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Pelvic Asymmetry and Spinal Fixation in Myelomeningocele

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Pelvic Asymmetry in Myelomeningocele Associated with Scoliosis

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Introduction

Spinal fusion has been used to treat scoliosis for more than one hundred years and over that time, dramatic improvements have been made in technique and technology to improve outcomes and reduce complications. Unfortunately, high complication rates persist in neuromuscular scoliosis, especially when associated with myelomeningocele, which is commonly characterized by severe scoliosis.

Implant failure, especially distal fixation failure, and soft tissue complications including infection are two of the most significant complications in this population. Stable and low-profile implants are necessary to reduce the risk of these complications. Studies of pelvic fixation in neuromuscular scoliosis have shown that sacral alar iliac (SAI) screw fixation may have an improved complication profile compared to other fixation methods, however, myelomeningocele patients are at best a small portion of the patients included in these studies. We hypothesize that the dysplastic and variable pelvic anatomy in some myelomeningocele patients will preclude the use of these typical fixation strategies. While anterior surgery may offer a better complication profile in this patient population, it is not appropriate for all spina bifida patients, especially those with larger curves and pelvic obliquity. Therefore, improving operative techniques for posterior instrumentation remains important in this challenging population.

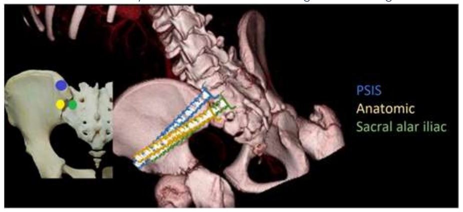
Axial spinal asymmetry has been well established in idiopathic scoliosis, including pedicle morphology. Additionally, Ko et al. showed that transverse pelvic plane asymmetry is prevalent in patients with scoliosis and severe cerebral palsy, possibly making iliac fixation more challenging. However pelvic morphologic differences have not been well described in the myelodysplasia population. Therefore, we aim to describe the pelvic morphology in patients with myelomeningocele and scoliosis including asymmetry in previously described screw trajectories to help guide ideal pelvic fixation strategies. We will evaluate the current typical fixation methods with respect to their ability to provide stable segmental anchors and promote ease of rod placement and limit the use of additional bulky connectors.

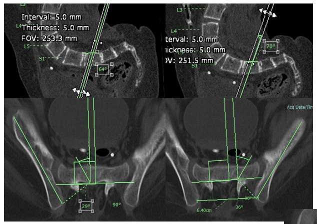
Methods

- 26 patients with myelomeningocele matched with age and sex matched controls with pelvic CT scan
- Age from 1.9 to 19.4 with average 10.4
- Variety of comorbidities and motor levels included
- Cohort CT scans obtained for preoperative planning
- Control CT scans from appendicitis evaluation
- Compare screw trajectories for typical techniques, evaluate intersegmental relationships and pelvic morphology
- 2 pediatric orthopedic surgeons measured each 3-dimensional reformat with excellent interrater reliability for measuring the screw trajectories and distances

Methods

Trajectories for iliac screws with PSIS and anatomic start points, and sacral alar iliac screws were obtained by three-dimensional reformatting of the CT images

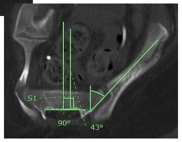




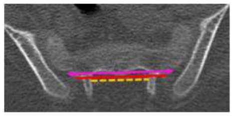
Sagittal angles were measured from the line parallel to the posterior body of S1 (PSIS) or S2 (anatomic and SAI) to the trajectory of the screw into the supraacetabular corridor for each side

Axial angles were measured between the screw trajectory as above and a line perpendicular to the posterior surface of the sacrum

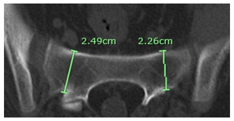
Some pelvises were very asymmetric and dysmorphic and most had asymmetry in both planes



Posterior sacral width (pink arrows), SAI screw distance (red solid), canal width (yellow dashed) were all measured



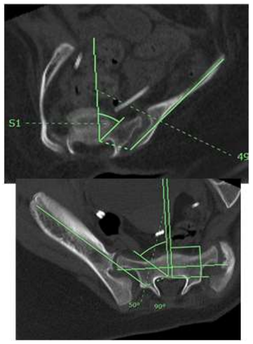
Sacral ala thickness was also measured in all patients



Results

54% of patients with myelomeningocele vs 4% of control patients had at least 1 traditional screw trajectory that was impossible to cannulate

Most commonly SAI screws could not enter the sacrum and still cross the SI joint, but some iliac screws were also impossible



Results

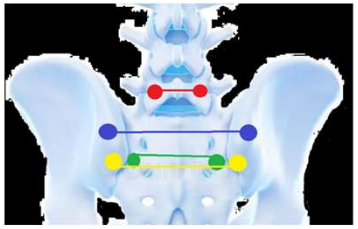
When we compared the differences in screw trajectories from left to right in the patients with possible trajectories bilaterally, we found increased differences compared to the healthy control group. In the controls, both screw trajectories could be found easily on one sagittal cut in comparison to the trajectories in the myelomenigocele patients (SAI and anatomic screw trajectories used the same sagittal cut)

	Measure	Control (N=26)	Cases (N=26)
Sagittal Plane Asymmetry	SAI (°)	0 (0, 3)	16 (0, 39)
	PSIS (°)	0 (0, 0)	9 (0, 34)
Axial Plane Asymmetry	SAI (°)	2 (0, 5)	5 (1, 33)
	PSIS (°)	2 (0, 9)	9 (1, 33)
	Anatomic (°)	3 (1, 9)	6 (0, 33)
Multiplanar Asymmetry (axial + sagittal plane)	SAI	2 (0, 5)	21 (1, 72)
	Anatomic	3 (1, 9)	19 (1, 72)
	PSIS	2 (0, 9)	17 (1, 59)

Presented as median (range)

For all comparisons p<0.001 from Wilcoxon rank sum test

On average, the sacral alar iliac start point was more likely to line up with the L5 start point and the PSIS start point was furthest away but 17% of patients had more concordant anatomic or PISIS start point



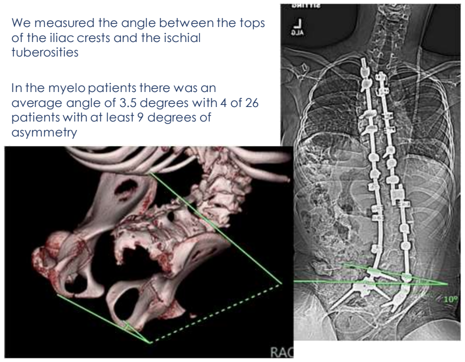
Screw	Myelo	Control	Sig
Sacral alar iliac	-0.18	-0.08	0.002
Anatomic iliac	0.25	0.35	0.094
PSIS iliac	0.66	0.47	0.005

Pesented as median

p-value computed from Wilcoxon rank sum test

We measured the angle between the tops of the iliac crests and the ischial tuberosities

In the myelo patients there was an average angle of 3.5 degrees with 4 of 26 patients with at least 9 degrees of asymmetry



Other Findings

- All patients had sacral ala thickness >1cm except one with congenital scoliosis and unilateral sacral ala with no difference in thickness between cases and controls
- 4/26 cases had less than 2 cm of available sacral surface for SAI screw placement (1 cm/side)
- Curve size was associated with SAI and PSIS screw asymmetry but not anatomic screw asymmetry
- Patients with more than 10 degrees of acetabular index asymmetry were more likely to have SAI screw asymmetry. Hip subluxation and dislocation did not correlate with pelvic screw asymmetry

Conclusions

- Variable anatomy between patients is best served by personalized constructs
- Preoperative planning with 3-dimensional imaging is important in achieving stable low profile pelvic fixation in patients with myelomeningocele
- There is variation in intersegmental anatomy and therefore start point harmony between patients is also variable
- Multiplanar asymmetry, deficient bone stock and variable sacroiliac relationships make screw placement and planning challenging
- Intraoperative navigation may be helpful in cannulating difficult planned screw trajectories

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