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6.1 Introduction (Background of the Epidemiology of Osteonecrosis)

The incidence of a disease is an important parameter for epidemiological research. For example, the incidence of rheumatoid arthritis is estimated to be 23.7 cases per 100,000 person-years [1], while that of osteoarthritis in the hip joint to be 47.3–88 cases per 100,000 person-years in the United States [2, 3]. These data have been adopted to elucidate the burden, risks, and trends of the disease in a general population [1, 4].

Nontraumatic osteonecrosis (ON) of the femoral head is a pathologic process that often progresses to a subchondral collapse, following femoral head deformity and eventually resulting in hip joint destruction. Many studies have been performed to elucidate its etiology, such as the association with corticosteroid usage or alcohol abuse [5, 6]. However, regarding the incidence of nontraumatic ON in any general population, only a few detailed data are available.

6.2 Incidence of Osteonecrosis in Japan [7]

In Japan, nontraumatic ON is designated as an intractable disease by the Specified Disease Treatment Research Program, which is a subsidy program under the Japanese Ministry of Health, Labour and Welfare (secondary ON associated with femoral neck fracture, capital femoral

epiphysis, irradiation, dysbarism, or Perthes' disease is not included in this subsidy program). Based on the registration data of this program, the incidence of nontraumatic ON in Japan was calculated.

Nontraumatic ON patients who were newly identified under the Specified Disease Treatment Research Program in Fukuoka Prefecture between 1999 and 2008 were investigated. Fukuoka Prefecture continuously had populations of almost five million (5,004,276–5,050,216) in this 10-year period. The crude incidence rates were calculated as the number of nontraumatic ON patients divided by the total population of Fukuoka Prefecture.

A total of 1,244 nontraumatic ON patients were newly registered in Fukuoka Prefecture, during this 10-year period, including 758 men (61 %) and 486 women (39 %). The gender ratio (men/women) was 1.6. The mean age was 48 (17–85) years for men, and the peak age ranged in the 40s and 50s. On the other hand, the mean age for women was 56 (13–92) years, and a bimodal peak distribution was seen in their 50s and 70s. The crude incidence rate during the 10-year period was 2.58 cases per 100,000 person-years, with a range of 1.54–3.66 (Table 6.1). The age-adjusted incidence rates were 1.56–3.71 cases per 100,000 person-years, and the average of age-adjusted incidence rates was 2.51 cases. Based on the data from Fukuoka Prefecture, the number of newly registered patients with nontraumatic ON of the femoral head in Japan (population, ~120 million) was estimated to be 3,200 cases per year [7].

6.3 Other Data on the Incidence of Osteonecrosis

The Research Committee on Idiopathic Avascular Necrosis of the Femoral Head was established in 1975. The committee has reported five nationwide surveys on the prevalence

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Table 6.1 Incidence of nontraumatic ON of the femoral head per 100,000 person-years in Fukuoka Prefecture

| Age at identified | Year | | | | | | | | | | All years |
|-------------------|-------------------------------------|------|------|------|------|------|------|------|------|------|-------------|
| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | |
| | Incidence rate/100,000 person-years | | | | | | | | | | |
| –20 | 0.18 | 0.18 | 0.00 | 0.19 | 0.49 | 0.20 | 0.20 | 0.00 | 0.11 | 0.32 | 0.19 |
| 20–29 | 1.43 | 0.78 | 1.08 | 1.22 | 2.48 | 1.12 | 1.82 | 1.36 | 1.23 | 1.41 | 1.39 |
| 30–39 | 1.97 | 2.62 | 2.37 | 1.85 | 3.45 | 3.96 | 4.10 | 3.54 | 3.25 | 2.41 | 2.95 |
| 40–49 | 2.42 | 2.98 | 4.44 | 3.62 | 6.76 | 2.94 | 4.24 | 4.86 | 4.83 | 3.31 | 4.04 |
| 50–59 | 2.25 | 2.96 | 2.15 | 2.94 | 6.20 | 4.23 | 4.90 | 5.04 | 4.55 | 4.17 | 3.94 |
| 60–69 | 2.52 | 2.34 | 2.59 | 2.56 | 4.92 | 3.51 | 4.34 | 4.25 | 3.44 | 3.43 | 3.39 |
| 70–79 | 1.04 | 1.30 | 2.18 | 1.63 | 4.55 | 3.34 | 4.89 | 4.91 | 3.98 | 2.50 | 3.03 |
| 80– | 0.54 | 2.15 | 1.45 | 0.00 | 0.44 | 1.65 | 2.89 | 2.58 | 2.80 | 2.67 | 1.72 |
| Crude rate | 1.54 | 1.91 | 2.03 | 1.75 | 3.66 | 2.62 | 3.42 | 3.32 | 3.02 | 2.53 | 2.58 |
| Age-adjusted rate | 1.56 | 1.80 | 1.92 | 1.81 | 3.71 | 2.57 | 3.26 | 3.18 | 2.89 | 2.43 | 2.51 |

Reproduced from Ref. [7]

Table 6.2 Reported incidence of nontraumatic ON of the femoral head

| Population | Reference | Year of publishing | Diagnostic method | No. of people | Incidence (per 100 person-years) |
|-----------------------------|-----------------------|--------------------|-------------------|---------------|----------------------------------|
| SLE (high dose) | Nakamura et al. [12] | 2010 | MRI | 169 | 34.6 |
| | Nagasawa et al. [10] | 2005 | MRI | 45 | 31.1 |
| | Oinuma et al. [13] | 2001 | MRI | 72 | 44.4 |
| (Low dose) | Aranow et al. [14] | 1997 | MRI | 66 | 12.1 |
| Renal transplantation | Shibatani et al. [15] | 2008 | MRI | 150 | 24.7 |
| | Lopez-Ben et al. [16] | 2004 | MRI | 49 | 8.2 |
| | Kubo et al. [11] | 1997 | MRI | 51 | 25.5 |
| | Metselaar et al. [17] | 1985 | X-ray | 248 | 13 |
| Bone marrow transplantation | Torii et al. [18] | 2001 | MRI | 100 | 19 |
| Liver transplantation | Lieberman et al. [19] | 2000 | MRI | 203 | 0.48 |
| Cardiac transplantation | Bradbury et al. [20] | 1994 | MRI | 168 | 5.38 |
| Child ALL | Patel et al. [21] | 2008 | X-ray or MRI | 1,088 | 2.9 |
| | Arico et al. [22] | 2003 | N/A | 1,421 | 1.6 |
| Sickle cell disease | Milner et al. [23] | 1993 | X-ray | 2,524 | 2.92 |
| | Milner et al. [24] | 1991 | X-ray | 2,590 | 2.88 |
| HIV | Morse et al. [25] | 2007 | MRI | 239 | 0.65 |
| | Ho et al. [26] | 2007 | N/A | 967 | 0.34 |
| Neurosurgical patients | Wong et al. [27] | 2005 | MRI | 1,352 | 0.1 |
| General | Yamaguchi et al. [7] | | X-ray and MRI | Five million | 0.00258 |

Reproduced from Ref. [7]

of ON in Japan, which showed an annual increase. The prevalence was 6,700–8,200 (95 % confidence interval) in 1994 [8] and 10,100–12,800 (95 % confidence interval) in 2004 [9].

Previously, the incidence of nontraumatic or steroid-associated ON has been reported in disease-limited populations, such as systemic lupus erythematosus (SLE), organ transplantation, and sickle cell disease. Those reported data are summarized in Table 6.2. For example, in SLE patients, an MRI study showed the incidence of ONFH to be 31.1 % (14 of 45 patients) in 1 year [10], while in renal allograft recipients, osteonecrotic changes on MRI have been detected in 25.5 % of the patients (13 of 51 patients) [11].

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