PREVALENCE OF INCIDENTAL LUMBOSACRAL SPONDYLOLYSIS ON MULTIDETECTOR COMPUTED TOMOGRAPHY IN NEPALESE POPULATION

Amit Shrestha,[1] Subodh Shrestha,[2] Saraswati Surkheti,[1] Roja Khanal,[1] Sunil Pradhan,[1] Abhushan Siddhi Tuladhar,[1] Riwaz Acharya[1]

[1]Department of Radiology, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, [2]Department of Radiology, Om Hospital and Research Centre, Chabahil, Kathmandu, Nepal

ABSTRACT

Spondylolysis is a unilateral or bilateral anatomical defect of pars interarticularis of vertebral arch and commonly occurs at L5-S1 level (85-95%) and L4-5 level (5-15%). It is one of the most common causes of lower back pain (LBP), prevalent in approximately 6% of population and can progress to spondylolisthesis which in turn can cause radiculopathy. Although majority of patients may remain asymptomatic, symptomatic patients in early stages usually benefit from conservative treatment. Hence, early identification is very important and multidetector CT (MDCT) scan is the most sensitive technique to diagnose spondylolysis and spondylolisthesis. The prevalence and long-term prognosis of spondylolysis is still not known in the context of Nepal. This study aims to find out the prevalence of incidental lumbosacral spondylolysis on CT scan in Nepalese population. Cross-sectional descriptive study data was collected from 2629 CT abdomen and pelvis performed during four and half year's period at Nepal Medical College and Teaching Hospital. Presence of spondylolysis was evaluated on multiplanar and volumetric images. Associated feature like spondylolisthesis was also noted. Data obtained was compiled and analyzed using Statistical Package of Social Services – 20 (SPSS-20). Out of total 2629 patients, 1135 were males (43.1%) and 1494 were females (56.9%). Youngest was 14 year and oldest was 102 year old. There was linear positive relation between the age of the patients and frequency of spondylolysis. Incidental lumbosacral spondylolysis was seen in 146 patients with overall prevalence of 5.5%. Out of which 71 were males with 6.2 % prevalence and 75 were females with 5.0 % prevalence.Females were nearly equally affected as males . Frequency of spondylolysis was more in below 60 year (57.5%) compared to above 60 year age group (42.5%) . Commonest location was at L5-S1 level, seen in 134 patients (91.8%) followed by L4-L5 level in 8 patients (5.5 %) and both L4-L5 and L5-S1 levels in 4 patients (2.7 %). Spondylolisthesis was seen in 43 (29.5 %) out of 146 patients with spondylolysis, out of which 15 were males (34.9%) and 28 were females (65.1%). In presence of spondylolysis, females had more statistically significant prevalence of spondylolisthesis than males (p value<0.05). The overall prevalence of spondylolysis and at levels at which it occurs concur with that of established literatures. However, this study shows that females are only slightly less affected than males and is nearly equally prevalent in below 60 year age group unlike shown in previous studies.

KEYWORDS

Spondylolysis, spondylolisthesis, multidetector CT scan

***Received on**: November 13, 2022*
***Accepted for publication**: March 19, 2023*

CORRESPONDING AUTHOR

Dr. Amit Shrestha
Associate Professor,
Department of Radiology,
Nepal Medical College Teaching Hospital, Attarkhel,
Gokarneshwor-8, Kathmandu, Nepal
Email: austrygypsy@gmail.com
Orcid No: https://orcid.org/0000-0002-3274-6697
DOI: https://doi.org/10.3126/nmcj.v25i2.56047

INTRODUCTION

Spondylolysis, which is anatomical defect of pars interarticularis of the vertebral arch, commonly occurs at L5-S1 vertebral level 85-95% and at L4-5 level 5–15% of the time.[1] The defects can be unilateral or bilateral.[2] Spondylolysis is one of the most common causes of lower back pain (LBP) in children and adolescents, although it remains asymptomatic in the majority of patients.[3] This disease is prevalent in approximately 6% of population and twice as often in males as in females.[4] It is estimated that around 25% of the individuals with spondylolysis experience at least one episode of significant back pain at some point in their life, however, individuals engaged in athletic activities appear more likely to develop symptomatic LBP associated with spondylolysis.

Spondylolysis can progress to spondylolisthesis, which is defined as anterior or posterior displacement of the vertebral body in relation to the bordering vertebral bodies due to complete bilateral pars interarticularis fracture.[5] It appears that approximately 50-81% of people suffering from spondylolysis have associated spondylolisthesis which usually presents with symptoms of a radiculopathy due to nerve root compression.[6] Bony reunion can be expected, however, when the fracture becomes pseudoarthroses, spondylolysis can progress to isthmic spondylolisthesis.[7] Spondylolisthesis occurs in a significant proportion of individuals with bilateral spondylolysis.[8]

Although majority of patients may remain asymptomatic, symptomatic patients usually require conservative treatment and possibly surgical treatment depending on whether the defect is early, progressive, or terminal.[9] Young patients with spondylolysis generally receive conservative management as their initial treatment which generally consists of bracing, activity restriction, physical therapy and pain control.[10-11] There is a high rate of success rate in conservative treatment for early and progressive spondylolysis.[12] However, terminal spondylolysis is shown to be refractory to conservative management and requires surgical treatment.[13]

Multidetector CT scan (MDCT) is modality of choice in diagnosis as it reveals the presence of non-displaced spondylolysis when plain radiographs are normal. Conservative treatment for early and progressive spondylolysis requires surgical intervention in the form of screws in terminal and refractory cases.

The prevalence and long-term prognosis of spondylolysis is still not known in the context of Nepalese population. Therefore, this study will establish the prevalence and early diagnosis and help the patients and clinicians to decide treatment choices.

MATERIALS AND METHODS

Cross-sectional descriptive study was carried out on CT scan of abdomen and pelvis of 2,629 patients of all age group and gender at the Department of Radiology, Nepal Medical College and Teaching Hospital, Attarkhel, Gokarneshwor-8, between May 2018 and October 2022 (period of four and half years). Patients with previous history of spinal trauma or surgery and who were symptomatic for spinal pathology (LBP, radiculopathy) were excluded from the study.

After ethical clearance from Nepal Medical College Institutional Review Committee (NMC-IRC), data was collected from volumetric CT scan of abdomen and pelvis performed with a series of millimeter slices (0.5 mm thick) from the domes of diaphragm to pubic symphysis using Toshiba, Aquilon 64 slice multidetector CT scanner. Presence of spondylolysis was evaluated on multiplanar reconstruction (MPR) and volumetric images using Vitrea Vital 2 (Vital Images Inc, Medimark, W Europe), by single radiologist with more than 15 years experience. Other associated feature like spondylolisthesis was also noted. Grading of spondylolisthesis was based on Meyerding classification which divides the superior endplate of the vertebra below into 4 quarters ; grade I: 0-25% , grade II: 26-50%,grade III: 51-75%, grade IV:76-100% and grade V >100%. General information of the patient like age, sex and hospital number were obtained from CT register.Data obtained was compiled and analyzed using SPSS-20. Descriptive analysis was presented in numbers and percentages; analytical statistics was done using chi-square test.

RESULTS

Total of 2,629 patients, 1,135 males (43.1%) and 1,494 females (56.9%) were included in the study (Fig. 1). Incidental lumbosacral spondylolysis was seen in 146 patients with overall prevalence of 5.5%. Youngest was 14 year and oldest was 102 year old with mean age of 55.6 years amongst patients with spondylolysis (Table 1). Highest frequency was seen in above 60 years age group, 62 patients in total, with 42.5% prevalence (Table 2). This was

Table 1: Number and age of patients with incidental spondylolysis				
Number of patients (N)	**Minimum age in years**	**Maximum age in years**	**Mean**	**Standard Deviation**
146	14	102	55.6370	16.89761

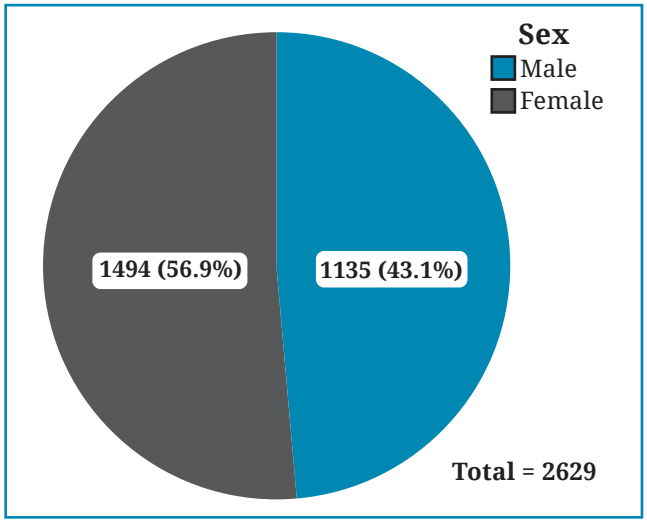

Fig. 1: Distribution of total number of patients according to gender

Table 2: Prevalence of spondylolysis in different age groups		
Age in years	**n**	**%**
10-20	3	2.1
21-30	9	6.2
31-40	20	13.7
41-50	25	17.1
51-60	27	18.5
>60	62	42.5
Total	**146**	**100.0**

Table 3: Prevalence of incidental spondylolysis in males and females			
	Total n of patients	**n of patients with incidental spondylolysis**	**%**
Male	1,135	71	6.2
Female	1,494	75	5.0
Total	**2,629**	**146**	**5.5**

followed by 27 patients (18.5 %) in 51 – 60 years age group. Out of 146 patients with incidental lumbosacral spondylolysis, 71 were males with 6.2% prevalence and 75 were females with 5.0% prevalence (Table 3). Females (5.0%)

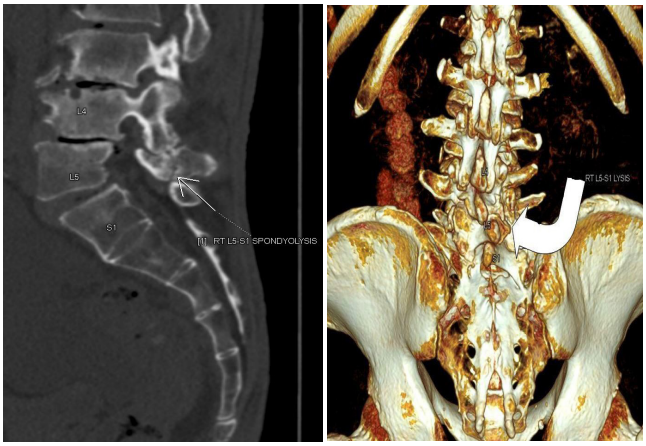

Fig. 2: a) Sagittal CT MPR image of L5-S1 spondylolysis *(arrow)* b) Posterior view of 3D CT image of right sided L5-S1 spondylolysis *(curved white arrow)*

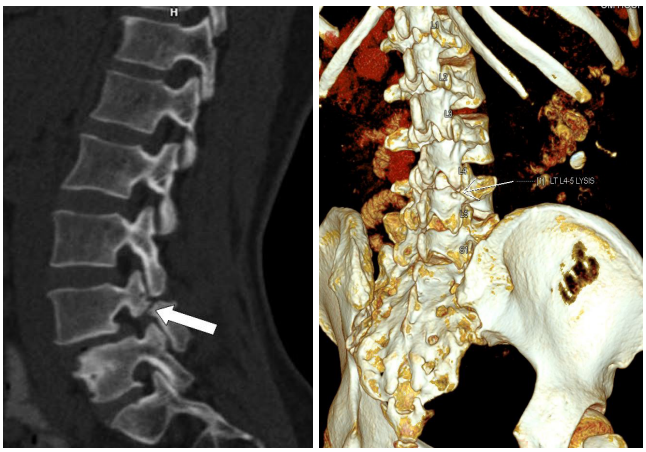

Fig. 3: a) Sagittal CT image of L4-5 spondylolysis *(arrow)* b) 3D CT Oblique view of left sided L4-5 spondylolysis *(arrow)*

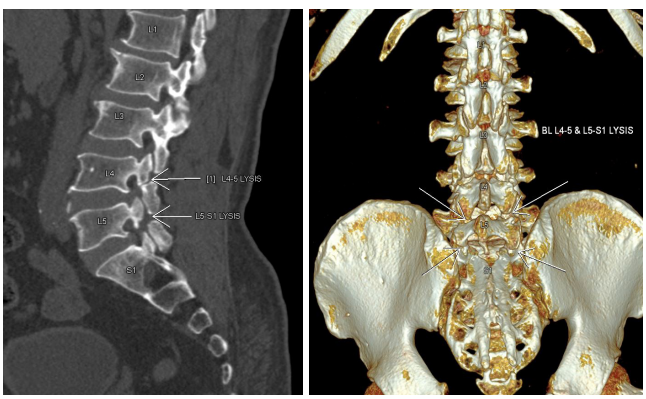

Fig. 4: a) Sagittal CT MPR image of L4-5 and L5-S1 spondylolysis *(arrows)* b) Posterior view of 3D CT image of bilateral L4-5 and L5-S1 spondylolysis *(arrows)*

Table 4: Vertebral levels and frequency of spondylolysis

Vertebral levels	n	%
L4-L5	8	5.5
L5-S1	134	91.8
L4-L5 and L5-S1	4	2.7
Total	**146**	**100.0**

Table 5: Frequency of laterality of spondylolysis

	n	%
Right Unilateral	7	4.7
Left unilateral	3	2.1
Bilateral	136	93.2
Total	**146**	**100.0**

were nearly equally affected as males (6.2%). Commonest location was at L5-S1 level (Fig. 2) seen in 134 patients (91.8%) followed by L4-L5 level (Fig. 3) in 8 patients (5.5 %) and both L4-L5 and L5-S1 levels (Fig. 4) in 4 patients (2.7 %) (Table 4). 136 patients (93.2%) had bilateral, seven (4.7%) had right sided unilateral and three patients (2.1%) had left sided unilateral spondylolysis (Table 5). Spondylolisthesis was seen in 43 (29.5%) out of 146 patients with spondylolysis, out of which 15 (34.9%) were males and 28 (65.1%) were females (Table 6). Forty two patients had anterolisthesis (anterior subluxation of superior over inferior vertebral body) and only one patient, 83 year old

Table 6: Frequency, sex distribution and grades of spondylolisthesis in presence of spondylolysis

Sex	Spondylolisthesis			Total
	Absent	Grade 1	Grade 2	
Male	56	15	0	71
Female	47	26	2	75
Total	**103**	**41**	**2**	**146**

Table 7: Frequency of grades of spondylolisthesis at different vertebral levels

Vertebral level	Spondylolisthesis			Total
	Absent	Grade 1	Grade 2	
L4-L5	3	3	2	8
L5-S1	97	37	0	134
L4-L5 and L5-S1	3	1	0	4
Total	**103**	**41**	**2**	**146**

Fig. 5: a) Sagittal CT MPR image of L4-5 spondylolysis with grade 1 anterolisthesis of L4 over L5 *(arrows)* and b) grade 1 retrolisthesis of L4 over L5 spondylolysis *(arrow)*

Table 8: Frequency of spondylolisthesis against laterality of spondylolysis

Laterality of spondylolysis	Spondylolisthesis		Total
	Absent	Present	
Right Unilateral	6	1	7
Left unilateral	3	0	3
Bilateral	94	42	136
Total	**103**	**43**	**146**

female, had grade 1 retrolisthesis (posterior subluxation) of L5 over S1 (Fig. 5). Out of 43 patients with spondylolisthesis, 41 patients (15 males and 26 females) had grade 1 and two females had grade 2 spondylolisthesis (Table 6). Thirty-seven patients had grade 1 anterolisthesis of L5 over S1, three patients had grade 1 and two had grade 2 anterolisthesis of L4 over L5 and only one patient had grade 1 retrolisthesis of L5 over S1 who had spondylolysis at both L4-5and L5-S1 levels (Table 7). Out of seven patients with right unilateral spondylolysis only one had spondylolisthesis. None out of three patients with left unilateral spondylolysis had listhesis. However, out of 136 patients with bilateral spondylolysis 42 (30.9%) had listhesis (Table 8). In presence of spondylolysis, females had more statistically significant prevalence of spondylolisthesis than males using Pearson Chi-Square test (p value <0.05). However, no statistical significance was seen between the genders and grades of spondylolisthesis using Pearson's correlation (p value- 0.46).

DISCUSSION

In a child with low back pain, one of the most common causes is spondylolysis.[1] It usually occurs as fatigue fracture of pars interarticularis due to the repetitive stress.

Spondylolysis is seen to be absent at birth and generally develops at a young age as shown by the prospective study performed by Tribus *et al*[4] which found a prevalence of 4.4% at the age of 6 years which increased to 6% by the time adulthood was reached. This is supported by our study which showed spondylolysis in an age as early as 14 year. Tribus *et al*[4] found the incidence of spondylolysis at a ratio of 2:1 male to female. However, this study showed that females (5.0%) are nearly equally affected as males (6.2%). Another study done by Wynne-Davies[13] found that first-degree relatives of those affected by spondylolysis had a higher incidence (19%) of spondylolysis compared to the general population which signifies that a genetic component is likely contributory.

The conclusion that spondylolysis can be caused by mechanical stressors can be drawn from the fact that spondylolysis has been shown to be absent at birth and the study showing the incidence of spondylolysis in a patient population of 143 adults who had never walked was 0.0%.[14]

Spondylolysis is usually asymptomatic and may be found incidentally on radiographic examination but if the patient is symptomatic with LBP, the pain will generally be worse with hyperextension. A 45 year follow up study was performed by Beutler *et al*[15] on 500 original subjects, 6.0% of them had spondylolysis in adulthood which is similar to our overall prevalence of 5.5 %. Beutler *et al*[15] showed that eight of the subjects had unilateral pars defects who never developed spondylolisthesis whereas the other 22 subjects had bilateral pars defects with 18 (81.1%) of these patients developing spondylolisthesis. The only prognostic indicator found in this study for the development of spondylolisthesis was whether or not there is unilateral or bilateral spondylolysis. We came across more frequent bilateral spondylolysis (93.2 %) than compared to the study by Beutler *et al.*[15] Ten patients (6.8%) had unilateral spondylolysis in our study, compared to 18.8% in the above study. However we could not evaluate laterality as prognostic factor by statistical tests due to data skewing.

A study on identification of the clinical features of lumbar spondylolysis in elementary school age children to elucidate its pathogenesis conducted on 30 lumbar spondylolysis patients (23 boys, seven girls); mean age 9.5 years, average 5–12 years), showed L5 spondylolysis in 27 (21 boys, six girls) patients (90.0 %) of which 17(63.0%) had terminal-stage fracture and 25 (92.6%) had spina bifida occulta (SBO) involving the S1 lamina.[16] Sixteen out of the 27 (59.3%) had SBO involving the affected lamina (L5) and S1 lamina. Lumbar spondylolysis in elementary school age children was seen as a terminal-stage bone defect at L5, not necessarily related to history of athletic activity and was sometimes asymptomatic. It was often associated with SBO, indicating a possible congenital predisposition. However, our study did not include associated features like congenital defects or degenerative changes as we included patients of all ages and without spinal symptoms.

A cross-sectional study performed in 580 patients undergoing computed tomography (CT) scans of abdominal or lumbar regions for reasons other than low back pain, to determine the incidence of spondylolysis and spondylolisthesis, and to elucidate when and how often spondylolisthesis occurs in patients with or without spondylolysis, showed the prevalence of spondylolysis in 37 patients (6.4%), of which 19 patients (51.4%) showed spondylolisthesis, whereas only 7.4% of non-spondylolysis patients showed spondylolisthesis ($p<0.05$).[17] When excluding unilateral spondylolysis, 90% (18/20) of spondylolysis patients aged ≥60 years-old showed spondylolisthesis. The results showed that the majority of bilateral spondylolysis patients aged ≥60 years-old show spondylolisthesis and suggest that spondylolisthesis occurs very frequently and may develop at a younger age when spondylolysis exists.

In comparison, our study showed spondylolisthesis in 43 (29.5 %) out of 146 patients, which is slightly less than above study. There was linear positive relation between the age of the patients and prevalence of spondylolysis in our study; although, this was not proven to be statistically significant which could be due to inhomogeneous distribution of patients' age in total population sample. However, our study showed more prevalence of spondylolysis in below 60 years (57.5%) compared to above 60 years (42.5%), which is significantly less compared to 90% in above 60 years age group in the above study. Unlike above study, we did not evaluate for the presence of spondylolisthesis in absence of spondylolysis as our main aim to find out the prevalence of incidental lumbosacral spondylolysis only. We did not come across grade 3 or 4 spondylolisthesis in our study. This is probably because higher grades tend to present with radiculopathy or LBP which were

excluded from the study.

Although it was apparent in our study that bilateral spondylolysis predisposes more to the development of listhesis than unilateral lysis, it could not be proven with statistical test. This was because of data skewing as more than 93 % (136 out of 146) had bilateral lysis and less than 7% (10 out of 136) had unilateral lysis.

Since most spondylolysis occurred at L5-S1 level, majority of the patients (37 out of 136) had grade 1 listhesis at the same level compared to L4-5 or both L4-5 and L5-S1 levels.

More often young patients with spondylolysis receive conservative management as their initial treatment. Surgical treatments especially pedicle hook screw fixation, butterfly plate fixation directly into the pars defect are used if no significant improvement are seen with conservative management. Early stage lesions are more likely to heal with little to no healing in terminal stages.[18-20] So it is important that the treatment plan be guided by patients' symptoms and their objectives toward the bone healing, pain management and optimization of physical function.[21]

MDCT is an excellent modality to diagnose incidental spondylolysis and since our study suggests that its prevalence in Nepal is comparable to that of rest of the world, it becomes a vital tool in guiding the patients to early and cost effective treatment even if they are asymptomatic.

Conflict of interest: none

Source of research fund: none

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