

# THE PREVALENCE OF SPONDYLOLYSIS AND SPONDYLOLISTHESIS IN SYMPTOMATIC ELITE ATHLETES: RADIOGRAPHIC FINDINGS

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## Summary

**Purpose:** to assess radiographically the prevalence of spondylolysis and spondylolisthesis in symptomatic athletes from plain radiographs.

**Methods:** a retrospective analysis was conducted on the plain radiographic lumbar spine series of 4243 male and female athletes with symptoms relating to the lumbar spine.

**Results:** the study showed that 590 athletes (13.90%) had a radiological diagnosis of spondylolysis with concomitant spondylolisthesis in 280 of these (47.45%).

**Conclusions:** high prevalence of spondylolysis in athletes with low back pain compared with the general population suggests that it would be good practise to include a radiological examination of the lumbar spine in symptomatic athletes engaged in sports who are considered to be at risk in the light of this and other studies.

**Key words:** low back pain, stress fracture, sport injury.

## Introduction

Several studies in orthopaedic, sports medicine and radiological literature, emphasised that the incidence of spondylolysis is higher in symptomatic athletes than in the general asymptomatic nonathletic population where the pars interarticularis defect is estimated to occur in approximately 3-5%. [1-3] Several authors highlighted the causative relationship between sport and lysis, stating the importance of mechanical factors. [4-7]

Wiltse et al. described five different types of spondylolysis and spondylolisthesis: [1] dysplastic, [2] isthmic, [3] degenerative, [4] traumatic, [5] pathologic; the isthmic variety with the subtype A (lithic) is the most common and important in the athletes. [8]

Radiographically, spondylolysis is usually demonstrated most accurately on 45° oblique views of the patient and 20° cephalad angulation of the central x ray beam; in this a typical "Scottie dog" appearance is produced. The pars interarticularis defects are demonstrated as uni- or bilateral radiolucent areas with or without associated reactive sclerosis. [9]

Although much debate has arisen in the past regarding the true nature of spondylolysis, many authors have attributed this condition to repeated loading in hyperflexion and hyperextension of the spine, causing a stress fracture of the pars interarticularis. This may heal or, more commonly, progress to pseudoarthrosis. [10-12]

It has also been reported that pars defects occur frequently in athletes participating in sports such as diving, weight-lifting, wrestling and gymnastics, thus supporting the current opinion that physical forces are major factors in its production. [13-21]

The purpose of our study was to ascertain the incidence of the pars defects as demonstrated radiographically in a symptomatic elite athletic population.

## **Methods**

A review was conducted of 4243 full series on each individual patient standing with plain radiographs of the lumbar spine including antero-posterior (AP), lateral and oblique views, from male and female athletes aged 15-27, referred to the Italian Olympic Committee's Sport Science Institute, between 1962 and 1998. All the images were interpreted by the senior author (FR) during the last 36 years. All the athletes who underwent radiography, suffered from low-back pain (interfering with sports activities) either acute in onset or chronic with acute exacerbation. In cases of uncertainty these views were complemented by oblique tomography; (accurate gonadal protection was applied).

In 19 cases, flexion and extension views were taken to demonstrate mechanical instability or spondylolisthesis.

The Meyerding method has been used for grading the amount of anterior displacement of the vertebral body; this method consists of dividing the superior end-plate of the sacrum or vertebral body into four equal quarters and grading the degree of slip of the posterior aspect of the displaced vertebrae one to four. [22]

A grade 1 spondylolisthesis is present when the posterior aspect of the displaced vertebral body lies between the posterior aspect of the sacrum and the first of the four divisions.

## **Results**

The study demonstrated that 590 of the 4243 athletes (13.90%), had a radiological diagnosis of spondylolysis, with an overall greater prevalence of the injury in men (484 men, 106 women; ratio 4.5:1). (Table 1)

Concomitant spondylolisthesis was found in 280 cases (47.45%) with grade I forward displacement in 75.5% (211 patients), grade II displacement in 23.21% (65 patients), and grade III displacement in 1.43% (4 patients). No patient in the study had a grade IV spondylolisthesis.

The isthmic lesions were most commonly found in the 5<sup>th</sup> lumbar vertebra (L5) segment (81.01%) (Fig.1), followed by lumbar vertebra 4 (L4) (14.40%), lumbar vertebra 3 (L3) (2.54%), lumbar vertebra 2 (L2) (1.70%) (Fig.2) and lumbar vertebra 1 (L1) (0.34%) (Fig.3). (Table 2)

In 561 cases (95.08%) only one segment was involved, in 27 cases (4.58%) pars defects were demonstrated at 2 levels, and in 2 patients (0.33%) there were pars defects at three levels. (Fig.4)

Spondylolysis was bilateral in 509 cases (86.27%) and unilateral in 81 cases (13.72%). (Fig.5)

Flexion and extension views, with the subject standing, did not demonstrate any instability of one vertebra on another or changes in angulation.

### **Discussion**

Lumbar spondylolysis is considered to be an acquired lesion, universally recognised as a fatigue fracture of the pars interarticularis, provoked by high static and dynamic sectorial stresses.

The diagnosis of spondylolysis can be made by different imaging modalities including plain radiographs, bone scan, computed tomography (CT) scan or magnetic resonance imaging (MRI).

According to recent Royal College of Radiologist guidelines, plain radiographs of the lumbar spine are not "routinely indicated" in the clinical setting of acute or chronic low back pain, except in the younger population where clinical suspicion of spondylolysis is higher. [23]

Although plain radiographs may be all that is required for diagnosis, Teplick et al. found an incidence of spondylolysis on CT of 5.4%, which was not observed on plain radiographs, even in retrospect. [24]

Congeni et al. performed CT scans on a group of 40 athletically active young people with back pain, who had normal radiographs (including oblique views) and positive bone scans. The CT showed chronic, non-healed fractures of the pars in 18 subjects (45%), acute fractures in various stages of healing in 16 (40%) and no obvious fractures in 6 patients (15%). The authors state that CT scan with reverse gantry angle cuts gives good visualization of pars defects.

Pars defects may be difficult to diagnose using the regular lumbar spine technique because the plane of the slice may be parallel to the fracture. [25]

Bone scintigraphy has been used in the past for evaluation of low back pain, because of its high sensitivity to alterations of bone metabolism, depicted as areas of increased radionuclide uptake.

Single photon emission computed tomography (SPECT), however, is more sensitive in depiction of metabolic changes in bone than planar scintigraphy and can yield more information in patients with spondylolysis. Lusins et al. however, in 1994, stated that SPECT scan is positive in acute spondylolysis but as pars defect becomes chronic the SPECT scan tends to appear normal even though healing of the spondylolysis has not occurred. [26-27]

Goldstein et al. in 1991 compared three groups of top level female gymnasts to a similar group of National calibre female swimmers; MRI scans of each participant were used to demonstrate disc or bony abnormalities. The authors stated that osseous abnormalities, including posterior elements fractures, may be visualised on MRI although it is likely that CT may be more sensitive in the evaluation of pars interarticularis fractures. [28]

It is widely accepted that MRI offers the most comprehensive evaluation of the lumbar spine, excluding more sinister pathology as malignancy or infection, and demonstrating degenerative disc disease, facet joint arthropathy, spondylolysis, spondylolisthesis and other causes of back pain. [29-31].

However, views are mixed on whether MRI can adequately demonstrate pars defects [32-34]. Spondylolysis can be difficult to identify on MR and there is a

high associated false positive rate [35]. CT allows better visualization of bony detail and when performed with reverse-gantry angle and thin sections, is the imaging modality of choice for identifying spondylolyses.

The results of our study confirm the high incidence of spondylolyses demonstrated radiographically in athletes with low back pain (13.9%) but probably the addition of different imaging modalities would increase this value. Spondylolyses were more commonly seen in sports characterised by forceful and repetitive hyperextension-hyperflexion and /or rotation of the lumbar spine; according to Table 1, this suggests that the actions of certain sports (especially in the first ten listed sporting activities) may predispose athletes to develop stress fractures of the pars interarticularis.

In summary, we recommend a radiological examination of the lumbar spine in symptomatic athletes who are considered to be at high risk of developing a spondylolysis, in agreement with other studies. [36]

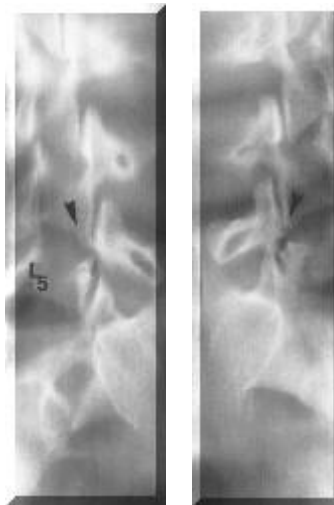
**Table 1 - The prevalence of spondylolysis in different sports and athletic populations presenting with low back pain**

Sport	No. Athletes	Spondylolysis	% with Spondylolysis
Diving	57	23	40.35
Wrestling	80	20	25
Weight Lifting	112	25	22.32
Modern Pentathlon and Triathlon	54	11	20.37
Track/field	353	61	17.28
Sailing	128	22	17.18
Gymnastics	673	112	16.64
Football	400	65	16.25
Skiing	154	25	16.23
Judo and martial arts	64	10	15.62
Bobsleighbing	36	5	13.88
Cycling	95	13	13.68
Fencing	143	19	13.28
Tennis	306	36	11.76
Canoeing	69	8	11.59
Water skiing	18	2	11.11
Boxing	27	3	11.11
Water polo, swimming, syncro.	307	34	11.07
Rugby	65	7	10.76
Volleyball	150	16	10.66
Shooting	76	8	10.52
Basketball	174	17	9.77
Luge	25	2	8
Rowing	246	19	7.72
Ice and field hockey	170	13	7.64
Handball	42	3	7.5
Ice skating	42	3	7.14

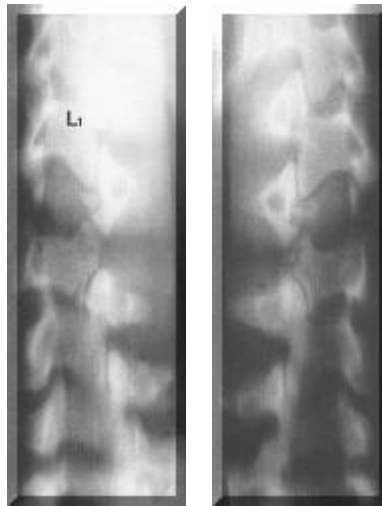
Equestrian	83	5	6.02
Golf	38	2	5.26
Baseball	21	1	4.76
Archery	26	0	0
Motorcycling	8	0	0
Table tennis	1	0	0
	4243	590	13.90

**Table 2 - Location of spondylolytic lesions in the athletes in this study, compared with the findings by Soler and Calderon [36] in Spanish elite athletes**

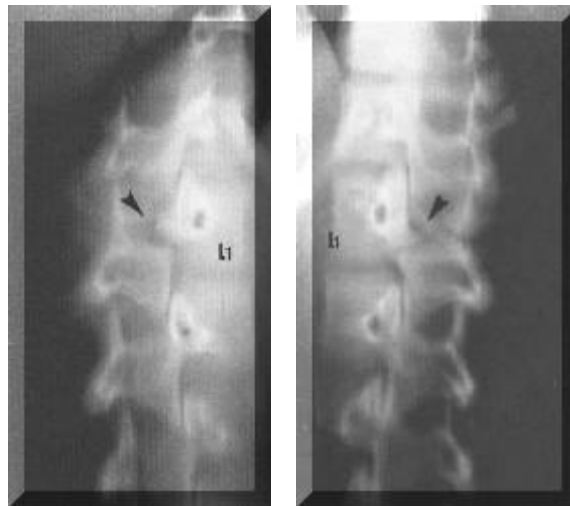
Level	Present Study		Soiler and Calderon [36]	
	n	%	n	%
L5	478	81.01	220	84.29
L4	84	14.40	31	11.88
L3	15	2.54	5	1.91
L2	10	1.70	2	0.77
L1	2	0.34	1	0.38
S1	-	-	2	0.77



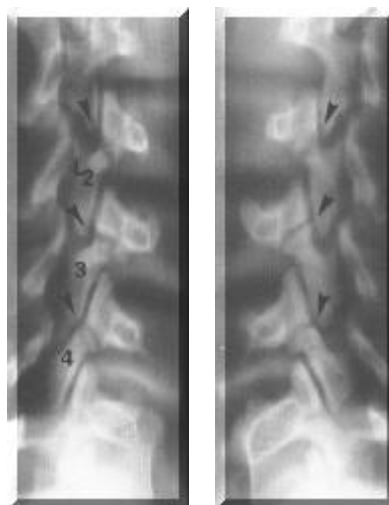
**Fig.1 - Oblique tomography showing bilateral isthmic defects of lumbar vertebra 5 (L5)**



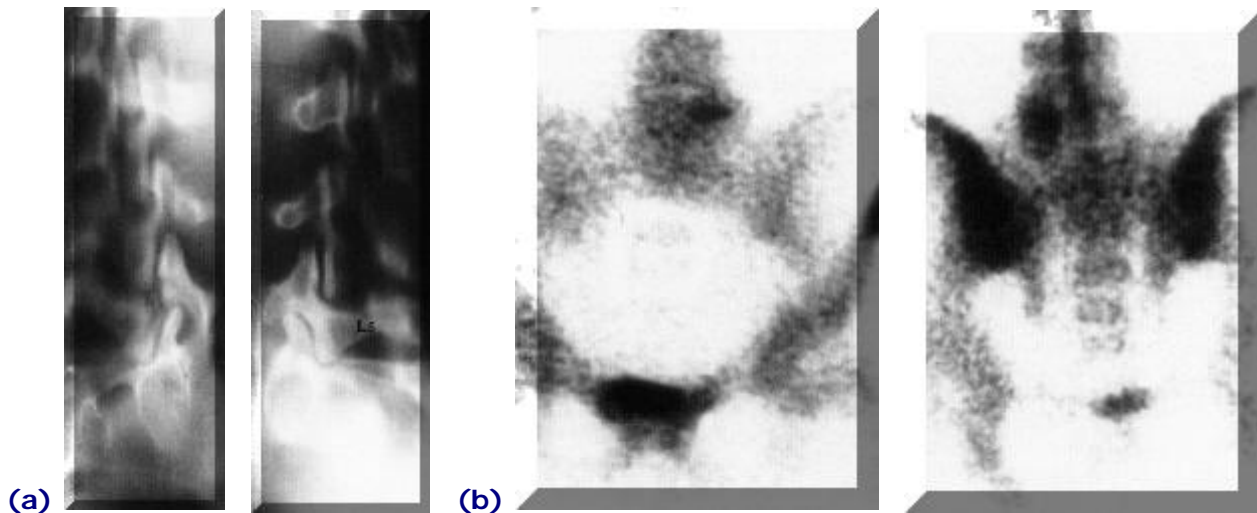
**Fig.2** -Oblique tomography showing bilateral L2 isthmic defects with interposed free articular fragments.



**Fig.3** - Oblique tomograms: bilateral L1 isthmic defects.



**Fig.4** - Oblique tomography with three levels (L2 – L3 – L4) of isthmic defects.



**Fig.5** - (a) Oblique tomography with unilateral left pars defect of L5 and isthmic sclerosis on the right; (b) bone scintigraphy of the same case with increased radionuclide activity in the left L5 isthmus.

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