Pediatric Occipital Condyle Morphometric Analysis Using Computed Tomography with Evaluation for Occipital Condyle Screw Placement

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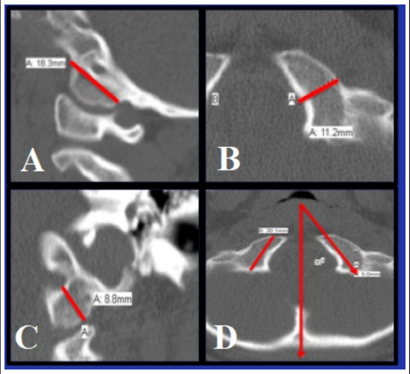
Introduction

Occipitocervical fusions in the pediatric population are rare, but can be challenging due to smaller anatomy. The procedure is even more challenging in patients with prior suboccipital craniectomy. A proposed method for occipitocervical fusion in these challenging patients is the use of occipital condyle screws. There is very limited literature on evaluating the pediatric occipital condyle for screw placement. Our institution seeks to determine if there is an age cutoff where condylar screw placement would be contraindicated.

Methods

A retrospective morphometric analysis of pediatric occipital condyles was performed using computed tomography (CT) imaging of the head, cervical spine, or CT angiography of the neck. The CT scans of 518 pediatric patients at our institution were evaluated. There were 205 females and 313 males, with ages ranging from 1 week to 9 years. Measurements of occipital condyles and screw trajectory were obtained in the axial, coronal, and sagittal planes (see Figure 1). Criteria used to determined feasibility of occipital condyle for screw placement was: minimum axial width of 8 mm and minimum coronal height of 6.5 mm (Lin et al.) Descriptive statistical analysis was performed using mean, standard deviation, and confidence intervals for all measurements. Probability values were calculated using Student's t-test. P value less than 0.05 was considered statistical significance.

Figure 1



(A) Sagittal view, condylar length measured using longest axis in the anterior-posterior plane. (B) Axial view, condylar width measured perpendicular to midpoint of the long axis. (C) Coronal view, condylar height measured perpendicular from the hypoglossal canal to the inferior edge of the condyle. (D) Axial view, projected screw length and angle measurements.

Results

Age distribution of all patients analyzed and percentage of patients that did not meet size recommendations for screw placement are summarized in Tables 1 and 2, respectively. Table 3 summarizes the average measurements of condylar length, height, and width, as well as projected screw angle and length. Overall, males had larger occipital condyles compared to females with statistical significance. As expected, there was a general trend toward older children having larger occipital condyles. Overall, 20.65% of all patients were found to have at least one occipital condyle measurement that would prevent screw placement, including at least one patient in every age group.

Table 1. Distribution of patients by age.

Age (year)	*# of cases*
1	43
2	102
3	62
4	41
5	60
6	46
7	42
8	60
9	62

Table 2. Percent of patients with occipital condyles that did not meet size recommendations for screw placement.

Age (years)	*Percentage (%)*
1	55.81
2	17.64
3	40.32
4	19.51
5	5.08
6	17.39
7	14.28
8	11.67
9	12.90
All ages	**20.65**

Table 3. Average measurements of condylar length/width/height and screw angle/length by age and gender, with standard deviations.

	Right Condylar Length (mm)	*Right Condylar Width (mm)*	*Right Condylar Height (mm)*	*Right Screw Angle (°)*	*Right Screw Length (mm)*	*Left Condylar Length (mm)*	*Left Condylar Width (mm)*	*Left Condylar Height (mm)*	*Left Screw Angle (°)*	*Left Screw Length (mm)*
Age (years)										
1	13.5 ± 2.3	8.4 ± 1.4	7.2 ± 1.1	35.8 ± 6.7	18.1 ± 3.1	13.4 ± 2.4	8.4 ± 1.7	7.0 ± 1.2	34.0 ± 6.0	18.0 ± 3.4
2	16.5 ± 2.2	9.3 ± 1.1	7.8 ± 1.0	31.4 ± 6.4	20.3 ± 3.9	15.7 ±2.1	9.4 ± 1.1	8.0 ± 1.0	30.8 ± 5.3	20.1 ± 3.9
3	14.6 ± 2.3	9.9 ± 1.5	7.4 ± 1.6	31.4 ± 5.3	19.4 ± 3.0	14.6 ± 1.7	9.9 ± 1.9	7.7 ± 1.5	30.9 ± 5.7	19.3 ± 3.0
4	16.1 ± 2.5	10.5 ± 1.2	7.9 ± 1.1	36.1 ± 4.0	23.1 ± 2.6	16.6 ± 1.7	10.6 ± 1.3	7.8 ± 1.1	36.1 ± 5.1	22.2 ± 2.7
5	18.2 ± 2.4	10.8 ± 2.4	8.0 ± 0.8	35.2 ± 5.3	22.0 ± 2.5	17.9 ± 2.2	10.7 ± 1.1	8.0 ± 0.9	34.0 ± 4.9	21.9 ± 2.4
6	17.6 ± 2.9	10.8 ± 2.6	8.1 ± 1.2	29.4 ± 4.3	19.8 ± 3.8	17.8 ± 2.3	10.9 ± 2.1	8.0 ± 1.3	29.1 ± 4.2	19.4 ± 3.0
7	18.3 ± 2.1	11.3 ± 1.3	8.6 ± 1.7	34.4 ± 5.1	23.0 ± 2.2	17.3 ± 1.8	11.5 ± 1.5	8.6 ± 1.5	32.7 ± 5.1	22.5 ± 2.5
8	18.7 ± 2.3	11.6 ± 1.5	8.9 ± 1.7	35.5 ± 4.9	24.0 ± 2.5	18.1 ± 2.3	11.4 ± 1.6	9.1 ± 1.7	35.6 ± 5.2	23.9 ± 3.2
9	19.2 ± 3.2	11.6 ± 2.5	9.1 ± 2.5	30.9 ± 5.5	21.6 ± 2.7	19.3 ± 2.7	11.2 ± 1.3	8.9 ± 1.2	30.4 ± 5.9	21.4 ± 2.9
Overall	**17.0 ± 3.0**	**10.4 ± 2.1**	**8.1 ± 1.6**	**33.0 ± 5.9**	**21.2 ± 3.5**	**16.7 ± 2.7**	**10.4 ± 1.7**	**8.2 ± 1.4**	**32.4 ± 5.7**	**20.9 ± 3.5**
Gender										
Female	16.2 ± 2.8	10.2 ± 1.9	7.8 ± 1.4	33.6 ± 6.0	20.2 ± 3.4	16.1 ± 2.5	10.0 ± 1.9	8.1 ± 1.4	32.6 ± 5.9	20.3 ± 3.4
Male	17.5 ± 3.0	10.6 ± 2.2	8.3 ± 1.7	32.7 ± 5.8	21.8 ± 3.5	17.1 ± 2.9	10.6 ± 1.6	8.2 ± 1.4	32.2 ± 5.6	21.3 ± 3.5

Discussion

The profile of traditional occipital hardware is especially important in the pediatric population, where these patients have smaller anatomy, thinner skin, and less subcutaneous tissue. Consequently, there can be increased risk of wound breakdown, hardware erosion through skin, and cosmetic defects. The use of occipital condyle screws for fusion can potentially bypass these challenges in pediatric patients. The potential role for occipital condyle screws is even greater in patients who have had prior suboccipital craniectomy (i.e. Chiari decompression), where the anatomy is even more limiting.

There is very limited literature on pediatric occipital condyle screws, as most of the literature is in the adult population. There is only one case of occipital condyle screw placement in a pediatric patient reported (Bekelis et al). In an effort to evaluate the feasibility of occipital condyle screws in the pediatric population, we performed this morphometric analysis of occipital condyles in patients <10 years of age. Lin et al. conducted a similar study that evaluated occipital condyles in children age 2 to 16 years. That study found the mean coronal height, sagittal length, and axial width dimensions to be 9.0 mm, 21.3 mm, and 9.8 mm, respectively. Our study found similar results in coronal and axial dimensions (8.1 mm and 10.4 mm, respectively). Our average sagittal length was 16.8 mm, however, which is significantly shorter. This can possibly be explained by the fact that we only evaluated patients <10 years old, in whom the anatomy is smaller.

Conclusions

Occipital condyle screw fixation is feasible in pediatric patients under 10 years old. All pediatric patients that require craniocervical fusion should undergo critical evaluation of the occipital condyles preoperatively to determine suitability for occipital condyle screw placement.

Learning Objectives

By the conclusion of this session, participants should be able to:
1) Be familiar with the technique of occipital condyle screw placement.
2) Realize that the technique is potentially feasible in pediatric patients less than 10 years old.

References

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