Incidence, trends, and associated risks of developmental hip dysplasia in patients with Early Onset and Adolescent Idiopathic Scoliosis

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ABSTRACT

Introduction: Early Onset and Adolescent Idiopathic Scoliosis, relatively common diagnoses (~3% general population), have been associated with developmental dysplasia of the hip (DDH); a more rare spectrum of anomalies related to the abnormal development of acetabulum, proximal femur, and hip joint. To the best of our knowledge, no high powered investigations have been performed in an attempt to assess incidence and associated risks of DDH in scoliosis patients.
Methods: The KID database was queried for ICD-9 codes from 2003 to 2012 pertaining to EOS (Congenital and Idiopathic < 10y/o) and AIS patients. Descriptive analysis assessed patient demographics and yearly trends in hip dysplasia rates. EOS and AIS patients with hip dysplasia were isolated, and incidence of hospital admissions for associated anomalies (osteonecrosis, osteoarthritis, recurrent hip dislocation, hip ankylosis) and hip arthroplasty (total + partial) were investigated. Univariate analysis of hip pathology determined significant predictors of hip arthroplasty. Binary logistic regression analysis was used to determine the relationship between these predictors.
Results: 111,827 scoliosis patients (EOS: 25,747; AIS: 77,183) were included. AIS patients were older (15.2 vs 4.3), more female (64.2% vs 52.1%), had a higher CCI (0.84 vs 0.64), and less racially diverse (all p < 0.001). The incidence of hip dysplasia was 1.4% for AIS patients and 3.9% for EOS patients (p < 0.001). Of the AIS (n = 1073) and EOS (n = 1005) patients with hip dysplasia, 0.3% (p > 0.05 between groups) developed hip osteonecrosis, 0% of patients were coded as having a hip labral tear, hip ankylosis, and 0.6% (EOS: 0.2%; AIS: 0.9%, p = 0.025) developed hip osteoarthritis. AIS patients were more likely to have recurrent hip dislocations (35.4% vs 17.0%, p < 0.001), and both groups had similar primary hip arthroplasty rates (6.7% vs 5.4%, p = 0.118) and revision hip arthroplasty rates (0% vs 0.4%, p = 0.053). Hip osteoarthritis (OR: 13.43[5.21–34.66], p= < 0.001) and older age (OR: 1.039[1.007–1.073], p = 0.017) were the only significant predictors of hip arthroplasty (p= < .001).
Conclusions: The incidence of hip dysplasia in EOS and AIS populations is higher than that of the general population. The rate of DDH was 3.9% and 1.8% for EOS and AIS, respectively. While the incidence of DDH is higher, associated anomalies of osteoarthritis, osteonecrosis, labral tears, and ankylosis appear to be a minimal risk for AIS and EOS patients with Hip Dysplasia.

1. Introduction

Early onset and adolescent scoliosis are three dimensional deformities of spinal curvature that, combined, occur at a relatively common rate in the general population (~3%, respectively).[1–3] Early onset scoliosis (EOS) presents before age 10 and encompasses Idiopathic, congenital, neuromuscular, and syndromic scoliosis.[4] Adolescent Idiopathic Scoliosis (AIS) is the most common form of scoliosis, and

presents between the age of 10 and skeletal maturity.[3,5]

EOS, and more rarely AIS, have been associated with significant comorbidities such as neurologic, musculoskeletal, cardiopulmonary, and urogenital anomalies.[2,6,7] Included under the umbrella of musculoskeletal anomalies is Developmental Dysplasia of the Hip (DDH), which is the range of deformities involving the growing hip. These deformities can include frank dislocation, subluxation and instability, or dysplasia of the femoral head and acetabulum.[8] It has been previously established that EOS and AIS patients have an increased rate of DDH compared to the general population (6.4 per 100 live births vs. 5.1 per 1000 live births), however, there have not been any recent high powered investigations into the current rate of DDH in the EOS and AIS population.[1,9,10]

Spine and hip pathology are related due to the pelvic attachment of the lumbosacral junction. Sagittal spine balance affects pelvic tilt at this point of attachment and thus pelvic tilt is able to function as a compensatory mechanism for sagittal malalignment.11 Due to the nature of the pelvis, this change in tilt can lead to hip comorbidities existing with spinal deformities.11–13,[17] Hip morbidities in the EOS and AIS populations, such as hip osteonecrosis, hip labral tear, hip ankylosis, hip osteoarthritis, etc, have been understudied to date.[9,10,14,15] Therefore, this study aimed to determine the true rate of DDH in patients diagnosed with EOS and AIS and the proportion of those patients who had concomitant diseases of the hip.

2. Methods

2.1. Study design and data source

This study was a retrospective review of all inpatient entries in the Kids Inpatient Database (KID), a subset of The Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP). The KID database is the largest all-payer pediatric (< 21 years at admission) inpatient database in the United States containing data for approximately 3 million discharges a year. Released every 3rd year, it can be used to identify, track, and analyze national trends in health care utilization, access, charges, quality, and outcomes. Discharge level weighted variables for the years 2003–2012 in our study.

2.2. Study population

Hospitalized patients with EOS and AIS were identified using International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9CM) codes. The diagnosis codes used were congenital and idiopathic scoliosis (7370 73710 73720 73730 73739 7378 7385 75610 73731 7542 73732) from 2003, 2006, 2009, 2012. Patients with an age of < 21 y/o were included for analysis. Patients less than 10 years old were stratified into the EOS group, while those greater than or equal to 10 years old were stratified into the AIS group.

2.3. Variables of interest

EOS and AIS patient demographics were assessed for each year. Demographics consisted of age, gender (male or female), and race/ethnicity (black, Hispanic, white, Asian and Pacific Islanders, or others). We then assessed the overall and annual incidences of DDH with respect to EOS and AIS patients. The incidence of hospital admissions of various hip anomalies within our populations were also assessed using specified ICD-9 codes, which included osteonecrosis, osteoarthritis, recurrent hip dislocation, hip ankylosis and hip arthroplasty (71885, 71895, 7265, 73343, 73342, 7151, 7150 7152, 71515, 71525, 71535, 71595, 71509, 71995, 7159, 71835, 71855, 71875, 71825, 8151, 8140, 8152, 8153, 0070, 0071, 0072, 0073, 0074, 0075, 0076, 0077, 0085, 0086, 0087).

2.4. Statistical analysis

National estimates for annual EOS and AIS hospitalization incidence were quantified using KID weighted discharges. Descriptive, chi-square, and independent sample *t*-test analyses assessed frequencies and means of demographic and hip diagnosis variables amongst EOS and AIS patients. Univariate analysis of all coded hip pathologies in the KID database was performed. Binary logistic regression analysis of significant univariate hip pathologies was used to determine significant predictors of hip arthroplasty. All tests were two sided, and significance was set to a p-value of less than 0.05. All statistical analyses were performed utilizing IBM Statistical Package for the Social Sciences (SPSS) version 23.0132 (Armonk, NY: IBM).

3. Results

3.1. Demographics

111,827 scoliosis patients were included in the study. There were 25,747 EOS and 77,183 AIS patients. The average age of AIS patients was 15.2 years vs. 4.3 for EOS. 64.2% of AIS patients were female compared to 52.1% for EOS and had a higher Charlson Comorbidity Index (CCI) (0.84 vs 0.64). Racial demographics were 49.9% White, 13.9% Hispanic, 11.9% Black, 4.2% Other, 2.0% Asian or Pacific Islander, 0.5% Native American (Table 1).

3.2. Incidence of DDH and hip anomalies in EOS and AIS

1073 AIS (1.4%) and 1005 EOS (3.9%) patients presented with DDH. The annual incidence of AIS was 186 (2003), 206 (2006), 309 (2009), 372 (2012). The annual incidence of EOS was 153 (2003), 195 (2006), 299 (2009), and 357 (2012). The incidence of hospital admissions for patients diagnosed with osteonecrosis, osteoarthritis, recurrent hip dislocation, hip ankylosis and hip arthroplasty (total + partial) in the EOS and AIS populations was then calculated. We found 0.3% (p > 0.05 between groups) developed hip osteonecrosis, and 0.6% (EOS: 0.2%; AIS: 0.9%, p = 0.025) developed hip osteoarthritis. There were 0% of patients coded as having a hip labral tear or hip ankylosis, AIS patients were more likely to have recurrent hip dislocations (35.4% vs 17.0%, OR: 2.67, p < 0.001), and both groups had similar primary hip arthroplasty rates (6.7% vs 5.4%, p = 0.118) and revision hip arthroplasty rates (0% vs 0.4%, p = 0.053) (Table 2).

3.3. Predictors of hip arthroplasty

Univariate regression analysis was performed to find the significant predictors of hip arthroplasty for all hip pathologies coded in the KID database. Significant predictors were identified as having P < 0.05. We identified age (p = .003, 1.048[1.016–1.081]), and osteoarthritis

Table 1
Demographics of EOS and AIS patients isolated from KID database.

Demographic Variable	Incidence (%) or Mean
Sample Size (N)	111,827
EOS Size	25,747
AIS Size	77,183
Age	15.2 (AIS), 4.3 (EOS)
Sex (female)	64.2 (AIS), 52.1 (EOS)
Race	
White	49.9
Hispanic	13.9
Black	11.9
Asian or Pacific Islander	4.2
Native American	2.0

Racial demographics were % White, % Hispanic, % Black, % Other, % Asian or Pacific Islander, .5% Native American. (Table 1).