Review article

Incidence and etiology of lumbar spondylolysis: review of the literature

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Abstract

Background. Lumbar spondylolysis is a defect of the pars interarticularis known to occur as a stress fracture. Its incidence varies considerably depending on ethnicity, sex, and sports activity. However, there are few literature reviews describing its incidence in different ethnic groups or in people who engage in different sports.

Methods. We reviewed the most relevant articles on spondylolysis published in scientific journals. First, we focused on its incidence in various ethnic groups distributed by sex, the familial occurrence, and in patients with relevant diseases. Second, we focused on the incidence of spondylolysis in relation to the sports practiced by the patients. Although placing special emphasis on the incidence of lumbar spondylolysis in the general population in Japan, we also reviewed the Japanese and English literature to investigate its incidence among those who engage in different sports.

Results. The incidence of lumbar spondylolysis in the general Japanese population was 5.9%. Most studies report that the incidence in higher in male subjects than in female subjects. We found that Japanese rugby and judo players were prone to suffer lumbar spondylolysis, at an incidence of about 20%. However, the incidence for Japanese professional soccer and baseball players was much higher, at 30%, which was more than five times the incidence in the general Japanese population.

Conclusions. The incidence of lumbar spondylolysis varies depending on ethnicity, sex, family history, relevant disease, and sports activity.

Introduction

Lumbar spondylolysis is a defect of the pars interarticularis that is known to occur as a stress fracture. Its incidence varies considerably depending on ethnicity, sex, and sports activity. However, there are few literature reviews describing its incidence in different ethnic groups or in subjects who engage in different sports. Especially, there are few review articles on its incidence in the general Japanese population. In this review of the Japanese and English literature, we focus on the incidence of lumbar spondylolysis in various ethnic groups distributed by sex and in patients with relevant diseases. We also focus on its incidence in subjects who engage in various sports.

Incidence of lumbar spondylolysis in various ethnic groups

The incidence of lumbar spondylolysis has been estimated to be approximately 6% in the general population. However, the incidence varies considerably according to ethnicity and sex. Furthermore, it differs depending on the method used in the analysis. Therefore, we reviewed the studies using three methods: skeletal study, plain radiography, and computed tomography.

Skeletal study

Japanese population

Hasebe found the incidence was 5.5% (7/125 skeletons) in 1912. Matsui et al. analyzed 233 skeletal bodies and reported an incidence of 5.6%. Furthermore, they found that the incidence in male subjects was twice that in female subjects. Interestingly, Suzuki examined human skeletons found at eight prehistoric Jomon sites in Japan and reported an overall incidence of 12.5% (10.9% in males, 14.6% in females).

Other ethnic groups

In a study of 4200 skeletal bodies, Roche and Rowe found that the incidence of spondylolysis differed by race and sex (white men 6.4%, African-American men 2.8%, white women 2.3%, African-American women...
Eisenstein examined 485 skeletons of adult South African “whites” and “Africans” of both sexes and reported its overall incidence was 3.5% (white men 3.8%, African men 3.5%, white women 5.7%, African women 2.6%). In Guam, Arriaza found 21% (men 29.4%, women 14.3%) of prehistoric human remains showed spondylolysis. A very high incidence (14%–45%) was also reported in skeletons from Alaska and Canada. The highest incidence was reported in Native residents in Greenland (overall 54%, men 61.9%, women 48%) by Simper.

Plain radiography study

Japanese population
Using plain radiograph films from 5000 medical examinations, Takahashi et al. found the overall incidence of spondylolysis was 3.8%, including 2.5% spondylolysis and 1.3% isthmic spondylolisthesis. Ogata et al. examined plain radiographs from 1918 orthopedic outpatients complaining of low back pain and/or leg pain and reported an 8.8% incidence of spondylolysis. Okuda et al. reported 4.3% incidence of spondylolysis in patients with osteoarthritis of the hip. Akimoto examined 1979 plain radiographs from adolescent outpatients and reported the incidence of spondylolysis was 3.2% in the “nonsports” group and 10.3% in the “sports” group. The difference between the two groups was statistically significant.

Other ethnic groups
Using plain radiographs, Fredrickson et al. performed a prospective study in the United States that involved 500 unselected first-grade children. They reported that the incidence of spondylolysis at the age of 6 years was 4.4% and increased to 6% in adults. Sonne-Holm et al. studied 4001 adults using lateral radiographs of the lumbar spine and reported that the incidence of spondylolysis was 4.6% in the Caucasian cohort. Amato et al. examined 1500 plain radiographs and found that the incidence of spondylolysis was 3.7%.

Furthermore, the incidence of spondylolysis was found to vary according to the occupation of the subjects. Libson et al. examined plain radiographs of 1598 male soldiers and found the overall incidence of spondylolysis was 9.7%. Weil et al. examined 3988 police officers using lumbar radiographs and found that its incidence was 4%.

Computed tomography study

Japanese population
We reviewed the computed tomography (CT) scans of 2000 subjects (age 20–92 years) who had undergone abdominal and pelvic CT on a single multidetector CT scanner for reasons unrelated to low back pain. Lumbar spondylolysis was found in 117 subjects (5.9%) (Table 1). The male/female ratio was 2:1. Multiple-level spondylolysis was found in five subjects (0.3%). Among the 117 subjects, there were 124 vertebrae with spondylolysis. Of them, 112 (90.3%) corresponded to L5, and 26 (21.0%) had unilateral spondylolysis. Of 124 vertebrae with spondylolysis, 75 (60.5%) showed low-grade (Meyerding grade I or II) spondylolisthesis. No subjects presented with high-grade spondylolisthesis. Spondylolisthesis was found in 74.5% of the subjects with bilateral spondylolysis and in 7.7% of those with unilateral spondylolysis.

Table 1. Incidence of lumbar spondylolysis in the general Japanese population

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Spondylolysis/total no. of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>78/991 (7.9%)</td>
</tr>
<tr>
<td>Women</td>
<td>39/1009 (3.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>117/2000 (5.9%)</td>
</tr>
</tbody>
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Lumbar spondylolysis in patients with relevant diseases

Spina bifida occulta
Spina bifida occulta (SBO) has been considered a benign entity of no clinically significant importance. However, there are several studies that support a positive association between SBO and spondylolysis. Sairyo et al. performed a biomechanical study using a finite element model (FEM) of the lumbar spine and demonstrated that SBO does not alter lumbar biomechanics with respect to stress and range of motion. The high coincidence of spondylolysis in spines with SBO may not be due to mechanical factors but to genetic factors. We first reported the positive association between SBO and spondylolysis in Japan and found that the incidence of spondylolysis was significantly higher in patients with SBO than in those without SBO (odds ratio was 3.7-fold).

Osteopetrosis
Osteopetrosis is a skeletal disorder characterized by defective bone resorption related to dysfunctional