese Ministry of Health, Labor, and Welfare has not yet approved this procedure, kyphoplasty, or the use of bone cement in vertebrae.

A prospective, randomized study for spine fracture patients without neurological deficit found that open surgery provided no major long-term advantage compared with nonoperative treatment.[11] Therefore, the current consensus regarding the indication for open surgery includes progressive neurological loss, severe unrelenting pain, and significant deformity.[12] It is unclear what percentage of elderly patients fit these indications. In a retrospective study of 497 osteoporotic spine fracture patients, 10 with spinal cord compression underwent anterior decompression and stabilization

procedures.[13] Obviously, the use of open surgery is greatly restricted in frail elderly patients because of its significant invasiveness.

With regard to bracing, a retrospective study of patients with thoracolumbar fractures suggested that braces might be important for pain control but probably did not change the long-term result.[14] However, a systematic review to assess the effects of lumbar supports for treatment of nonspecific low back pain found limited evidence that lumbar supports were more effective than no treatment, so it is still unclear whether lumbar supports are more effective than other interventions.[15] In the present survey, however, we found that 95.8% of hospitals use casting or bracing, showing that this technique retains a major role in conservative treatment in Japan.

Concerning pharmacological therapies, antiinflammatory analgesic plasters are a popular traditional treatment among Japanese, although they may not be a standard medicinal agent internationally. With regard to calcitonin, several randomized trials have demonstrated that calcitonin has a rapid analgesic effect; and they recommended that calcitonin be given for pain due to spine fractures.[16] With the expectation of a similar effect, it also seems to be used at a high rate in Japan. With respect to NSAIDs, one meta-analysis found that they are effective for short-term symptomatic relief in patients with acute low back pain of all causes.[17] NSAIDs are frequently used in Japan, either orally or in suppositories. However, an overwhelming 75.3% of hospitals selected NSAIDs in suppository form for analgesic treatment when pain was strongest, revealing a high level of trust in these drugs.

This study has several limitations. First, the response rate was about 40%. Second, the survey was conducted among hospitals authorized by the JOA and JCOA. Inpatient treatment for elderly patients with spine fractures, however, is done not only at those hospitals but also at nonaffiliated hospitals. Therefore, it was not possible to make an accurate estimate of the number of inpatients with spine fractures in Japan. Although these limitations could cause some bias, the large number of patients and hospitals in this study may in some measure compensate for any such bias.

Conclusion

We conducted the first nationwide survey in Japan on trends in the treatment of spine fracture patients ≥65 years of age. The results showed that there were 3.1 spinal fracture patients per hospital at the time of the survey, which accounted for 13.5% of all orthopedic surgery inpatients. Of this number, 91.9% underwent conservative treatment. Surgical treatment was mainly done with a posterior method at one-fourth of hospitals. Vertebroplasty was conducted at 16.7% of hospitals. MRI was far and away the most trusted diagnostic imaging technique, and it was found that bracing, mainly with corsets, was in general use. The status of pain relief treatment and rehabilitation was also revealed. This study provides basic data that will contribute to the current thinking about how to improve spine fracture treatment and make it more efficient.

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Original article

Nationwide one-decade survey of hip fractures in Japan

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Abstract

Background. To elucidate the characteristics of hip fractures and the current status of their treatment in Japan, the Japanese Orthopaedic Association (JOA) conducted a nationwide hip fracture survey from 1998 to the present. The aim of the current report was to present the changes in patient distribution by age and fracture type, cause of fracture, treatment selection, and duration of hospitalization for a study period of one decade.

Methods. A tally of all hip fractures that occurred in patients between 2001 and 2008 was conducted in JOA-authorized hospitals and in Japanese Clinical Orthopaedic Association (JCOA) hospitals. Registration forms were sent to these hospitals each year, and registration was performed based on their hospital records.

Results. The mean response rate was 51.8%, and the total number of patients aged ≥35 with new hip fractures between 2001 and 2008 was 402 760. A drastic increase in the number of patients, especially those aged ≥90 was observed over the course of the decade. More trochanteric fractures occurred than neck fractures during the observational period; however, the neck/trochanter ratio increased over time. Simple falls were the most common cause of fracture. About 94% patients were treated surgically with about a 5-day presurgical hospital stay, and the mean hospitalization period was 40.7 days in 2008.

Conclusions. This one-decade survey demonstrated a drastic increase in the number of patients over the course of the decade in Japan. Appropriate treatment and prevention of hip fractures, including the treatment of osteoporosis and more effective interventions for preventing falls, are important issues to address to reduce the burden of this fracture.

Introduction

Hip fractures are not only the most significant osteoporotic fracture in terms of health outcome or quality of life, they also account for a substantial proportion of health service expenses. As a result of the aging population in most industrialized countries, the burden of this fracture type on our health care systems is increasing, and the absolute number of hip fractures is expected to rise significantly over the next few decades.

A growing number of epidemiological surveys have shown a recent exponential increase in the number of hip fractures among various ethnic groups. It is well known that the incidence of hip fractures in northern Europe or North America is substantially higher than that in Asian counties; however, whereas this incidence was once increasing in Europe and America, it has now plateaued or is decreasing.[1,2] On the contrary, it has been reported that hip fracture incidence increased steadily from 1986 to 2006 in Japan,[3] which agreed with most other studies from Asia. It is estimated that the annual number of hip fractures worldwide will be 2.6 million by the year 2025, and the number of hip fractures could range between 7.3 and 21.3 million by 2050.[4] Although Europe and North America account for about one-half of all hip fractures among elderly people today, this proportion will fall to around one-fourth in 2050,

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Table 1. Number of institutions and response rates

Survey year	JOA-authorized hospitals	JCOA hospitals	Total	Response rate (%)
1998[a]	2270	1529	3799	48.4
1999[a]	2264	1430	3694	55.1
2000[a]	2312	1512	3824	47.0
2001	2291	1493	3784	53.0
2002	2276	1466	3742	53.6
2003	2252	1347	3599	52.1
2004	2264	1258	3522	51.3
2005	2229	1224	3453	48.3
2006	2201	1167	3368	48.9
2007	2031	1218	3249	51.8
2008	2016	1104	3120	55.4

JOA, Japanese Orthopaedic Association; JCOA, Japanese Clinical Orthopaedic Association
[a] Data are from reference 9

by which time steep increases will be observed throughout Asia and Latin America.[5] Therefore, the medical and socioeconomic burden of hip fractures will be growing rapidly in Asian countries.

Japan is the country with the longest life expectancy in the world. The average life expectancy at birth for Japanese individuals has steadily increased, reaching 78.56 years for men and 85.52 years for women in 2005. As a result, the population structure in Japan has changed dramatically over the past decade. The proportion of the population aged ≥65 years increased from 17.5% in 2000 to 22.3% in 2008, and the proportion aged ≥75 years grew from 7.1% to 10.5%.[6] As a result of these changes, Japan's population now contains more elderly individuals than any other developed countries, and the hip fracture burden will therefore be more serious in Japan than in any other country in the near future. In 2005, the life expectancy for 50-year-old men was 29.26 years and that for women was 35.94 years, and the residual lifetime risk of hip fracture for individuals 50 years of age in Japan was estimated to be 5.6% for men and 20.0% for women.[3] This compares to 10.7% and 22.9% in Sweden and 3.1% and 11.4% in the United Kingdom, for men and women, respectively.[7,8] Although the incidence of hip fracture in Japan is lower than that in Sweden,[3] the longer average life-span has elevated the residual lifetime fracture risk for individuals 50 years of age.

To elucidate the characteristics of hip fractures and the current status of their treatment in Japan, the Japanese Orthopaedic Association (JOA) conducted a nationwide hip fracture survey from 1998 to the present. We previously reported the survey results obtained between 1998 and 2000.[9] The aim of the current report was to present additional results from 2001 to 2008, thus describing for a study period of one decade the change in patient distribution by age and fracture type, cause of fracture, treatment selection, and duration of hospitalization.

Patients and methods

Data collection

A tally of all hip fractures that occurred in patients between 2001 and 2008 was conducted in JOA-authorized hospitals and in Japanese Clinical Orthopaedic Association (JCOA) hospitals. There were 2291 JOA-authorized hospitals and 1493 JCOA hospitals in 2001, and the number decreased thereafter (Table 1).

Inclusion criteria were femoral neck and trochanteric fractures in patients aged ≥35 years and treated in JOA-authorized or JCOA hospitals. Pathological fractures due to neoplasm or infection and removal of implants were excluded. Cases of refracture were included, but cases of reoperation due to delayed union or nonunion were excluded. Registration forms were sent to these hospitals by mail each year, and registration was performed by the hospital staff (including orthopedists) based on their hospital records. Registration information included name (initials), sex, date of birth, date of fracture, date of first hospital visit, fracture site, fracture type, fracture location, cause of injury, treatment, and duration of hospitalization. From 2005 onward, the initials and date of birth were omitted from the registration information for the purpose of protecting personal information. Therefore, duplication of cases and refracture were checked based on patient initials, date of birth, and prefecture before 2005 and by fracture date, age, sex, and prefecture from 2005 to 2008.

Causes of injury were divided into six categories: "in bed," "simple fall," "fall on stairs," "traffic accident," "not remembered," and "unknown." The term "in bed"

Table 2. Registered patients ≥35 years old with a hip fracture

Survey	No. of patients			Fracture site	
	Male	Female	Total	Right	Left
1998[a]	7 761	28 275	36 226	17 552	18 379
1999[a]	8 556	31 253	40 069	19 375	20 253
2000[a]	7 351	26 889	34 452	16 786	17 458
2001	9 193	35 097	44 469	21 650	22 565
2002	9 547	35 840	45 604	22 185	23 144
2003	9 414	35 189	44 807	21 731	22 790
2004	9 499	36 134	45 835	22 001	23 551
2005	9 644	36 397	46 145	22 287	23 376
2006	10 646	40 087	50 846	24 518	25 738
2007	11 937	44 787	56 816	27 409	28 950
2008	14 334	53 783	68 238	32 795	34 805
Total	84 214	317 314	402 760	194 576	204 919

Values are the number of patients
[a]Data are from reference 9

indicates a fracture that occurred when lying in bed, "simple fall" describes falling from a standing height or from bed, "not remembered" indicates that the patient did not remember the injury, and "unknown" denotes that the information could not be obtained from patients because of some difficulty, such as dementia. We identified "care fractures" as those that occurred during activities involving care of bed-ridden patients (e.g., during diaper changing and bed baths) and included them in the "in bed" category.

The duration of hospitalization was calculated based on the hospital where the patients were treated just after their injury. Surgical day for the first surgery (e.g., osteosynthesis, arthroplasty) was surveyed from 2003 to 2008, and the duration of hospitalization before surgery was calculated.

Statistical methods

Significant differences between two groups were tested with Wilcoxon tests for paired values (for the number of patients fractured on the right or left side during each year) and Mann-Whitney tests for unpaired values. Patient proportions between groups were compared using the chi-squared test. Seasonal variations were tested with the Friedman test. Approval was obtained from the ethics committees of the JOA, Tottori University, and each participating hospital. Statistical analysis was performed using SPSS (SPSS II for Windows Version 11.0.1J; SPSS Japan, Tokyo, Japan); and $P < 0.05$ was considered statistically significant. Patient data obtained between 1998 and 2000, which we previously reported,[9] was included in this analysis.

Results

Response rates and number of patients

Response rates ranged from 48.3% to 55.4% (mean 51.8%) (Table 1). The total number of patients aged ≥ 35 years with new hip fractures between 2001 and 2008 was 402 760 (84 214 men, 317 314 women, sex not indicated 1232 cases) (Table 2). The number of women was 3.8 times that of men.

Fractures occurred on the right in 194 576 patients and on the left in 204 919 patients (fracture site was not indicated in 3265 cases) (Table 2). More left hips were fractured than right in all survey years, and the difference was statistically significant ($P < 0.02$, Wilcoxon test).

Age-specific and sex-specific patient totals

Age-specific and sex-specific patient totals were calculated for each survey year. Patient numbers correlated with higher age and peaked in the 85- to 89-year-old group for both sexes (Fig. 1). Patients in the 80- to 89-year-old age group accounted for about half of the total number of patients. However, increases in patient numbers over time (from 1998 to 2008) were more prominent for ages ≥90 years for both sexes. The numbers of female patients were 6531, 6241, and 2766 in 1998 for the age groups 80–84, 85–89, and 90–94 years, respectively; they were 12 147, 13 180, and 8358, for these same groups in 2008. The ratios of fracture numbers in 2008 to those in 1998 are 1.90, 2.11, and 3.04, respectively. There were 1413 women and 202 men aged ≥100 years with hip fractures during the period 2001–2008.

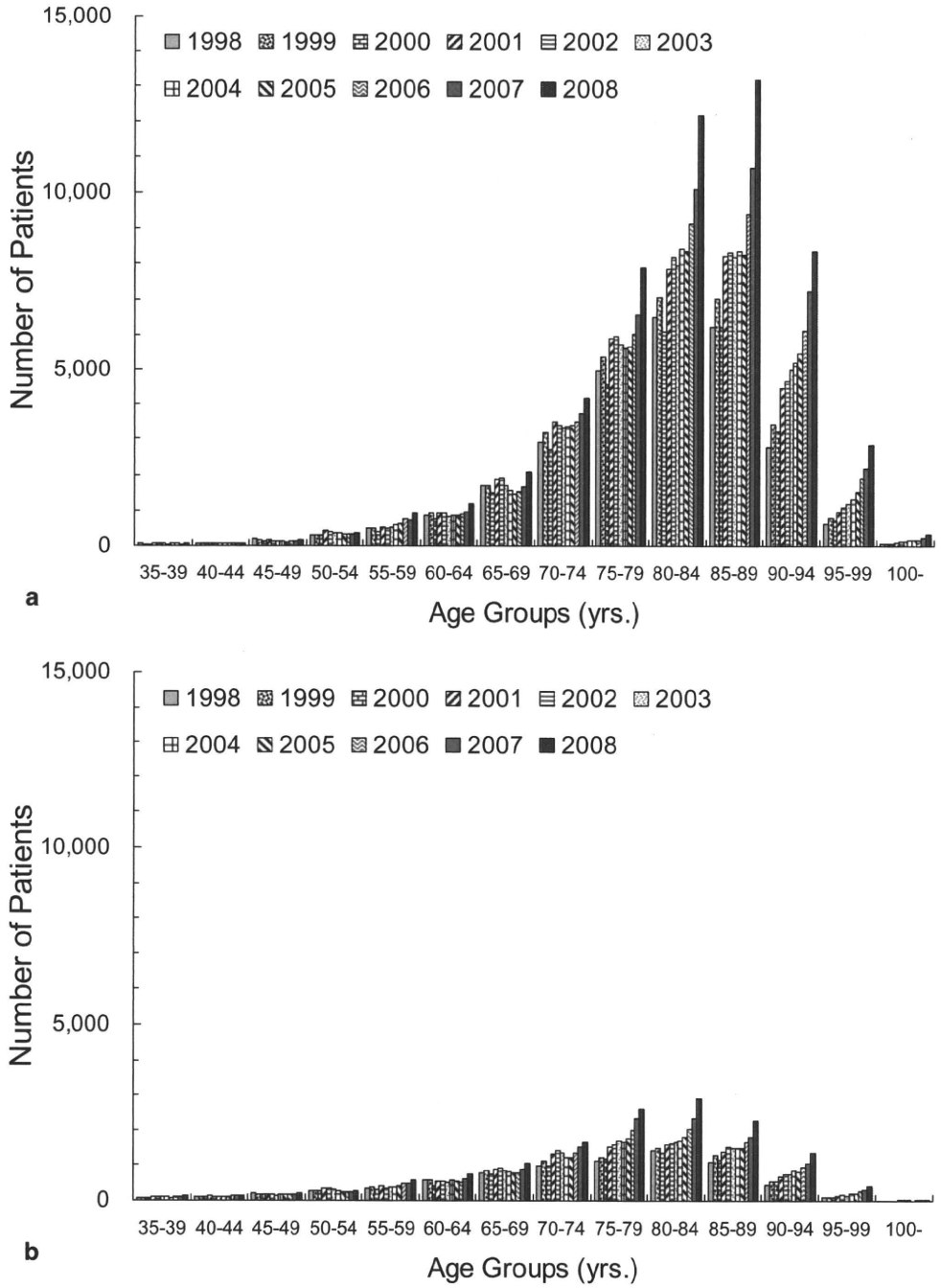

Fig. 1. Age-specific annual numbers of patients with hip fractures. **a** Women. **b** Men. The number increased with age and peaked at age 85–89 years for both sexes. Patients in the 80- to 89-year-old age group accounted for about one-half of the total number of patients; but for both sexes the increases were more prominent for those aged ≥90 years

Fracture type

The survey found 182 576 neck fractures and 216 788 trochanteric fractures (3396 unclassified fractures) during the observational period from 2001 to 2008. The change over time in the prevalence of both fracture types is shown in Fig. 2. More trochanteric fractures occurred than neck fractures during the observational period; however, the neck/trochanter ratio increased over time.

Refractures

Patients with refracture at either the opposite or same side of the first fracture side were determined from 2001 to 2004 based on patients' initials and dates of birth (Table 3). During the 1-year observational period 1916 patients (197 men, 1719 women) suffered refracture (Table 3). Initial fractures occurred on the right side in 981 patients and on the left side in 908 patients (fracture side not indicated in 27 cases); 883 of these were neck

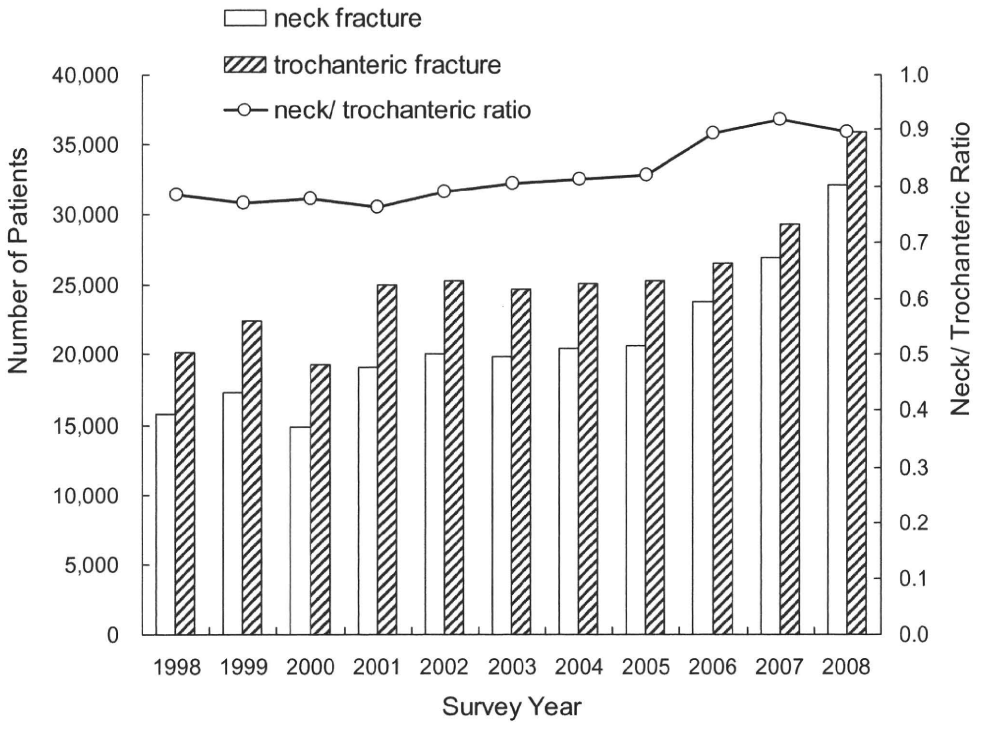

Fig. 2. Fracture type-specific annual numbers of patients with hip fractures. More trochanteric than neck fractures occurred during the observational period, although the neck/trochanter ratio increased over time

Table 3. Patients with refracture

Parameter	2001	2002	2003	2004	Total
Sex (no.)					
Men	49	42	51	55	197
Women	430	431	429	429	1719
First fracture					
Fracture site (no.)					
Right	244	248	244	245	981
Left	228	220	231	229	908
Fracture type					
Neck	239	215	225	204	883
Trochanteric	236	254	244	267	1001
Second fracture of the same type	70.1%	64.1%	66.3%	69.0%	67.4%

fractures, and 1001 were trochanteric fractures (fracture type not indicated in 32 cases). Refractures were of the same type as the initial fractures in 67.4% of cases and on the same side in 2.3% of cases.

Fracture causes

Fractures were due to a simple fall in more than two-thirds of men and four-fifths of women (Table 4). In patients aged ≥90 years, a simple fall was the cause in more than 84% of cases. "Care fractures" were identified in 0.2% of the total number of patients.

Altogether, 75% (277 657) of patients sustained fractures indoors, and 25% (93 679) sustained them outdoors (the site of the injury was not indicated in 31 424 cases). Patients aged ≥90 years sustained their fractures indoors 87.9% of the time, whereas this was the case for only 71.8% of patients <90 years of age, a statistically significant difference ($P < 0.001$, chi-squared test). Comparing sexes, 78.7% of women and 60.3% of men suffered fractured indoors, again a difference that was statistically significant ($P < 0.001$, chi-squared test).

Monthly variation

The total number of patients per month was the highest in January in all survey years from 1998 to 2008. It was the lowest in June in all survey years except 2000, when the lowest number was observed in July (Fig. 3). This monthly variation was statistically significant ($P < 0.01$, Friedman test).

Table 4. Cause of hip fractures

Cause	Total	Men	Women	Age < 90 years	Age ≥ 90 years
Simple fall	305 473 (77.7%)	56 950 (69.1%)	248 523 (80.1%)	247 634 (76.4%)	57 839 (84.1%)
Traffic accident	32 754 (8.3%)	15 293 (18.5%)	17 461 (5.6%)	30 688 (9.5%)	2 066 (3.0%)
Fall on stairs	21 994 (5.6%)	4 847 (5.9%)	17 147 (5.5%)	19 776 (6.1%)	2 218 (3.2%)
In bed	5 540 (1.4%)	945 (1.1%)	4 595 (1.5%)	4 292 (1.3%)	1 248 (1.8%)
Not remembered	5 294 (1.3%)	816 (1.0%)	4 478 (1.4%)	4 415 (1.4%)	879 (1.3%)
Unknown	21 843 (5.6%)	3 607 (4.4%)	18 236 (5.9%)	17 317 (5.3%)	4 526 (6.6%)
Care fracture[a]	805 (0.2%)	136 (0.2%)	669 (0.2%)	594 (0.2%)	211 (0.3%)

Values are the total number of patients (years 2001–2008)
[a]Those that occurred during the care of bedridden patients, such as when changing a diaper

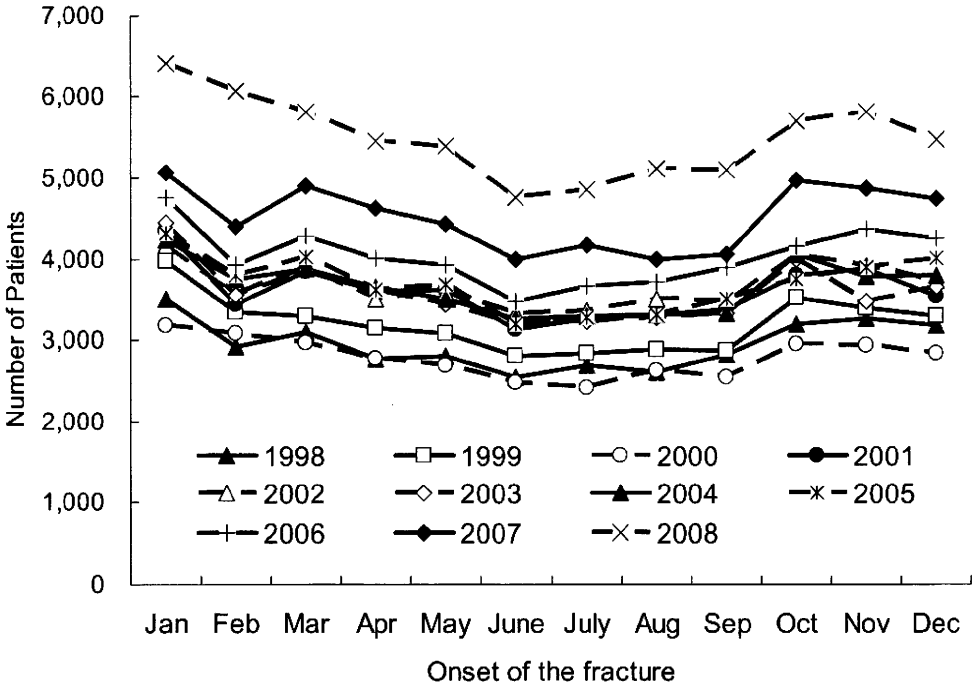

Fig. 3. Monthly variation in the number of patients with hip fractures

Length of stay before surgery or other treatment

More than 90% of patients were treated surgically (Table 5). Among patients with femoral neck fractures, 67.5% were treated with arthroplasty including hemiarthroplasty and total arthroplasty.

The mean length of stay (LOS) before surgery was 5.6 days in 2003, becoming shorter with time over successive observational periods (Table 6). The LOS for neck fractures was longer than that for trochanteric fractures during all survey years ($P < 0.001$ Mann-Whitney). Among patients with neck fractures, the mean LOSs before surgery for patients receiving arthroplasty were 6.5, 6.3, 6.2, 6.1, 6.0, and 5.8 days in 2003, 2004, 2005, 2006, 2007, and 2008, respectively. Those for patients undergoing osteosynthesis were 4.7, 4.6, 4.5, 4.8, 4.2, and 4.3 days, respectively. These differences between fracture types were significant in all survey years ($P < 0.001$ Mann-Whitney). The mean LOSs before surgery among patients aged ≤90 years were 5.7, 5.4, 5.4, 5.2, 5.1, and 4.9 days in 2003, 2004, 2005, 2006, 2007, and 2008, respectively. Those among patients aged ≥90 years were 5.2, 5.1, 4.8, 5.0, 4.8, and 4.7 days, respectively. These differences between age groups were significant in all survey years ($P < 0.001$ Mann-Whitney).

Duration of hospitalization

The mean hospitalization period was 53.4 days in 2001, and it became shorter over successive observational periods (Table 6). There was no significant difference in hospitalization duration between patients with neck fractures and those with trochanteric fractures. The hospitalization period was longer in patients <90 years of age than in those ≥90 years in all survey years ($P < 0.001$ Mann-Whitney).

Table 5. Selected treatment for patients with hip fractures

Treatment	Neck	Trochanter	Total
Conservative	11 151 (6.2%)	11 589 (5.4%)	22 740 (5.8%)
Surgery	167 549 (93.8%)	201 715 (94.6%)	369 264 (94.2%)
Arthroplasty	113 130 (67.5%)	2 276 (1.1%)	115 406 (31.3%)
Osteosynthesis	53 450 (31.9%)	198 316 (98.3%)	251 766 (68.2%)
Not indicated	969 (0.6%)	1 123 (0.6%)	2 092 (0.6%)

Values are the total number of patients (years 2001–2008)

Table 6. Preoperative and hospitalization periods

Survey year	Preoperative period (days)			Hospitalization period (days)		
	Neck fracture	Trochanteric fracture	Total	Neck fracture	Trochanteric fracture	Total
2001	—	—	—	53.2, 46 [31–67]	53.5, 46 [29–69]	53.4, 46 [30–68]
2002	—	—	—	50.2, 43 [28–63]	50.6, 43 [27–65]	50.5, 43 [28–64]
2003	5.9, 5 [3–7]	5.3, 4 [2–7]	5.6, 4 [2–7]	48.4, 41 [27–61]	49.6, 42 [26–64]	49.2, 42 [27–63]
2004	5.4, 4 [2–7]	5.0, 4 [2–6]	5.4, 4 [2–7]	47.0, 40 [26–60]	49.0, 41 [26–63]	48.1, 40 [26–61]
2005	5.3, 4 [2–7]	4.9, 4 [2–6]	5.3, 4 [2–7]	47.4, 40 [26–60]	48.6, 41 [25–63]	48.0, 40 [26–62]
2006	5.2, 4 [2–7]	4.8, 4 [2–6]	5.2, 4 [2–7]	44.7, 38 [24–57]	45.2, 38 [23–59]	44.9, 38 [24–58]
2007	5.4, 4 [2–7]	4.7, 4 [2–6]	5.0, 4 [2–6]	42.0, 35 [22–54]	42.7, 35 [22–56]	42.3, 35 [22–55]
2008	5.3, 4 [2–7]	4.6, 4 [2–6]	4.9, 4 [2–6]	40.6, 33 [21–51]	40.7, 33 [21–53]	40.7, 33 [21–52]

Values are the mean, median, and [25%–75% percentiles]

Discussion

This study evaluated the relation of hip fracture incidence to age and fracture type, cause of fracture, treatment selection, length of stay before surgery, and duration of hospitalization. The survey showed a drastic increase in number of patients, especially those aged ≥90 years, over the course of one decade. Simple falls were the most common cause of fracture, and about 94% patients were treated surgically with about a 5-day presurgical hospital stay.

Studies in Japan have indicated that hip fracture incidence has been increasing up to the present time.[3,10] A recent study showed a slight decline in the incidence of hip fracture; however, it is limited in some age groups.[11] The current study demonstrated a drastic increase in the number of patients over age 80 years between 1998 and 2008, with numbers in 2008 eclipsing those in 1998 by factors of 1.90, 2.11, and 3.04 for the age ranges 80–84, 85–89, and 90–94 years, respectively. The number of patients ≥100 years of age with hip fractures quadrupled from 1998 to 2008. These increases are much higher than those seen in the remainder of the Japanese population from 1998 to 2008, where ratios were 1.64, 1.56, and 1.63 for the age groups 80–84, 85–89, and 90–94 years, respectively.[6] The registered number of patients per year in each hospital also increased during the observational period. As the 50% response rate demonstrates, this study does not cover all patients with hip fractures in Japan. Nonetheless, the substantially higher number of patients registered than those expected based on the Japanese population increase is due to the increase in hip fracture incidence in individuals aged ≥ 80 years that we previously reported.[3] The overall decrease in physical activity stemming from a Westernized lifestyle may explain the increase in fracture incidence among Japanese patients. Another explanation may be that more seniors with poor health because of other conditions are being treated, which results in people living longer at a time when their risk of falling is quite high.[3]

The most serious social and economic concern facing our health care system is the rapid rise in the number of patients aged ≥90 years. It has been estimated that these patients will account for half of the total number of hip fractures within the next two decades, by which time the total number of hip fractures sustained per year will be about 300 000, approximately double that in 2008. Establishing effective measures to support elderly patients with hip fractures is one of the more urgent issues in our society.

The incidence of femoral neck fractures is higher than that of trochanteric fractures in northern European and African populations, whereas femoral neck fractures are less common than trochanteric fractures in Japanese populations.[3,12,13] Because trochanteric fractures have a closer relation with low bone mass than do femoral neck fractures, they occur more frequently in the very

elderly.[14] As a result, we had expected that the increase in hip fractures over the last decade would be marked by a relatively higher number of trochanteric fractures than femoral neck fractures — when in fact the opposite was seen. A recent survey in Sweden showed that the neck/trochanteric fracture incidence ratio had leveled off.[15] Although the reason for these trends is uncertain, the neck/trochanteric fracture ratio in Japan might be approaching values observed in northern European populations.

In this study, more left-sided fractures than right-sided fractures were observed. Most patients are right-handed,[16] and it is speculated that falls to the left side exert more impact on the proximal femur than falls to the right owing to poor protection by the nondominant hand.

It is well known that the risk of further hip fractures increases after an initial fracture,[17] so we evaluated second hip fractures occurring during the same year. Although a 1-year observation is insufficient to elucidate the risk of second fracture, about one-fourth of all subsequent fractures occur within 1year after a first fracture.[18] In this study, the primary hip fractures in patients with a refracture occurred more on the right side than the left, implying that patients with their first hip fracture on the right side have a higher risk of sustaining a second hip fracture than those in whom the primary fracture occurred on the left side.

In this study, a peak in the number of patients with hip fractures was seen in January. A recent study indicated that incidence rates of fragility fractures were highest in winter and lowest in summer.[19] Significant seasonality and an association of monthly hip fracture admission rates with ambient temperature were observed in both sexes.[20] Several explanations have been proposed, including low blood pressure, reduced vitamin D production, and heavier clothing during cold weather months. Because the present study found simple falls to be the most common cause of hip fractures and more fractures occurred indoors than outdoors, reducing the risk of indoor falling during the winter is a significant point to be emphasized for the prevention of hip fractures.

This study was the first to report on the length of stay before surgery throughout Japan. The average length was about 5 days, which is substantially longer than the duration reported by other countries.[21–23] Although it does not seem that high-quality evidence has been established up to this point, early surgery (within 2 days) is recommended to minimize postsurgical hospitalization time and complications.[24,25] We have to make every endeavor to shorten the length of hospital stays before surgery.

This study showed that over the course of one decade the duration of hospitalization after surgery became shorter with time, although even as of 2008 it remained much longer than that reported in Europe or North America. The Japanese health care system and insurance programs might contribute to this fact. In a recent study performed in the United States and Japan, shorter lengths of stay after surgery did not predict better survival across the two countries.[23] Another study demonstrated that reducing the length of stay in initial acute care hospitals may be just a method of shifting costs to subsequent care services and is unlikely to bring overall cost saving to the Japanese health care system.[26] It is necessary, therefore, to develop strategies that move beyond simple approaches and efficiently and effectively reduce the hospital stay of hip-fractured patients.

There are several limitations to this study. First, the response rate of 50% was somewhat low. Second, although the survey was conducted in hospitals authorized by the JOA and JCOA, surgery for hip fractures is performed not only in these hospitals but also at nonaffiliated hospitals. However, the large number of patients surveyed in this study for more than one decade may compensate for any such bias. Third, the initials and date of birth were omitted from the registration information from 2005 onward; therefore, patients with refracture were not evaluated thereafter. This may have affected the result, although patients moved from other hospitals were checked by each hospital and most patients analyzed for this study were those hospitalized just after the injury.

Conclusion

This one-decade survey studied more than 400 000 patients with hip fractures and demonstrated a drastic increase in the number of patients over the course of the decade, especially in the group aged ≥90 years. Appropriate treatment and prevention of hip fractures, including the treatment of osteoporosis and more effective interventions to prevent falls, are important issues to address to reduce the burden of this fracture.

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fore, these reasonable components should be integrated into multifactorial fall prevention programs.

It has to be stressed that our study was an effectiveness study and not a randomized clinical trial. The aim of the program was to disseminate and implement fall prevention in the majority of nursing homes in a complete federal state, which means that the program had to be feasible within the daily routine considering limited personal and financial resources. Participating homes committed themselves to offer the strength and balance training at least once a week. There was no funding for hip protectors. There were no direct financial incentives.

The fall prevention liaison nurses were instructed to introduce the program in their nursing homes to all staff members who spend time with residents. Nursing assistants or aides were considered to be major target groups of the in-house teaching sessions.

If nursing homes employed occupational therapists, they were usually involved in the program as exercise instructors and members of the fall prevention team. It was not possible to assign a larger role. A large percentage of German homes do not employ occupational therapists as staff members. Therefore, the program had to respect these limitations.

We absolutely agree that fall prevention measures might have other benefits than fracture reduction. Examples are the reduction of the number of falls and the increase of mobility. Both can contribute to better quality of life.

Since the reported trial, the implementation has been modified in several ways. The exercise is now being delivered twice weekly, a hip protector learning tool has been introduced, nursing staff has played a more active role in the recruiting process, a national guideline on fall prevention in nursing homes was published in 2005, and the intervention has been transferred to other federal states. It remains to be seen whether these changes will be successful at increasing physical activity, reducing falls and fractures in this vulnerable group.

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DOES FALL-RELATED SELF-EFFICACY IN HIP-PROTECTOR USERS AFFECT QUALITY OF LIFE AND PHYSICAL ACTIVITY IN NURSING HOMES IN JAPAN?

To the Editor: Cameron and colleagues[1] reported that supplementary effects of hip protectors in wearers increased fall-related self-efficacy (fall self-efficacy) in community life and led to better physical activity and quality of life (QOL), but whether hip protectors were effective for older adults in care facilities in Japan and in the community was questioned, and the effects of hip protectors on fall self-efficacy, QOL, and physical activity in female nursing home residents in Japan was therefore re-investigated.

METHODS

The subjects of this study were 52 female nursing home residents aged 70 and older who had a score of 20 or higher on the Mini-Mental State Examination (MMSE)[2] and who were selected through a prospective cluster randomized controlled trial (26 hip protectors, 26 controls). Data were obtained through the Falls Efficacy Scale (FES),[3] the Physical Component Summary (PCS) and Mental Component Summary (MCS) of the Medical Outcomes Study 8-Item Short-Form Health Survey (SF-8),[4] and step count according to a pedometer at the beginning and 6 months after. Adherence to hip protectors and numbers of falls and fracture for 6 months were also investigated.

The FES was designed to assess the degree of perceived efficacy in avoiding a fall during each of 10 activities of daily living (ADLs).[3] A question on an activity was scored on a scale of 1 (completely confident) to 10 (no confidence),[3] but because the subjects in the present study were residents of a nursing home, the daily activities assessed were modified to fit those in a nursing home situation. It was confirmed that internal consistency and reliability were as significant as those in the original reports.[3,5]

Two-way (period and groups) repeated analysis of variance (ANOVA) was used for statistical analysis. $P < .05$ was considered significant.

RESULTS

ANOVA revealed that there was no interaction between groups in FES ($P = .99$), PCS ($P = .71$), MCS ($P = .55$), and steps ($P = .23$) (Figure 1). No significant difference was observed in number of falls and fracture between the hip protector and control groups.

DISCUSSION

The present results did not support the results of Cameron and colleagues.[1] The effect of hip protectors on fall

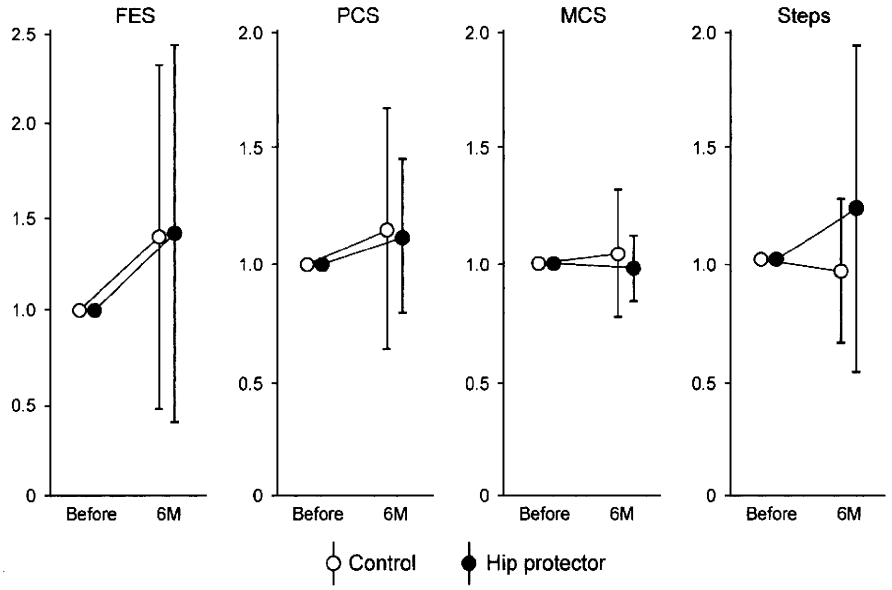

Figure 1. Changes in standardized measured values 6 months (6 M) after the beginning of the study. Values at 6 months were expressed in relation to those at the beginning of the study (before). There was no significant difference between Falls Efficacy Scale (FES), Physical Component Summary (PCS), and Mental Component Summary (MCS) scores and number of steps.

self-efficacy is controversial. A difference in the physical function of subjects between Cameron and colleagues[1] and the present study must be considered. The mean FES score for older adults in nursing homes was also lower (40.6 ± 23.9) than that for older people in the community or in intermediate care facilities (18.6 ± 9.0).[3] Because there was a relationship between ADLs and FES,[6] there remains a possibility that subjects with lower physical function had less fall self-efficacy. Moreover, the wide range in the standard deviation (Figure 1) of FES suggested that the individual difference in fall self-efficacy for institutionalized older adults was large.

Other than FES, no significant differences in interaction between PCS, MCS, and steps were observed between the hip protector and control group, and the number of falls and fractures also showed no significant difference.

Adherence is an important factor in the effects of hip protectors. Average hip protector adherence was 50% in a previous study[7] and 75% the present study. Cameron and colleagues[1] sought to encourage adherence using adherence nurses' visits to subjects' homes during their trial, whereas no instruction was given during the current study. Education of subjects should affect the result of this study, and without it hip protectors might not be effective.

Regarding the use of the FES for older adults, one study reported that it confirmed the internal consistency or reliability of the FES,[8] but some older adults in nursing homes may not have engaged in ADLs. If participants were unable to perform an ADL, they were asked to reply "how confident they would be to do so without falling." At such time, the subjects may not have sufficiently reflected their fear of falling. Thus, application of FES might be limited in such subjects.

CONCLUSION

No indirect effects of improvement in fall self-efficacy, QOL, and steps were observed in female nursing home residents using hip protectors.

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ONCE-DAILY MEMANTINE: PHARMACOKINETIC AND CLINICAL CONSIDERATIONS

To the Editor: The Food and Drug Administration (FDA) approved memantine in the United States in October 2003 for the treatment of moderate to severe Alzheimer's disease.[1]

The relatively long plasma elimination half-life of this drug suggests that once-daily dosing may be comparable with the current twice-daily practice. We offer a pharmacokinetic rationale for once-daily prescribing and suggest that the once-daily strategy may be comparable to traditional twice-daily dosing and improve adherence.

METHODS

The time course and accumulation to steady-state plasma concentration curves were derived for memantine 10 mg every 12 hours and for 20 mg every 24 hours. Peak, trough, and average steady-state concentrations were derived using a one-compartment model for dosing over 21 days using population pharmacokinetic parameters for a 70-kg person (Table 1).[1–3]

RESULTS

In memantine-naive subjects, the initiation of 20 mg once daily is predicted to result in an initial peak plasma concentration of 19.5 μg/L, twice that which would occur after an initial dose of 10 mg, 5 hours after ingestion. Because the elimination half-life of memantine is approximately 70 hours, steady state is reached after 2 weeks. As steady state is approached, the difference in peak plasma concentrations between 20 mg once-a-day and 10 mg twice-a-day dosing diminishes (Figure 1). The calculated steady-state peak plasma concentration (92.9 μg/L) after 20 mg once daily is only 6.7% higher than 10 mg twice daily (87.1 μg/L). Similarly, the calculated steady-state trough memantine concentration after 20 mg daily (77.0 μg/L) is only 5.3% lower than with 10 mg twice daily (81.3 μg/L). Furthermore, because of the long elimination half-life, there is only an 8-μg/L variation around the mean for 20 mg once daily, compared with a 3-μg/L variation around the mean for the 10 mg twice daily. As expected, this model is internally consistent because it predicts the same average concentrations at steady state for both regimens (85.0 μg/L for 20 mg once daily, 84.2 μg/L for 10 mg twice daily).

Table 1. Population Pharmacokinetic Parameters Used to Predict Peak, Trough, and Average Steady-State Concentrations of Memantine

Parameter	Value
Elimination half-life, $T_{1/2}$	70 Hours
Rate of elimination, k_e (= 0.693/$t_{1/2}$)	0.0099 (1/h)
Time of absorption	5 hours
Specific volume of distribution, v_d	10 L/kg
Fraction bound in plasma, b	0.45
Fraction absorbed, f	0.7

DISCUSSION

This analysis suggests that steady-state memantine therapy can be conveniently administered as a single daily dose. The small peak-to-trough steady-state variation with 10 mg twice- and 20 mg once-daily dosing schemes could be anticipated because of the inherently long half-life of elimination of 60 to 80 hours in subjects with normal renal function. In older adults, reductions in renal function will further increase its elimination half-life.[1–3] Older adults may have even smaller peak-to-trough fluctuations at steady state than the current analysis predicts.

The peak-to-trough variation derived for the twice-daily regimen assumes 12-hour dosing. In reality, patients are neither instructed nor likely to adhere to 12-hour regimens. A twice-daily dosing regimen, moreover, lends itself to lower adherence than with a single daily dose. The variation between these two drug dosing regimens, therefore, is likely to be even less in favor of 10 mg twice daily than the small differences in plasma levels that the theoretical construct predicts. Validation of the analysis requires blood sampling from patients on these two dosing schemes.

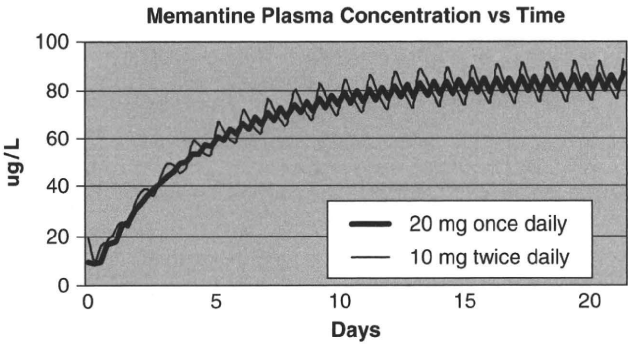

Figure 1. Calculated plasma concentrations of memantine to steady state with dosages of 10 mg every 12 hours and 20 mg every 24 hours.

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特集 サルコペニア―研究の現状と臨床への応用―

各論

10. サルコペニアに対する臨床的アプローチ

原田 敦 飛田 哲朗 奥泉 宏康

● サルコペニア
● 運動器不安定症
● ロコモティブシンドローム
● 四肢筋量
● 骨折リスク

整形外科の教科書にはまだサルコペニアは扱われておらず，臨床の場では，運動器不安定症，ロコモティブシンドロームなどの症候群に含めて対処されている．今後，サルコペニア研究がいっそう進んで，高齢になって動きが不自由になる基礎疾患という位置づけが確かなものになることが望まれる．筋肉量の臨床的評価には，全身DXA法が有用で，将来的には転倒や骨折のリスクファクターとして使用できることになることが期待される．

はじめに

サルコペニアは，「加齢に伴う筋肉量の減少と筋力の低下」と医学的には定義されるが，初期においては全く無症候であり，かなり進行した段階になって，臨床的には，「力が入らない」「転びやすい」などの主訴を自覚するようになる．しかし，「年齢のせい」と受け入れてしまい，現時点ではサルコペニアだけで受診に至る例は少ない．その姿はかつての骨粗鬆症と非常に似ている．そのようなサルコペニアを診療するためのアプローチに関して，まず整形外科での現状を説明し，次いで臨床で扱っている筋肉量評価法や補正四肢筋肉量と，転倒や骨折との関連性について述べる．

整形外科におけるサルコペニアの認識

1．教科書におけるサルコペニア

整形外科は，骨・関節・筋から構成される運動器の疾患に対して，長年にわたって診断と治療を担ってきたが，その歴史の中で，筋肉の扱われ方は，骨および関節に比して量的にも質的にも低いままに留まっている．例えば，代表的な整形外科教科書[1]をみると，基礎科学の章では，骨と関節については，構造，生化学，病態生理，損傷修復・再生が50ページ以上を割いて記述されているのに対して，筋は3ページにすぎず，疾患総論の章では，感染症，関節リウマチ，退行性関節疾患，循環障害，先天性骨系統疾患，先天異常症候群，代謝性骨疾患，腫瘍と続き，最後に神経疾患/筋疾患という項があり，筋疾患にはミオパシーとして4ページを当てて，多発性筋炎，皮膚筋炎，進行性筋ジストロフィー，周期性四肢麻痺の4疾患が説明されているだけで終わっている．全体を見渡しても，サルコペニアや筋肉減少症などの病名は全く取り上げられていない．骨粗鬆症が，代謝性骨疾患の項で，成因から，検査として二重エネルギーX線吸収測定法(dual-energy X-ray absorptiometry，以下DXA法)などによる骨量測定や骨代謝マーカー測定，診断基準，エビデンスのあ

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る薬剤治療までが詳しく説明されているのとは，対照的である．このように教科書にはサルコペニアは扱われていないが，高齢者の増加に伴って転倒をはじめとしたサルコペニアを基礎とした患者は増加の一途であるので，それに対応して，次の2つの症候群が臨床の場で提唱されている．

2．運動器不安定症

最近，定義を高齢化によりバランス能力および移動・歩行能力の低下が生じ，閉じこもり，転倒リスクが高まった状態として，わが国で日本整形外科学会が提唱して保険収載された症候群に「運動器不安定症」がある．この症候群の基礎疾患である11の運動機能低下を来す疾患には，神経・筋疾患，長期臥床後の運動器廃用，高頻度転倒者が含まれるが，サルコペニアは取り上げられていない[2]．

3．ロコモティブシンドローム

さらに，日本整形外科学会が提唱する「ロコモティブシンドローム(運動器症候群)」がある．運動器の障害による要介護の状態や要介護リスクの高い状態と定義され，①片脚立ちで靴下がはけない，②家の中でつまずいたり，滑ったりする，③階段を上るのに手すりが必要である，④横断歩道を青信号で渡りきれない，⑤15分くらい続けて歩けない，⑥2 kg程度の買い物をして持ち帰るのが困難，⑦家のやや重い仕事が困難である，のうち，1つでも当てはまれば，「ロコモティブシンドローム」の可能性があり，開眼片足立ちやスクワットなどの訓練を行うように勧めるとされている[3]．これらの病像はサルコペニアそのもののように思われるが，やはりこの病名は見当たらない．

このように，整形外科で繁用されるようになった「運動器不安定症」や「ロコモティブシンドローム」は，サルコペニアの概念と大きく重複すると考えられるが，その説明には，加齢に伴う筋肉量の減少と筋力の低下は指摘せずとも自明の前提であると考えるためか，サルコペニアという用語は使用されておらず，整形外科の臨床の場において，その認識は非常に低いままで推移しているのが現状である．今後，研究がいっそう進んで，サルコペニアが高齢になって動きが不自由になる基礎疾患という位置づけが確かなものになることが望まれる．

サルコペニアに対する筋肉量の臨床的評価

筋肉量の評価法は多数報告されており，詳細は他稿に譲るが，大きく分けると，DXA法，生体インピーダンス法，CT，MRI断面積法，四肢周囲径計測がある．

1．DXA法

これは骨密度測定で用いられている方法であり，整形外科領域では馴染み深い方法である．2種類の強さのX線を生体に照射し，それぞれの減衰率から全身身体組織の組成量を，骨塩量，脂肪量，除脂肪量の3種に分け計算することができる．DXA法により測定された組織量と実際に計測された重量とはよく一致し，内臓重量の影響を受けない上下肢においては，除脂肪量と骨格筋量がほぼ一致する．このようにして測定された上下肢の筋量を，BMIと同様の手法により，身長の2乗で割った，補正四肢筋量(appendicular skeletal mass index，以下ASMI)がサルコペニアの研究において標準的に用いられている．CTやMRIの筋肉の断面積で計測した筋量ともよく相関し[4]，正確性も高い方法であるが[5]，全身骨を測定できるDXAの装置が必要である．ただ，この方法も臨床の場では広く使用されているとはいえない．全身骨は測定時間が長く，骨粗鬆症ガイドラインなどの測定部位となっておらず，筋肉量測定は保険診療の対象ではないことなどのためと思われる．

2．生体インピーダンス法

これは家庭用体脂肪計の原理と同じで，生体に微弱な交流電気を流し，筋肉と脂肪の電気抵抗が異なる特徴を利用して筋肉量を計算する．簡便で被験者の負担が少ないが，水分量，骨量の影響を受けやすく，合併する疾患の影響を受