Skeletal Radiol (2010) 39:669–673
DOI 10.1007/s00256-009-0825-4

SCIENTIFIC ARTICLE

Lumbar spine spondylolysis in the adult population: using computed tomography to evaluate the possibility of adult onset lumbar spondylosis as a cause of back pain

Benjamin K. Brooks · Samuel L. Southam · Gary W. Mlady · Jeremy Logan · Matthew Rosett

Received: 17 July 2009 / Revised: 15 October 2009 / Accepted: 26 October 2009 / Published online: 13 November 2009

Abstract
Objective To determine if new onset of low back pain in adults could be secondary to lumbar spondylolysis by establishing the age-related prevalence in the general population by examining patients undergoing computed tomography (CT) for reasons unrelated to back pain.
Materials and methods The records of 2,555 patients who had undergone abdominal and pelvic CT in 2008 were reviewed electronically. In order to determine a true representation of the general population, we reviewed all indications for CT, excluding patients with a primary complaint of low back pain as the primary indication for imaging. Equal numbers of patients were separated into age groups by decade to ensure an even distribution of ages for statistical analysis. Patients older than 70 years were grouped together to provide case numbers comparable to those of the other decades. Logistic regression analysis was performed to evaluate the significance of the results. Three board-certified radiologists, including two musculoskeletal fellows and a radiology resident, retrospectively evaluated CT scans for lumbar spondylolysis, including unilateral and bilateral defects.
Results Of the 2,555 cases evaluated, there were 203 positive cases of defects of the lumbar pars interarticularis. This corresponded to an overall prevalence of 8.0%. Prevalence per decade was fairly evenly distributed and ranged from 7.0%(ages 30–39 years) to 9.2% (ages 70 years and above). Prevalence of ages 20–49 years was 7.9%, and that of ages 50 years and older was 8.0%. Male to female ratio was 1.5:1. Logistic regression showed no significant increase in spondylolysis based on age.
Conclusion No significant increase in the prevalence of lumbar spondylolysis was demonstrated in patients older than 20 years. This suggests that the development of symptomatic lumbar pars defects do not occur in this population and should not be considered as a rare but potentially treatable cause of new onset low back pain in adults. This study demonstrated an overall prevalence of pars defects of 8.0% in our population. As demonstrated in previous studies, the male to female ratio of 1.5:1 was a statistically significant difference.

Keywords Spondylolysis · Pars interarticularis defect · Spondylolisthesis · Computed tomography

B. K. Brooks (✉) · S. L. Southam · G. W. Mlady · J. Logan · M. Rosett
Department of Radiology,
University of New Mexico School of Medicine,
MSC10 5530,
Albuquerque, NM 87131-0001, USA
e-mail: BBrooks@salud.unm.edu

S. L. Southam
e-mail: SSoutham@salud.unm.edu

G. W. Mlady
e-mail: GMlady@salud.unm.edu

J. Logan
e-mail: JLogan@salud.unm.edu

M. Rosett
e-mail: MRosett@salud.unm.edu

Introduction

Lumbar spondylolysis is a commonly encountered entity classically described as developing in childhood or adolescence through increased stress on the pars interarticularis from bipedal locomotion or certain activities that exaggerate those stresses [1, 2]. The prevalence of lumbar spondylolysis varies between studies. A defect of the pars interarticularis has been reported in only one infant [3].

Spondylolysis occurs in children after they are able to walk, but rarely before they are 5 years old [3]. The lesion is more common at the age of 7 years or 8 years [3]. The development of the defect can be painful, but low back pain after the completion of the fractures has not been shown to correlate with the presence of spondylolysis [4].

Although spondylolysis has been well studied in the symptomatic population, few studies have attempted to demonstrate its significance in adults. A recent study using lateral plain film radiographs suggests that lumbar spondylolysis can develop in adulthood [5]. Limitations of the study, as described by its authors, included the use of a single lateral radiograph, which is less sensitive than computed tomography (CT) for unilateral or early non-slipped defects [6]. One large study that evaluated spondylolysis with CT in adults, has been performed, but the relationship between age and prevalence was not established [7]. In our practice, we had been subjectively identifying a high prevalence of pars defects which appeared to increase with age. We hypothesized that pars defects could be acquired during adulthood and that the development of spondylolysis should be considered as a cause of new onset low back pain in adults. If recognized during its development, this could represent a potentially treatable cause of new onset back pain in adults. Our aim was to establish the prevalence of lumbar spondylolysis in the general adult population and to evaluate whether there was a significant correlation between age and prevalence.

Materials and methods

Patients The research protocol, which complied with the US Health Insurance Portability and Accountability Act (HIPAA), was approved by the institutional review board, and a waiver of informed consent was granted. This retrospective study included patients who had undergone CT between July 2008 and November 2008. To ensure the most accurate representation of the general adult population, we selected patients that met the following criteria: over the age of 20 years at the time of imaging and any CT examination including the lower lumbar spine and lumbosacral junction. For this study, we considered as adults those patients that were 20 years or older at the time of imaging. Patients with low back pain as the primary indication for the CT examination were excluded, to prevent result bias. The patient list was generated by the radiology interface system to search the database for cases to meet the above requirement. Both inpatients' and outpatients' data were evaluated. Some of the most common primary indications for imaging included trauma, abdominal pain, and cancer staging/follow up. These indications were assumed to be random, unrelated to the presence or absence or lumbar spondylolysis, and would allow evaluation of the spine regardless of whether the patient did or did not have low back pain at the time of imaging. The patient population was chosen to have near equal numbers of subjects in each decade range over 20 years so that there was similar power for each age group. Initially, 2,609 patients were chosen for the study so that sufficient power would be provided to differentiate significantly between a hypothetical prevalence of 3% in the younger half of the group and 5% in the older half (using the Fisher exact test). Of the 2,609 patients, 2,555 were included in the final group; the other 57 cases did not allow sufficiently adequate evaluation of the lumbar spine for us to confirm the presence or absence of spondylolysis. Some of the most common reasons for inadequate visualization included severe degenerative disease that obscured the pars interarticularis and prior lumbar spine surgery with hardware obscuring the images.

Scanning parameters CT was performed on one of three 16-multi-detector computed tomography (MDCT) machines (two Siemens Sensation and one Siemens Emotion) or a dual source 64-MDCT (Siemens Definition) system. Scanning was performed with or without the administration of contrast agents, based on the primary indication of the study. Because the images were obtained from patients with different indications and by different protocols, the axial slice thickness varied from 0.75 mm to 3 mm. Trauma-related studies were accompanied by sagittal and coronal two-dimensional (2D) bone algorithm reconstructions or the lumbar spine (2 mm thickness).

Data acquisition All CT scans were reviewed by one of three board-certified radiologist (G.M., a musculoskeletal radiologist with 10 years of experience, S.S. and J.L., musculoskeletal fellows with 6 years of radiology experience) or a 4th year radiology resident (B.B.). Images were reviewed on a secure-access picture-archiving communication system (PACS) (Philips Sectra). Axial images were initially reviewed. Sagittal reconstructed images were reviewed in cases of uncertainty based on the axial images alone. If not available on the primary examination, sagittal 2D reconstructions were performed on the workstation at the time of interpretation. All examinations were evaluated for the presence or absence of lumbar pars interarticularis defects, the level of the defect, and whether the defect were bilateral or unilateral. Both bilateral and unilateral spondylolysis were scored as positive, and age and gender of each patient was recorded.

Statistical analysis All statistical analyses were preformed with SAS software (version 9.2). Data graphing and display were performed with software [R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria). Logistic regression analysis was used to

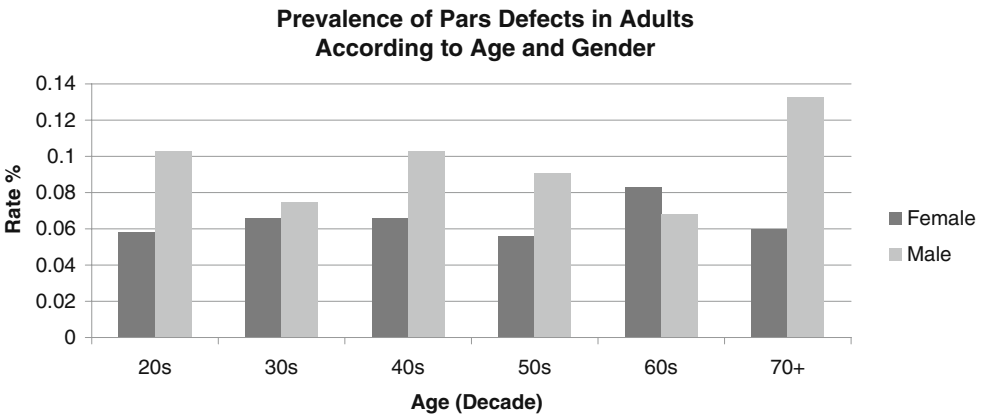

Fig. 1 Prevalence of spondylolysis per decade by gender

demonstrate the significance of the probability of lumbar spondylolysis in the population studied. A *P* value less than 0.05 was considered to be statically significant.

Results

A total of 2,555 patients were examined and had the following distribution: 1,282 men, 1,273 women, 433 aged 20–29 years, 426 aged 30–39 years, 428 aged 40–49 years, 428 aged 50–59 years, 426 aged 60–69 years, and 414≥ 70 years of age. Within this population, 203 positive cases of lumbar spondylolysis were demonstrated. This corresponded to a prevalence of 8.0% across the studied adult population. Prevalence per decade was fairly evenly distributed, ranging from a low of 7.0%(for ages 30–39 years) to a high of 9.2% (≥70 years). Spondylolysis prevalence in ages 20–49 years was 7.9%, and, in ages 50 years and older, it was 8.0% (Fig. 1). Male to female prevalence was 9.4% to 6.5% (*P*= 0.00473). Because the difference between male and female prevalence was statically significant, these two groups were considered individually for age and prevalence analysis. Logistic regression curves with 95% confidence bands were generated for both men and women, showing no statistically significant difference in the prevalence of lumbar spondylolysis based on age (Figs. 1 and 2). The female odds ratio comparing spondylolysis with age was 1.004 (0.991–1.016 95% Wald confidence limit) and the male odds ratio was 1.004 (0.993 to 1.014 Wald confidence limit) (Figs. 3 and 4).

Discussion

This is the largest CT-based study of the prevalence of lumbar spondylolysis across the adult population to date.

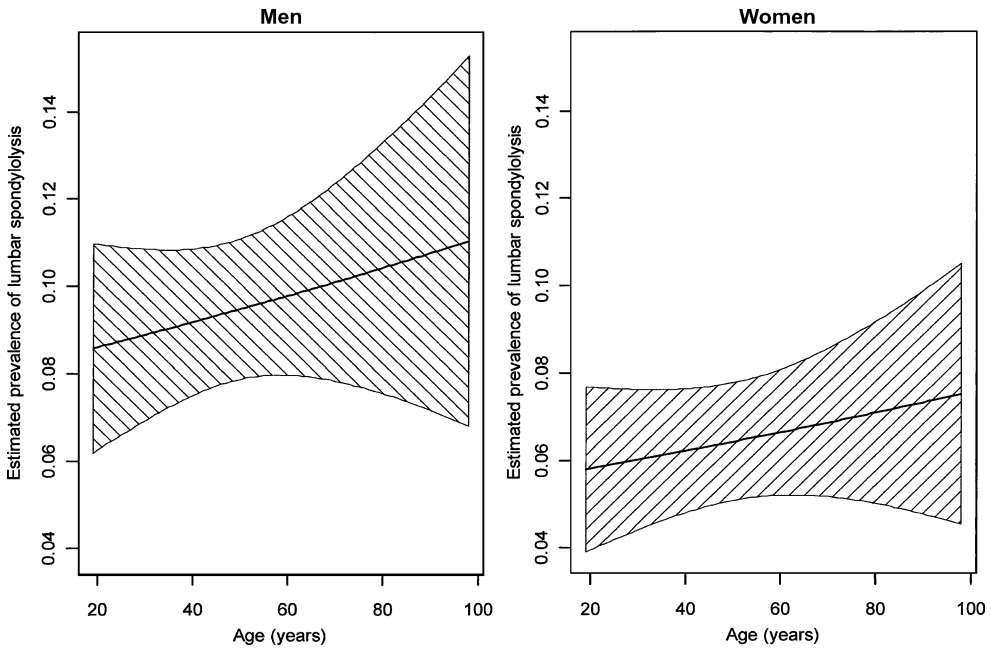

Fig. 2 Logistic regression curves with 95% confidence bands for men and women show no significant change in the rate of spondylolysis

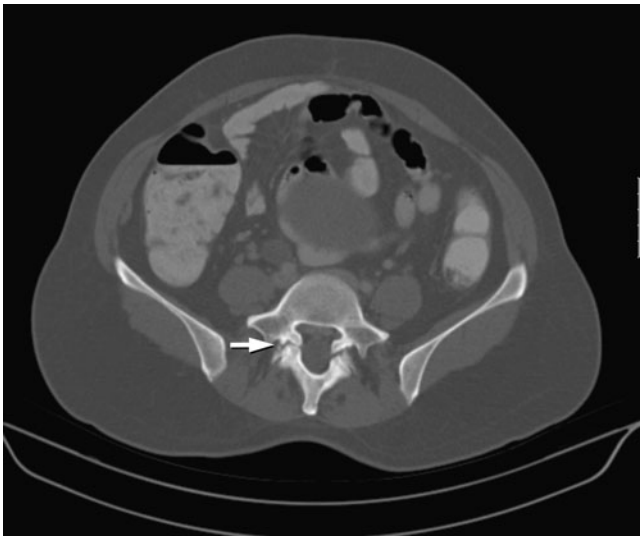

Fig. 3 Bilateral L5 spondylolysis, with an *arrow* delineating the pars defect

The study failed to support our hypothesis that lumbar spondylolysis would increase with age. Even though some patients showed unilateral pars defects with contralateral pars sclerosis, suggesting active developing defects, this appeared to be fixed, as the prevalence was not significantly different between older or younger patients. These findings differ from those of the large plain film-based study by Sonne-Holm et al., which demonstrated age-related differences in lumbar spondylolysis [5]. There are two possible explanations for the difference. The study by Sonne-Holm et al. provided sufficient power to differentiate L4 and L5 levels by age and gender [5]. Our study included all lumbar levels together, in order to provide enough power to demonstrate a difference as small as 2%. The use of CT in our study allowed better evaluation of unilateral lesions and lesions with no listhesis, both potentially missed on single lateral-view lumbar radiographs. Our study excluded patients for whom, on the images, the anatomy of the pars interarticularis had been obscured by prior surgery or by severe degenerative change. It is possible that lumbar spondylolysis was present but obscured by severe facet hypertrophy or by hardware. However, Sonne-Holm et al. excluded all patients with a prior history of back surgery, and plain films are no more sensitive than CT images for the evaluation of pars defects in the setting of severe degenerative changes [5, 6]. The development of spondylolysis has been shown to correlate with symptoms, but the mere presence of spondylolysis does not [3, 4]. We hypothesized that lumbar spondylolysis could develop in adults, as suggested by Sonne-Holm and colleagues, and should be considered as a possible cause of new onset of back pain in adults, which could be corrected either conservatively or surgically [5]. Our findings did not support our hypothesis or the findings by Sonne-Holm et al. [5].

Our overall and gender-specific prevalence of lumbar spondylolysis was similar to that found in prior studies. The male to female ratio was 1.5:1, with a prevalence of 9.4% to 6.5%, respectively. A previous CT-based study demonstrated a prevalence of 5.7% and a male to female ratio of 2:1 [7]. Fredricksen et al. reported an incidence of pars defects in 6-year-old children of 4.4% [8]. The same patients demonstrated an incidence of 6.0% at adulthood. The male to female ratio for that study was 2:1. Harvey et al. demonstrated an incidence of 4–8% in the general population, and Leone et al. reported an incidence of spondylolysis of 6% in the general population [9, 10]. Rauch and Jinkins reported an incidence ranging from 3–10% [11]. Their reported male to female ratio ranged from 2:1 to 4:1 [11]. The above referenced studies, excluding that by Belfi et al., were performed with plain film radiography [7].

Our findings confirmed the presence of a male predominance of spondylolysis, although not as great as in other series. Among both men and women in our population the prevalence of spondylolysis remained unchanged with increasing age.

Conclusions

Despite recent plain film findings suggesting that lumbar spondylolysis occurs during adulthood and should be considered as a potential treatable source of adult onset back pain, we found no significant change in the age-related prevalence in adulthood using a more sensitive imaging modality.

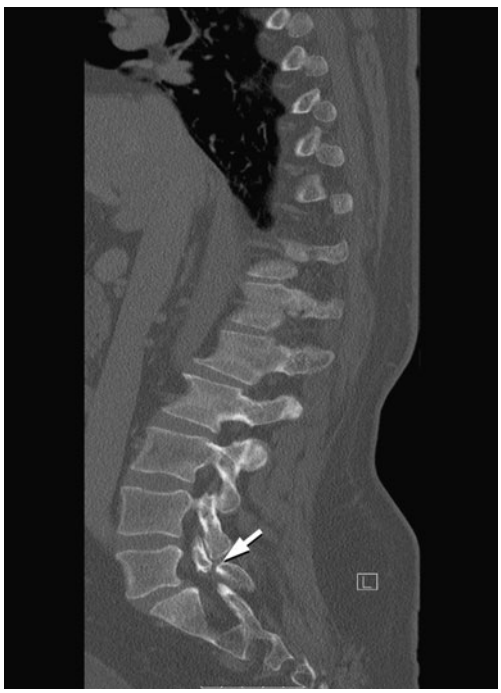

Fig. 4 Sagittal reconstruction, L5 pars defect with an *arrow* delineating the defect

References

1. Iwamoto J, Abe H, Tsukimura Y, Wakano K. Relationship between radiographic abnormalities of lumbar spine and incidence of low back pain in high school rugby players: a prospective study. Scand J Med Sci Sports. 2005;15:163–8.
2. Lundin DA, Wiseman DB, Shaffrey CI. Spondylolysis and spondylolisthesis in the athlete. Clin Neurosurg. 2002;49:528–47.
3. Hensinger RN. Spondylolysis and spondylolisthesis in children and adolescents. J Bone Joint Surg Am. 1989;71:1098–107.
4. Kalichman L, Kim DH, Li L, Guermazi A, Berkin V, Hunter DJ. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. Spine. 2009;34:199–205.
5. Sonne-Holm S, Jacobsen S, Rovsing HC, Monrad H, Gebuhr P. Lumbar spondylolysis: a life long dynamic condition? A cross sectional survey of 4.151 adults. Eur Spine J. 2007;16:821–8.
6. Teplick JG, Laffey PA, Berman A, Haskins, ME. Diagnosis and evaluation of spondylolisthesis and/or spondylolysis on axial CT. AJNR Am J Neuroradiol. 1986;7:479–91.
7. Belfi L, Ortiz O, Katz D. Computed tomography evaluation of spondylolysis and spondylolisthesis of asymptomatic patients. Spine. 2006;31:E907–10.
8. Fredricksen BE, Baker D, McHolick WJ, Yuan, HA, Lubicky, JP. The natural history of spondylolysis and spondylolisthesis. J Bone Joint Surg Am. 1984;66:699–706.
9. Harvey CJ, Richenberg JL, Saifuddin A, Wolman, RL. The radiological investigation of lumbar spine spondylolysis. Clin Radiol. 1998; 53:723–8.
10. Leone A, Cerase A, Aulisa AG, Tamburrelli, F. Imaging of lumbar spondylolysis. Radiologist. 2001;8:73–86.
11. Rauch RA, Jinkins JR. Lumbosacral spondylolisthesis associated with spondylolysis. Neuroradiol Clin North Am. 1993;3: 543–53.