Early Adverse Events Following Pediatric Mandibular Advancement: Analysis of the ACS NSQIP-Pediatric Database

Kevin J. Carlson MD, Suhas Bharadwaj MS, Rohan Sharma BS, William M. Dougherty MD, Eric J. Dobratz MD

Eastern Virginia Medical School, Department of Otolaryngology-Head and Neck Surgery, Norfolk, VA

Introduction

In patients with Pierre Robin Sequence (PRS), upper airway obstruction from a diminutive mandible is often most pronounced in the neonatal period. While traditional orthognathic surgery is usually not performed until adolescence[1, 2], mandible distraction osteogenesis (MDO) can be performed in neonates. MDO uses internal or external distraction devices to lengthen the mandible over the course of days, positioning the tongue more ventrally. Since its introduction, this procedure has become the preferred procedure to manage the upper airway obstruction associated with PRS.[3]

While the efficacy of MDO in avoiding tracheostomy and improving feeding difficulties in patients with PRS has been well described [4-8], the procedure has been associated with various complications.[5, 7, 9, 10] Though often minor, adverse events have been reported in as many of 40% of patients undergoing MDO.[5] Many complications can early in the postoperative course, including surgical site infection, bleeding or hematoma, emergent reintubation, and device failure necessitating reoperation.[5, 9] Risks associated with the procedure are considered to be acceptable given the serious long-term implications of tracheostomy.[11] However, the overall complication rate of MDO varies significantly throughout the literature making it difficult to risk stratify patients.[5]

This study aims to assess patient factors associated with early adverse events following mandibular advancement utilizing the American College of Surgeons (ACS) National Surgical Quality Improvement Program Pediatric database (NSQIP-Pediatric). This database has been used extensively to analyze 30-day surgical outcomes and is of particular use for less commonly performed surgical procedures.[12-20] Our analysis focuses on the infant and neonatal population for whom advancement via MDO is most often employed in setting of PRS with the goal of helping to guide the timing of the operation and aid in pre-operative risk stratification.

Methods

The NSQIP-Pediatric database from 2012 to 2019 was queried for patients with procedural and post-operative diagnosis codes consistent with mandibular distraction osteogenesis (MDO) and 30-day adverse events are assessed.

Patients were initially identified in the database via primary procedure Current Procedural Terminology (CPT) codes 20692, 20696 and 21196. Patients with primary procedure CPT diagnosis code 20692 or 20696 but without a secondary CPT codes for mandible augmentation or osteotomy (CPT codes 21125, 21193, 21195, 21196, 21198) were excluded. Patients were excluded if they underwent other concurrent orthognathic procedures of the midface and mandible, cranial vault, tumor resections, or microvascular reconstructions. Post-operative diagnosis codes were examined and patients with procedural diagnoses irrelevant to mandible advancement excluded.

The primary outcome measure was any adverse event recorded in the database. Secondary outcomes included specific complications and hospital length of stay. This study was deemed exempt from review by the Eastern Virginia School of Medicine Institutional Review Board.

Results

	≤365 days (n= 88)	>365 days (n= 120)	P-Value
Age, median (IQR), days	29 (18.25-56.50)	4286 (1754-5988)	0.0005
Weight, median (IQR), kg	3.58 (3.13-4.24)	40.32 (16-60)	0.00005
Gender (n)			
Male	45 (51.1%)	54 (45.0%)	NS
Female	43 (48.8%)	66 (55.0%)	
Race (n)			
Caucasian	64 (72.7%)	96 (80.0%)	NS
Unknown	15 (17.0%)	12 (10.0%)	
Black	7 (8.0%)	7 (5.8%)	
Asian	1 (1.1%)	4 (3.3%)	
Native American	1 (1.1%)	1 (0.8%)	
Length of Stay, mean (SD), days	29.6 (20.1)	2.58 (2.4)	0.00005

Table 1: Demographics and hospital length of stay among patients ≤ and >365 days.

	All Patients			Patients ≤365 days					
	≤365 days (n= 88)	>365 days (n= 120)	P-Value	Age ≤28 days (n=44)	Age >28 days (n=45)	P-Value	Weight ≤4kg (n=63)	Weight >4kg (n=26)	P-Value
Total Adverse Events	23 (26.1%)	13 (10.8%)	**0.005**	13 (29.5%)	10 (22.2%)	0.47	20 (31.7%)	3 (11.5%)	0.063
Surgical Site Infection	4 (4.5%)	4 (3.3%)	0.725	4 (9.0%)	0	0.053	4 (6.3%)	0	0.317
Reintubation	5 (5.7%)	2 (1.7%%)	0.136	2 (4.5%)	3 6.7%)	1	3 (4.7%)	2 (7.7%)	0.627
Urinary Tract Infection	1 (1.1%)	0	0.423	0	1 (2.2%)	1	0	1 (3.8%)	1
Transfusion within 72hrs of Surgery	5 (5.7%)	1 (0.8%)	0.085	0	5 (11.1%)	0.056	4 (6.3%)	2 (7.7%)	1
Cardiac Arrest	1 (1.1%)	0	0.423	1 (2.2%)	0	0.489	1 (1.6%)	0	1
Unplanned Readmission	4 (4.5%)	5 (4.2%)	1	1 (2.2%)	3 (6.7%)	0.617	4 (6.3%)	0	0.317
Reoperation	10 (11.4%)	4 (3.3%)	**0.027**	7 (15.9%)	3 (6.7%)	0.191	9 (14.2%)	1 (3.8%)	0.27

Table 2: Rates of adverse events between those ≤/>365 days. For patients ≤365 days, patients were further stratified into those ≤/>28 days and ≤/> 4 kg

	Univariate				Multivariate			
	All Patients		Only Patients Age ≤365 days		All Patients		Patients Age ≤365 days	
Comorbidity	OR (CI)	P-Value	OR (CI)	P-Value	OR (CI)	P-Value	OR (CI)	P-Value
Age ≤365 days	**2.91 (1.38 -6.15)**	**0.005**	/	/	2.95 (0.39-13.64)	0.166	/	/
Age ≤28 days	/	/	1.52 (0.253-1.72)	0.394	/	/		
Weight ≤4kg	**3.75 (1.79-7.88)**	**0.0005**	**3.4 (0.913-12.74)**	0.068	**5.28 (1.25 - 22.18)**	**0.023**	3.23 (0.068-1.42)	0.131
Male Gender	1.47 (0.714-3.031)	0.295	5.87 (0.815-5.87)	0.12			**3.77 (1.12-12.7)**	**0.032**
Preterm Birth	1.05 (0.369-2.96)	0.934	1.74 (0.460-6.62)	0.413				
Ventilator Dependence	**5.13 (2.011-13.07)**	**0.001**	**4.42 (1.38-14.1)**	**0.012**	**7.56 (2.41-23.74)**	**0.001**	2.56 (0.525-12.5)	0.245
History of Asthma	0.16 (0.021-1.22)	0.077	/	/	**0.097 (0.01-.898)**	**0.04**		
Bronchopulmonary Dysplasia/Chronic Lung Disease	1.21 (0.324-4.54)	0.775	/	/				
Oxygen Support	1.36 (0.510-3.66)	0.537	0.922 (0.314-2.70)	0.882				
Tracheostomy	0.574 (0.126-2.61)	0.472	/	/				
Structural Pulmonary/Airway Abnormalities	**2.79 (1.27-6.13)**	**0.011**	1.49 (0.482-4.58)	0.49	2.13 (0.867-5.24)	0.099		
Esophageal/Gastric/Intestinal Disease	1.87 (0.867-4.015)	0.111	1.78 (0.630-5.00)	0.275	**2.98 (1.19-7.5)**	**0.02**		
Developmental Delay	0.783 (0.333-1.841)	0.574	0.447 (0.051-3.93)	0.468				
Seizure Disorder	0.673 (0.080-5.65)	0.716	/	/				
Ostomy	0.603 (0.195-1.87)	0.38	0.278 (0.033-2.35)	0.24			0.307 (0.033-2.88)	0.3
Nutritional Support	**2.55 (1.225-5.30)**	**0.012**	2.56 (0.850-7.74)	0.096	1.2 (0.475-3.04)	0.696	1.72 (0.465-6.34)	0.417
Hematologic Disorder	1.65 (0.423-6.41)	0.472	1.80 (0.394-8.22)	0.448				
SIRS/Sepsis/Septic Shock within 48hrs Prior to Surgery	4.89 (0.298-79.9)	0.266	2.91 (0.174-48.5)	0.457				
Congenital Malformation	0.642 (0.263-1.57)	0.33	1.97 (0.310-12.6)	0.475				
Cardiac Risk Factors	1.13 (0.507-2.50)	0.77	0.924 (0.353-2.40)	0.87				

Table 3: Univariate and multivariate regression analysis for any adverse event among all patients and those ≤365 days

Discussion

We found an 17.3% rate of adverse events among 208 patients undergoing mandible advancement within the ACS NSQIP-Pediatric database. The primary aim of this study is to utilize this database to assess reported morbidity following mandible distraction osteogenesis (MDO). While traditional orthognathic surgery is not performed until adolescence at the earliest, MDO maybe performed in a much younger population. We focus our analysis on patients less then 365 days of age (n=88) from whom mandible advancement would be performed exclusively via MDO. Not surprisingly, this younger cohort had a higher rate of adverse events then the remainder of patients (26.1% v. 10.8%; p=0.005).

Among patients one year of age or younger, patients ≤28 days old and ≤4kg did not have higher rates of early adverse events. While weight ≤4kg was associated with complication following a multivariate analysis of all patients, this association was not found after analysis including only patients younger than one year. Tahiri et al similarly compared complications and rates of surgical success between 81 patients weighing less than 4kg to 40 patients 4kg or more.[21] Complication rate, surgical success and need for repeated distraction were not different among the two cohorts. In a study of the Kids' Inpatient Database, Lee at al. were able to show that neonatal age (≤28 days) did not result in increased post-operative stay, number of additional procedures (including tracheostomy and gastrostomy) or hospital charges following MDO.[22]

Within our entire cohort, we found ventilator dependence and esophageal, gastric or intestinal disease to be most strongly correlated with 30-day adverse events using multivariate regression analysis (Table 3). Each of these commodities reflects overall medical complexity in the pediatric population and their association with early adverse events can be expected. Airway complexity has been associated with adverse events following MDO and lower airway abnormalities have also been associated with failure to avoid tracheostomy in syndromic patients undergoing MDO.[4] To our knowledge gastrointestinal disease has not been associated with complication following mandible advancement. However, uncontrolled gastroesophageal reflux disease and swallowing disfunction have been associated with failure to facilitate decannulation.[4]

Conclusions

Early complications are relatively common following mandible advancement. However, among patients less than one year of age, patients ≤28 days old or ≤4kg at the time of operation did not experience higher rates of adverse events. This is in agreement with previous findings and suggest providers should consider early intervention in patients with severe symptomatic micrognathia that have failed non-surgical options.

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