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Original Investigation

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Assessment of the Prevalence of Paediatric Spondylolysis

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ABSTRACT

AIM: To determine the frequency of spondylolysis (SLi) in children examined due to trauma, which has not been reported before in Turkey, and to discuss the demographic features of these cases together with accompanying secondary pathologies.

MATERIAL and METHODS: Between January 2013 and June 2023, lumbar computed tomography (CT) scans performed due to traumafor children aged 0-18 years were evaluated. Demographic data of the patients, the unilateral or bilateral occurrence of SLi, and additional findings detected on CT were recorded. Differences between Turkish citizens and Syrian immigrants were also assessed.

RESULTS: From lumbar CT scans performed for children aged 0-18 years, the prevalence of SLi was found to be 5.8%. The prevalence was significantly higher in boys and it increased with age, with significantly higher rates in the age group of 11-18 years compared to younger children. Although the difference between Turkish and Syrian children was not statistically significant, Syrian children showed a numerically higher incidence of SLi. Among SLi cases, the rate of spondylolisthesis was 33.3%, and it was significantly more prevalentin cases ofbilateral SLi than cases of unilateral SLi. Spina bifida was significantly more common among patients with SLi than those without.

CONCLUSION: The prevalence of SLi in children is affected by some demographic characteristics. However, the rate did not differ between Turkish and Syrian children. Spondylolisthesis and spina bifida were significantly more commonin patients with SLi than in the normal paediatric population.

KEYWORDS: Epidemiology, Paediatric spondylolisthesis, Spondylolysis

INTRODUCTION

Spondylolysis (SLi) involves the presence of a defect between the posterior elements of vertebrae and their vertebral bodies, most often in the pars interarticularis. It commonly occurs at the L5 and L4 vertebrae and can be unilateral or bilateral (1). Various theories exist regarding its aetiology. Stress fractures due to repetitive minor trauma and loading are frequently implicated, supported by the higher prevalence of SLi among athletes involved in sports requiring repetitive lumbar extension such as gymnastics, Olympic lifting, American football, and pole vaulting, as well as among individuals engaged in heavy lifting (1,5). However, the varying reported frequencies in different populations suggest that genetic factors also play a role (2).

Spondylolysis is a common condition in children and adolescents with back pain, but it can also be incidentally detected in asymptomatic children (5). The prevalence of SLi in children is largely established through radiological studies. The reported prevalence rates in the general paediatric population range from 0% to 7% across different countries (4,7,11,12,14,15).

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There are no studies on the prevalence of SLi in children in Turkey. This study was designed to determine the prevalence of SLi in this country.

MATERIAL and METHODS

Ethical Approval

This study received approval from the institutional review board of the relevant hospital (2024/02/08/022).

Patient Population

All records of lumbar spine computed tomography (CT) scans performed for children aged 0-18 years between January 2013 and June 2023 were identified using our hospital's digital imaging archive system. To ensure that the study group represented the general paediatric population, only examinations conducted due to trauma were included, while the records of children identified in the imaging archive system who underwent CT scans for non-traumatic reasons such as non-specific back pain were excluded from the study.

Evaluation

Axial and sagittal sections of the analysed lumbar CT scans were reviewed by an experienced author for the presence of SLi, spondylolisthesis (SL), spina bifida (SB), and other congenital or traumatic abnormalities (Figure 1). SB was recorded for occurrences at the most common levels of SLi (L4 and L5) for patients without SLi and for occurrences at the same level as SLi occurrence for patients with SLi. All findings were documented. Patient age, gender, nationality, and clinical data were recorded from the hospital records.

Data Analysis

Patients were divided into two groups based on the presence or absence of SLi. The groups were compared regarding age, gender, nationality, and the presence of SL, SB, and other abnormalities. Additionally, the entire patient cohort was stratified into four age groups of 0-5, 6-10, 11-14, and 15-18 years and the prevalence of SLi was compared among these age groups.

Statistical Analysis

Data were analysed using the E-PICOS program. Categorical variables were presented as percentages. The normality of numerical data was assessed using the Kolmogorov-Smirnov test. Normally distributed numerical data were expressed as mean ± standard deviation, while non-normally distributed and ordinal data were presented as median values with

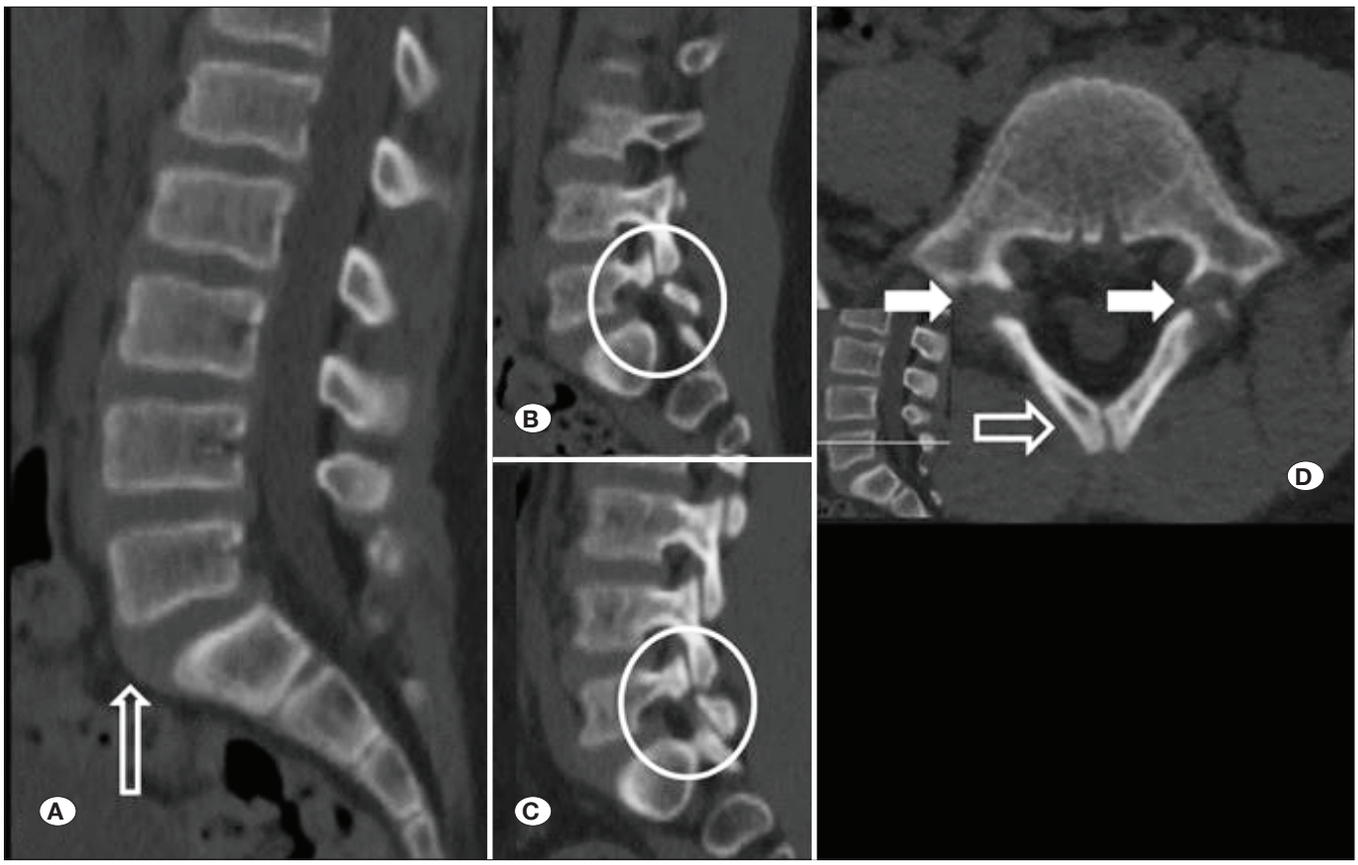

Figure 1: An 8-year-old boy **A)** showing grade 1 spondylolisthesis at L5-S1 in the midline sagittal reconstruction of lumbar CT (*white arrow*) and **B)** demonstrating bilateral spondylolysis at the L5 level on the right and **C)** in the left parasagittal sections (*white circles*). **D)** An axial section passing through the L5 level reveals spina bifida (*hollow white arrow*) and defects of bilateral spondylolysis (*solid white arrows*).

minimum and maximum values. Categorical variables were compared between groups using chi-square or Fisher exact tests according to patient numbers. Normally distributed numerical data were compared using t-tests and non-normally distributed or ordinal data were compared using Mann-Whitney U tests. Values of $p<0.05$ were considered statistically significant.

RESULTS

A total of 2368 lumbar spine CT scans were identified within the target age group. After removing duplicate scans obtained for the same patient, 2337 scans remained. Two patients were excluded due to significant motion artifacts that hindered clear evaluation of their CT scans. Additionally, 117 patients whose scans were performed for non-traumatic reasons were excluded from the study, resulting in 2218 patients being included in the analysis (Figure 2).

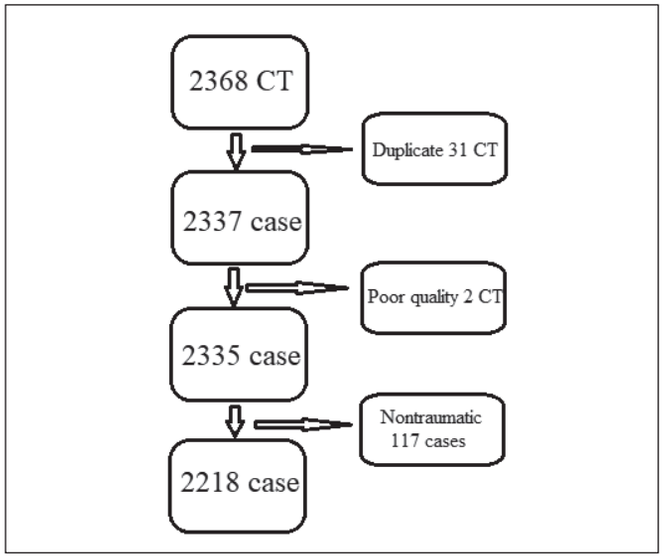

Figure 2: Flowchart showing the numbers of cases included and excluded from the study.

Demographic Data

The distribution of the genders, ages, and nationalities of the patients is presented in Table I. Of all patients, 63% were male and the median age was 13 years (range: 0-18 years). While 94% of the patients were of Turkish nationality, 6% (133 cases) were Syrian.

Prevalence of SLi

From among the total of 2218 patients, 129 (5.8%) were diagnosed with SLi. The prevalence of SLi was 6.7% in boys and 4.2% in girls, with a statistically significant difference ($p=0.015$). Patients with SLi were significantly older compared to those without SLi ($p<0.001$). Furthermore, it was observed that the prevalence increased with age, being significantly higher in the age groups of 11-14 and 15-18 years (prevalence rates of 1.8%, 4%, 8.7%, and 9.3% for the age groups of 0-6, 6-10, 11-14, and 15-18, respectively; $p<0.001$) (Table I). The frequency of SLi was numerically higher among Syrian nationals compared to Turkish nationals, but this difference was not statistically significant (9% vs. 5.6%, respectively; $p=0.104$).

Location and Side of SLi

The distribution of SLi levels and sides is presented in Table II. Bilateral SLi was observed in 72.1% of cases and L5 was involved in 88.3% of cases. There were no cases of multi-level SLi. Among the 117 patients excluded due to non-traumatic reasons for the performance of lumbar CT scans, 17.1% (20 cases) had SLi (Figure 3).These 20 cases were not included in the analysis.

Associated Abnormalities

The rate of cases with SL accompanying SLi is presented in Table III. Among cases with SLi, 33.3% had SL, whereas only

Table I: Demographic Data and Prevalance of Spondylolysis

	All	SLi no	SLi yes	p-value
All, n (%)	2218	2089 (94.2)	129 (5.8)	
Gender M, n (%)	1393 (63)	1299 (62)	94 (73)	0.015*
Age (median/min.-max.)	13 (0-18)	12 (0-18)	14 (2-18)	<0.001[a]
Age groups distribution, n (%)				
0-6	492	483 (98.2)	9 (1.8)	
7-10	371	356 (96)	15 (4)	<0.001*
11-14	472	431 (91.3)	41 (8.7)	
15-18	883	819 (92.7)	64 (9.3)	
Nationality, n (%)				
Turkish	2081	1964 (94.4)	117 (5.6)	0.104*&
Syrian	133	121 (91)	12 (9)	
Others	4	4 (100)	0 (0)	

***:** *Chi² test;* **a:** *Mann-Whitney U test;* **&:** *between Turkish and Syrian; significant p values were given in italic characters.*

2 out of 2089 cases without SLi exhibited SL. Excluding one case, all instances of SL were located at the L5-S1 level. In one case ofbilateral L4 SLi, there was also grade 1 SL. The prevalence of SL was significantly higher in cases of bilateral SLi compared to unilateral cases (44% vs. 5.5%, Fisher exact test, p<0.001). Among these cases, one was classified as grade 2 according to the Meyerding system, while the others were grade 1.

The prevalence of SB was 24% among patients with SLi and 13.7% among patients without SLi, reflecting a statistically significant difference (p=0.0011) (Table III). The presence of other spinal congenital anomalies and spinal traumatic lesions did not differ significantly between patients with and without SLi (Table III).

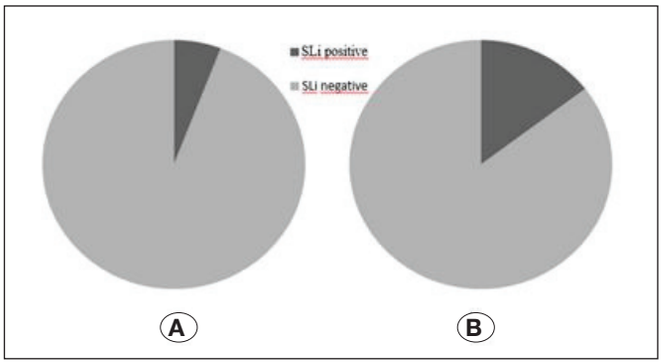

Figure 3: Rate of spondylolysis in patients undergoing CT scans for **A)** trauma-related and **(B)** non-trauma-related reasons.

Table II: Level and Side of Spondylolysis

	n (%)
Level	
L2	1 (0.8)
L3	2 (1.6)
L4	12 (9.3)
L5	114 (88.3)
Multiple	0 (0)
Site	
Right	18 (13.9)
Left	18 (13.9)
Bilateral	93 (72.1)

DISCUSSION

The development of SLi has been associated with genetic factors, with studies reporting significantly higher rates of SLi among first-degree relatives of affected individuals compared to the general population (16). This is further supported by varying prevalence rates reported across different ethnic groups. Studies have documented notably higher SLi prevalence among Eskimos and Native Americans compared to other populations (5,10). Fredrickson et al., in a prospective study with 500 children in the United States, reported SLi prevalence of 4.4% at age 6, increasing to 6% in adulthood (4). In France, Lemoine et al. found a 4.7% prevalence rate of SLi among asymptomatic children (7). Suzue et al. reported SLi prevalence of 0.005% among children and adolescents playing soccer in Japan (12). Studies from Chile by Urrutia et al., Korea by Song et al., and the Netherlands by van den Heuvel et al. reported SLi rates of 3.5%, 2.5% in a symptomatic children, and 0% in non-sporting and pain-free children, respectively (11,14,15). A study from the United States indicated varying SLi prevalence across different races and genders, with the highest rate of 6.4% observed in white males and lower rates among black children (2.8% in boys and 2.3% in girls) (8).

No studies regarding the prevalence of SLi in children or adults have been conducted in Turkey. Therefore, our study is the first of its kind for this country. We found a prevalence rate of 5.8% for SLi among children younger than 18 years who underwent lumbar CT scans due to trauma. Excluding patients for whom lumbar CT scans were performed for reasons other than trauma likely allowed us to reflect the general paediatric population more accurately. Our findings generally align with prevalence rates reported in studies conducted in the United States and European countries (4,7,8).

Consistent with other studies, our study found that SLi prevalence increased with age and was significantly higher in the age groups of 11-14 and 15-18 years compared to younger children. This is expected as older children engage more frequently in physically demanding sports and play activities, increasing the likelihood of SLi. In the literature, SLi prevalence in adults is reported to be about 5-6% (3,4,6). The rates of 8.7% in the 11-14 age group and 9.3% in the 15-18 age group observed in our study are higher than those reported for adult populations in other countries, but direct comparisons with adult rates in the Turkish population cannot be made due to the lack of studies to date on adult prevalence in Turkey.

Table III: Associated Abnormalities on Computerized Tomography

	All	SLi no	SLi yes	p-value
SL, n (%)	45 (2)	2 (0.001)	43 (33.3)	<0.001[&]
L4-5 SB, n (%)	317 (14.3)	286 (13.7)	31 (24)	0.0011*
Spinal traumatic lesions, n (%)	105 (4.7)	102 (4.8)	3 (2.3)	0.28[&]
Spinal other congenital lesions, n (%)	17 (0.7)	16 (0.7)	1 (0.7)	1[&]

*[&]: Fisher exact test; *: Chi² test; **a:** Mann-Whitney U test; **&:** between Turkish and Syrian; significant p values were given in italic characters.*

In our study, SLi prevalence was significantly higher in boys than girls (6.7% vs. 4.2%, respectively). This male predominance is consistent across nearly all studies conducted in both adult and paediatric age groups. This phenomenon may be attributed to higher physical exertion experienced by boys compared to girls and could also involve anatomical differences. Zehnder et al. reported significantly reduced interpedicular distances at lower lumbar levels in children with SLi, suggesting potential anatomical variations, although gender was not specifically evaluated in their study (17). Further studies are needed to assess whether such anatomical differences exist between boys and girls.

Previous series have reported that SL accompanies SLi in 5-68.4% of patients with SLi (4,7,11,13). In our study, SL was present in 33.3% of cases of SLi, and the rate of SL was significantly higher in cases ofbilateral SLi compared to unilateral cases (44% vs. 5.5%). Only two patients without SLi had grade 1 SL.

The presence of SB at the same level has been reported as a risk factor for developing SLi (6). Urrutia et al. evaluated SLi and SB prevalence in children and adults, reporting the SLi and SB prevalence as 3.5% and 41.2% in children and as 3.8% and 7.7% in adults, respectively, and attributing the higher prevalence in children to incomplete ossification (14). Another study comparing SLi rates between patients with and without SB did not find a significant difference (13). On the other hand, Sakai et al. concluded that the SLi rate in patients with SB was 3.7 times higher than that in the general population (9). Consistent with the findings of Sakai et al., our study demonstrateda significantly higher prevalence of SB at the same level in patients with SLi compared to those without SLi.

Our hospital serves a relatively high number of Syrian immigrants, and particularly in the emergency departments. Therefore, we compared the SLi prevalence in Turkish and Syrian children to evaluate whether there was an ethnic difference. The prevalence in Syrian children was found to be numerically higher compared to Turkish children (9% vs. 5.6%), but this difference was not statistically significant.

Limitations

Our study focused exclusively on lumbar CT scans performed due to trauma, excluding those performed for other reasons such as back pain. Therefore, we believe our results reflect the general paediatric population well. However, the lack of standardization in lumbar CT scans and the use of thicker slices, particularly for younger children to reduce radiation exposure, may have led to some cases of SLi being missed. This could potentially explain why SLi prevalence was found to be lower in the age group of 0-10 years compared to older children. Nonetheless, similar studies evaluating SLi prevalence in paediatric age groups consistently report lower rates in younger children, which supports the accuracy of our study's results.

CONCLUSION

We identified a prevalence rate of 5.8% for SLi among children aged 0-18 years who underwent lumbar CT scans due to trauma. The prevalence was significantly higher in boys. We also observed an increase in prevalence with age, with significantly higher rates in the age group of 11-18 compared to younger children. Although the difference was not statistically significant, Syrian children had a higher prevalence of SLi compared to Turkish children. Among patients with SLi, the rate of accompanying SL was 33.3%, and that rate was significantly higher when SLi was bilateral compared to unilateral cases.

Declarations

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: AO, FKG
Data collection: AO, AAT
Analysis and interpretation of results: FKG, IG, BE
Draft manuscript preparation: FKG, AO, AAT
Critical revision of the article: FKG, AO, AAT, IG, BE, NSB
Other (study supervision, fundings, materials, etc...):
All authors (AO, AAT, IG, BE, NSB, FKG) reviewed the results and approved the final version of the manuscript.

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