Differences in monthly variation, cause, and place of injury between femoral neck and trochanteric fractures: 6-year survey (2008-2013) in Kyoto prefecture, Japan

Motoryuki Horii1
Hiroyoshi Fujiwara2
Yasuo Mikami2
Takumi Ikeda3
Keichi Ueshima2
Kazuya Ikoma2
Toshiharu Shirai2
Masateru Nagae2
Yoshinobu Oka2
Koshiro Sawada3
Nagato Kuriyama4
Toshikazu Kubo2

1 Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan
2 Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan
3 Department of Rehabilitation Medicine, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan
4 Department of Epidemiology for Community Health and Medicine, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan

Address for correspondence:
Motoryuki Horii
Graduate School of Medical Science
Kyoto Prefectural University of Medicine
Kyoto, Japan
E-mail: horii@koto.kpu-m.ac.jp

Summary

Background. The incidence of femoral neck and trochanteric fractures reportedly differ by age and regionality. We investigated differences in monthly variations of the occurrence of femoral neck and trochanteric fractures as well as place and cause of injury in the Kyoto prefecture over a 6-year period.

Methods. Fracture type (neck or trochanteric fracture), age, sex, place of injury, and cause of injury were surveyed among patients aged ≥65 years with hip fractures that occurred between 2008 and 2013 who were treated in 1 of 13 participating hospitals (5 in an urban area and 8 in a rural area). The proportion of sick beds in the participating hospitals was 24.7% (4,151/16,781). Monthly variations in the number of patients were investigated in urban and rural areas in addition to the entire Kyoto prefecture. Place of injury was classified as indoors or outdoors, and cause of injury was categorized as simple fall, accident, or uncertain.

Results. There were 2,826 patients with neck fractures (mean age, 82.1 years) and 3,305 patients with trochanteric fractures (mean age, 85.0 years). There were similarities in the monthly variation of the number of fractures in addition to the place and cause of injury between neck and trochanteric fractures. Indoors (approximately 74%) and simple falls (approximately 78%) were the primary place and cause of injury, respectively. The place of injury was not significantly different by fracture type with each age group. Significantly more patients with neck fracture had “uncertain” as the cause of injury than trochanteric fracture in all age groups.

Conclusions. Based on the results of the present study, the injury pattern might not have a great effect on the susceptibility difference between neck and trochanteric fractures.

KEY WORDS: epidemiology; monthly variation; hip fracture; femoral neck fracture; trochanteric fracture.

Background

Both femoral neck (hereafter referred to as neck fracture) and trochanteric fractures are considered primary osteoporosis-related fractures, and many epidemiologic surveys treat them indiscriminately as hip fractures. However, differences in the incidences have been reported related with age (1-6) and geography (7, 8).

Our previous investigation in the Kyoto prefecture between 2008 and 2010 suggested that the incidence of trochanteric fracture was similar in urban and rural areas whereas the incidence of neck fracture had higher rate in urban areas than in rural areas (9); these results support those previously reported in Norway (10). There has been a noted increase in the incidence of neck fracture (11) compared to that of total hip fractures (12, 13) in Japan.

The differences might suggest the existence of the distinctive risk factors for each fracture. Accumulation of individual epidemiologic data for them might lead to more specific preventive measures. In this study, we focused on variation in the number of fractures, place of injury, and cause of injury by month.

Methods

Thirteen Japanese Orthopaedic Association (JOA)-authorized hospitals in Kyoto Prefecture, Japan, were involved in this retrospective, multicenter, observational study (9, 14). Five of the 13 hospitals were located in urban areas with population densities >10,000/km², while the other 8 were located in rural areas with densities of approximately 200/km² (14). The ratio of acute-care beds to the total number of beds was 19.6% (2,188/11,158) in the combined hospitals in the urban areas and 34.9% (1,963/5,623) in the combined hospitals in the rural areas.

Patients aged ≥65 years who sustained hip fractures between January 1, 2008, and December 31, 2013 and were treated at
The average age (± SD) for the entire sample was 83.7 (± 7.6)(1122/1888). The 75-84 years old, 1.11 (1301/1173); and ≥85 years old, 0.59 age group were as follows: 65-74 years old, 1.65 (403/244); overall neck/trochanteric (N/T) ratio was 0.86, and the ratios by trochanteric fracture occurred in 3,305 (53.9%) patients. The Neck fracture occurred in 2,826 (46.1%) patients, and 2013. There was a total of 6,131 hip fractures (4,977 in women, 1,006 cases in 2008, 961 in 2009, 997 in 2010, 1,012 in 2011, 1,043 in 2012, and 1,112 in 2013. The following data were obtained using registration forms from a JOA nationwide survey (9, 15): sex, age, fracture type (neck vs trochanteric), place where the fracture occurred (indoors vs outdoors), and cause of injury. The 6 categories for cause of injury on the form [in bed, simple fall, fall on stairs, traffic accident, could not be recalled, and unknown] integrated into the following 3 categories: simple fall, accidents (fall on stairs and traffic accident), and uncertain (in bed, could not be recalled, and unknown). Ages were categorized as 65-74, 75-84, and ≥85 years. The differences in the number of fractures, place of injury, and cause of injury by month were investigated in Kyoto prefecture as a whole. In addition, the differences in the number of fractures were investigated separately in urban and rural areas. The values for each month were the sum of that month for 6 years. In addition, the place and cause of injury were compared between neck and trochanteric fractures in each age group.

Ethical approval was obtained from the ethics committee of Kyoto Prefectural University of Medicine. Student's t tests were used to compare the ages between neck and trochanteric fractures. Chi-square tests were used to compare differences between neck and trochanteric fractures in place of injury, cause of injury, and number of fractures by month. A P value < 0.05 was regarded as significant. Statistical analyses were conducted with StatFlex Ver. 6.0 (Artech Co., Ltd., Osaka, Japan).

Results

There was a total of 6,131 hip fractures (4,977 in women, 81.2%) during the 6-year period: 1,006 cases in 2008, 961 in 2009, 997 in 2010, 1,012 in 2011, 1,043 in 2012, and 1,112 in 2013. Neck fracture occurred in 2,826 (46.1%) patients, and trochanteric fracture occurred in 3,305 (53.9%) patients. The overall neck/trochanteric (N/T) ratio was 0.86, and the ratios by age group were as follows: 65-74 years old, 1.65 (403/244); 75-84 years old, 1.11 (1301/1173); and ≥85 years old, 0.59 (1122/1888). The average age (± SD) for the entire sample was 83.7 (± 7.6) years. The average age (± SD) was 82.1 (± 7.6) years for patients with neck fracture and 85.0 (± 7.3) years for patients with trochanteric fracture (P = 0.0000). The proportions of patients with neck and trochanteric fractures that were women were 81.5% (2,302 patients) and 80.9% (2,675 patients), respectively. The number of total hip fractures, including both neck and trochanteric fractures, was low in summer (Figure 1). The number of new fractures varied by approximately 10% every four months: the percentages were 100.2% (from February to May), 89.1% (from June to September) and 110.7% (from October to January) respectively. The percentages of neck fracture were 100.7, 90.4 and 108.9% for each period, while those for trochanteric fracture were 99.8, 88.1 and 112.2%. In addition, the practical ratio of occurrence number was not low in February considering the fewer number of days (Table 1).

Monthly variations were more obvious in rural areas than in urban areas (Figure 2). The neck/trochanteric (N/T) ratios per month were 0.742-1.004 (average, 0.854) for the entire Kyoto prefecture (P = 0.58062), 0.962-1.355 (average, 1.107) for urban areas (P = 0.49465), and 0.616-0.889 (average, 0.727) for rural areas (P = 0.58964). The patterns of monthly variations in neck and trochanteric fractures were similar in both urban and rural areas (Figure 2). The percentages of injuries that occurred indoors varied only slightly between the months, with the lowest (70.5%) in July and highest (81.2%) in February. Patients without indication about the place of injury (not-indicated cases) were excluded. The variation in the number of indoor injury cases per month for neck fracture was similar to that for trochanteric fracture (Figure 3).

Regarding the cause of injury, the monthly variations in simple falls occurred in a parallel fashion to those of total hip fractures (Figure 4). The percentages of simple falls were between 76.6% (January) and 83.8% (August) for total hip fractures, 69.9% (March) and 80.4% (August) for neck fractures, and 79.1% (May) and 87.2% (August) for trochanteric fractures; patients without indication about the cause of injury (not-indicated cases) were excluded. The variation in the number of indoor injury cases per month for neck fracture was similar to that for trochanteric fracture (Figure 3).

Regarding the place where the fracture occurred, the percentages of fractures that occurred indoors (excluding "not-indicated" cases) were 74.9% (1,999/2,687) for neck fracture and 78.0% (2520/3231) for trochanteric fracture. The ratios of indoors were higher in proportion to the age in both fractures (Table 2). There were no differences in the place where the in-
Differences in monthly variation, cause, and place of injury between femoral neck and trochanteric fractures: 6-year survey (2008-2013) in Kyoto prefecture, Japan

Table 1 - The ratio of the number of fractures by month, based on the monthly average as well as meteorological data for each month.

<table>
<thead>
<tr>
<th>Month</th>
<th>Hip fractures</th>
<th>Neck fractures</th>
<th>Trochanteric fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>110.1</td>
<td>116.8</td>
<td>104.5</td>
</tr>
<tr>
<td>Feb</td>
<td>97.7</td>
<td>91.9</td>
<td>98.3</td>
</tr>
<tr>
<td>Mar</td>
<td>102.2</td>
<td>94.1</td>
<td>93.1</td>
</tr>
<tr>
<td>Apr</td>
<td>101.4</td>
<td>104.8</td>
<td>102.3</td>
</tr>
<tr>
<td>May</td>
<td>104.0</td>
<td>103.0</td>
<td>102.1</td>
</tr>
<tr>
<td>Jun</td>
<td>88.6</td>
<td>89.9</td>
<td>89.3</td>
</tr>
<tr>
<td>Jul</td>
<td>90.0</td>
<td>97.9</td>
<td>98.2</td>
</tr>
<tr>
<td>Aug</td>
<td>86.0</td>
<td>81.6</td>
<td>82.2</td>
</tr>
<tr>
<td>Sep</td>
<td>91.9</td>
<td>97.9</td>
<td>98.7</td>
</tr>
<tr>
<td>Oct</td>
<td>119.4</td>
<td>122.8</td>
<td>122.8</td>
</tr>
<tr>
<td>Nov</td>
<td>106.4</td>
<td>104.8</td>
<td>107.6</td>
</tr>
<tr>
<td>Dec</td>
<td>106.6</td>
<td>115.5</td>
<td>113.6</td>
</tr>
</tbody>
</table>

Table 2 - Differences in place and cause of fractures between neck and trochanteric fractures in each age group.

<table>
<thead>
<tr>
<th>Age group, y</th>
<th>65-74</th>
<th>75-84</th>
<th>84-85</th>
<th>85-89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture type</td>
<td>Neck</td>
<td>Trochanter</td>
<td>P-value</td>
<td>Neck</td>
</tr>
<tr>
<td>Neck-to-trochanteric fracture ratio</td>
<td>1.59</td>
<td>0.58</td>
<td>1.10</td>
<td>0.172</td>
</tr>
<tr>
<td>Place of injury, n (%): Indoors</td>
<td>225 (55.8%)</td>
<td>155 (63.5%)</td>
<td>871 (67.0%)</td>
<td>836 (71.3%)</td>
</tr>
<tr>
<td>Outdoors</td>
<td>160 (39.7%)</td>
<td>87 (35.7%)</td>
<td>370 (28.4%)</td>
<td>313 (26.7%)</td>
</tr>
<tr>
<td>Not indicated</td>
<td>18 (4.5%)</td>
<td>2 (0.8%)</td>
<td>60 (4.9%)</td>
<td>24 (2.1%)</td>
</tr>
<tr>
<td>Cause of injury, n (%): Simple fall</td>
<td>273 (61.7%)</td>
<td>181 (74.2%)</td>
<td>968 (78.6%)</td>
<td>955 (83.0%)</td>
</tr>
<tr>
<td>Accident</td>
<td>998 (21.7%)</td>
<td>998 (21.7%)</td>
<td>998 (21.7%)</td>
<td>998 (21.7%)</td>
</tr>
<tr>
<td>Fall on stairs</td>
<td>159 (12.2%)</td>
<td>159 (12.2%)</td>
<td>159 (12.2%)</td>
<td>159 (12.2%)</td>
</tr>
<tr>
<td>Traffic accident</td>
<td>50 (4.3%)</td>
<td>50 (4.3%)</td>
<td>50 (4.3%)</td>
<td>50 (4.3%)</td>
</tr>
<tr>
<td>Uncertain</td>
<td>23 (5.7%)</td>
<td>23 (5.7%)</td>
<td>23 (5.7%)</td>
<td>23 (5.7%)</td>
</tr>
<tr>
<td>Not indicated</td>
<td>6 (1.5%)</td>
<td>6 (1.5%)</td>
<td>6 (1.5%)</td>
<td>6 (1.5%)</td>
</tr>
</tbody>
</table>

Note: Totals do not always sum to 100% because of rounding to the first decimal place.
jury occurred between patients with neck and trochanteric fracture within each age group. The cause of injury was unknown for all of the patients whose place of injury was not indicated.

The percentages of simple falls (excluding not-indicated cases) were 77.1% (2,152/2,790) for neck fracture and 83.3% (2,732/3,278) for trochanteric fracture. More patients were in-

Figure 2 a, b - Monthly variations in the number of total hip fractures in urban (a) and rural (b) areas in the Kyoko prefecture (2008-2013). The number of total hip fractures represents the combined total of neck and trochanteric fractures.

Figure 3 - Monthly variations in the number of injuries that occurred indoors for each fracture type.
juries by simple fall in the older age groups for both fracture types. There were significantly more patients who answered with "uncertain" as the cause of injury with neck fractures than with trochanteric fractures in each age group. There were no differences in the proportions of accident as the cause of injury between the fracture types (Table 2).

Discussion

There were similarities in the monthly variation of the number of fractures in addition to the place and cause of injury between neck and trochanteric fractures. There was an interesting difference in the cause of injury between them, although it had little effect for their total numbers of occurrence. The monthly variation in hip fracture occurrence in the Kyoto prefecture was similar to that of the Japanese nationwide survey (15). The low patients number in the summer was not necessary related to the air temperature itself, but was affected more by the decreasing temperature (Table 1). A number of patients were injured indoors and by simple falls, with consistent rates throughout the year and for both types of fracture. Seasonal changes in rural life might cause greater monthly variations than in urban areas. Both neck and trochanteric fractures showed similar monthly variations not only in patients number (Figures 1, 2) but also in place and cause of injury, with no significant difference in accidents as the cause of injury. These findings may indicate that the pattern for injury was not the primary factor for the epidemiologic differences between neck and trochanteric fractures.

There was a significantly greater number of patients who had an uncertain cause of injury with neck fractures than with trochanteric fractures (Table 2); this might mean that individuals with physical complications and/or cognitive impairment are more susceptible to neck fractures.

Data regarding complications were not available in the present study, but previous studies suggest that patients who experience a neck fracture have higher body fat percentages (16), higher body mass indices (BMIs), undergone treatment for hypertension (17), and lower levels of 25(OH)D (18). Furthermore, a higher prevalence of lifestyle-related diseases, such as diabetes and hypertension in the Okinawa prefecture, is thought to be related to a high incidence of hip fractures with a relatively high N/T ratio compared with the national average in Japan (15, 19). The influence of westernization on dietary habits and dwelling environment, which is associated with the increase in lifestyle-related diseases in Japan, is considered to be higher among urban residents than among rural residents. The incidence of neck fracture is reportedly higher in urban areas than in rural areas (9, 10); therefore, neck fractures might be more strongly related to westernized living habits than trochanteric fractures.

Because of the variety and complexity of osteoporotic fractures, the precise determination of risk factors for each osteoporotic fracture might be virtually impossible (20). However, some osteoporosis patients might be susceptible to neck fractures and some to trochanteric fractures, based on the fact that contralateral hip fractures are reportedly of the same anatomical type as the primary fractures (21). Therefore, determination of characteristic risk factors for each fracture might lead to more effective prevention.

This study has certain limitations. First, data were not available for bone mineral density, height and weight, complications, and medication history. Second, the incidence of the fractures could not be examined. However, our previous study indicated that differences in N/T ratio between urban and rural locations primarily originate from the different incidences in neck fracture, not trochanteric fracture (9). Third, the survey was not conducted in all hospitals in the Kyoto prefecture. However, our previous study for three years (2008-2010) in Kyoto prefecture (9) showed that the ratio of men to women and N/T ratios for each age group were compatible with those of the nationwide annual reports of the JOA (2008-2010).

Conclusions

There were similarities in the monthly variations of the number of patients in addition to the main place (indoors) and major cause (simple fall) of injuries between neck and trochanteric fractures. There were more patients with neck fracture whose cause of injury were "uncertain" than patients with trochanteric fracture in all age groups. Factors other than injury pattern,
such as bone fragility, might have greater effect on the susceptibility difference between neck and trochanteric fractures. Further epidemiologic surveys should focus on the difference between neck and trochanteric fractures for the development of specific and effective prevention strategies.

Competing interests

The Authors declare that they have no competing interests.

Authors’ contributions

MH, HF, NK, and TK contributed to the conception and design of the study. MH, TI, KU, KS, and YO participated in the data collection. MH and NK performed the statistical analysis. MH, YM, and MN drafted the manuscript. All Authors read and approved the final manuscript.

Acknowledgements

None of the Authors reports any relevant financial conflict of interest. The Authors would like to thank the following for their invaluable help and contribution to the study by registering their interest. The Authors would like to thank the following for their invaluable help and contribution to the study by registering their interest.

Competing interests

None of the Authors reports any relevant financial conflict of interest.

References