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Institutional Variability in Anesthesia Time for Mehta Casting in Early Onset Scoliosis (EOS)

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B. Drafted the work or revised it critically for important intellectual content
C. Approved of the version to be published
D. Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Consent to Participate: Informed consent was obtained from all participants included in this study upon enrollment into the registry.

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Abstract

Purpose—Mehta casting is a potentially curative intervention for early onset scoliosis (EOS) that typically requires multiple anesthetics. The Food and Drug Administration (FDA) reported that >3hrs of anesthesia under the age of three years old may alter brain development; however, no standard exists for duration of anesthesia during casting. The purpose of this study is to quantify variability in anesthesia during Mehta casting. We hypothesis significant institutional variability exists and may be attributed to modifiable factors.

Methods—An EOS registry was used to identified patients who underwent at least one Mehta casting procedure. Anesthesia exposure was quantified, and site variability was assessed by patient characteristics, cast placement, procedure type, and equipment used.

Results—Our cohort consisted of 208 patients from 5 institutions(age 2.6±1.4yo). There were 1097 Mehta casting procedures with 5.4±3.6 castings per patient. Of these patients, 106 (51%)were female with an average age of 2.11±1.29 years old at the time casting was initiated. Patient etiologies included 154 idiopathic (74.0%), 22 syndromic (10.6%), 18 congenital (8.7%), 11 neuromuscular (5.3%), and 3 unknown (1.4%). Anesthesia time was 69±31min and varied significantly between sites (59±14 to 117±46min; p<0.001). Cumulative anesthesia time for patients under 3yo was 320±197min with 120/161 (74.5%) patients exceeding 3 hrs. Anesthesia time was lower after the FDA warning in 2016 compared to pre-2016 (71±30 vs 66±32, p=0.008).

Conclusions—Patients undergoing Mehta casting are at significant risk of exceeding 3hrs of anesthesia which the FDA has stated may be harmful for children <3yo. Significant site variability indicates that standardization protocols should be developed to encourage best practice and minimize anesthetic times.

Keywords

Early Onset Scoliosis (EOS); Mehta casting; anesthesia time; procedure time; Food and Drug Administration (FDA)

INTRODUCTION

Early onset scoliosis (EOS) is a 3-dimensional deformity of the spine diagnosed before ten years of age. Cases diagnosed at the age of 3 years old or younger are considered infantile scoliosis, while cases diagnosed between 3 and 10 years of age are classified as juvenile scoliosis [1]. Progressive infantile scoliosis can lead to pulmonary insufficiency and early death if left untreated [2–5]. Mehta casting is a potentially curative, non-invasive intervention for patients with infantile and early juvenile scoliosis that relies on traction and de-rotation to progressively correct the spinal curvature [6, 7]. Mehta originally described casting as most successful when replacing outgrown casts every eight to ten weeks for patients under two and then every twelve to sixteen weeks for older children. In addition to the frequency of casting changes, her technique also relied upon the use of anesthesia during the procedures to prevent feelings of alarm or distress given the young age of the patients[6].

While anesthetic use is standard practice during Mehta casting, there has been recent concern that early exposure to prolonged anesthetic episodes may have a negative impact on the developing brain [8–10]. A black box warning is the most serious drug safety warning that the Food and Drug Administration (FDA) can issue for a prescribed treatment specifying the dangers associated with the treatment on the product[11]. In 2016, the FDA announced a black box warning which stated that excessive anesthesia exposure younger than three years old could cause long term impairment in children, especially when exceeding three hours cumulatively [12, 13]. Baky et al. quantified anesthesia exposure in patients with EOS, including infantile scoliosis, and found that patients on average have 1606 minutes of cumulative exposure during their treatment, nearly ten times greater than what the FDA stated as concerning[8]. Additionally, they found that Mehta casting alone took 122 minutes of anesthesia per application with a cumulative anesthesia time of 848 minutes [8]. However, this was a single center study and sources of variability in anesthesia exposure time were not assessed. Given the still unknown risks associated with pediatric anesthesia exposure, surgeons have become more cautious and have tried methods to reduce, or even eliminate, anesthesia time during Mehta casting [8, 14, 15].

Although anesthesia time is of significant concern to surgeons, it needs to be considered in relation to the enormous benefit that Mehta casting provides patients with EOS. The consequences of avoiding this noninvasive technique can lead to surgical intervention in many cases which also involves significant anesthetic exposure, and a greater risk of complications [16]. Until an effective alternative to Mehta casting is developed, institutions should focus on becoming more efficient at this procedure to reduce anesthesia time. The purpose of this study is to determine institutional differences in anesthesia time for Mehta casting. Specifically, the study examined how etiology, procedure type, location of cast placement, and type of table used affected anesthesia time when surgeons followed the Mehta protocol.

METHODS

Study Design and Setting

This is a retrospective cohort study of institutions participating in the Pediatric Spine Study Group. Five sites with verified standardized Mehta casting protocols participated in the study. Institutional review board approval was obtained prior to the start of the study (Protocol AAAB5378).

Study Participants

This study investigated patients with EOS who underwent Mehta casting from 2006 to 2019. Each Mehta casting procedure was documented, and anesthesia time was compared between sites. Anesthesia time was measured as patient induction to extubation. The study seeks to specifically look at factors influencing anesthesia time in casting procedures. Thus, procedures only involving removal of the cast were excluded from the analysis, as well as due to the fact that the vast majority of removal only procedures were performed in clinic without the use of anesthesia (311/333, 93.4%). Only procedures following the Mehta protocol as outlined in previous literature[6, 17] were included. While there was standardization of casting protocol, the type of table varied among institutions. The type of casting table used during each procedure was recorded. Casting tables were categorized as specialized Mehta tables or non-Mehta tables (OSI, Risser, Traction, etc.).

Data Analysis

Descriptive analyses were performed to describe the study population. Means are reported along with standard deviations. ANOVA and t-tests were performed for continuous variables. Chi-square and Fisher exact tests were used for categorical data. Baseline characteristics were investigated to identify confounders. All statistics were 2-tailed and set significance level at 0.05. IBM SPSS Statistics, Version 27 (Armonk, NY) was used for the analysis. A power analysis was performed to calculate the minimum sample size with power set at 0.8 and significance level at 0.05 which yielded a minimum of 216 casting procedures.

RESULTS

A cohort of 208 patients with EOS who underwent Mehta casting at 5 hospitals were identified in the registry. Out of the total of 208 patients,106 (51%) were female with an average age of 2.1±1.3 years old at the time casting was initiated. A total of 1097 Mehta casting procedures were reported with patients undergoing an average of 5.4±3.5 casting procedures during their treatment. 463 (42.2%) of the casting procedures were performed under the shoulders. Patient etiologies included 154 idiopathic (74.0%), 22 syndromic (10.6%), 18 congenital (8.7%), 11 neuromuscular (5.3%), and 3 unknown (1.4%). Patient demographics and procedure details for individual castings are shown in Table 1. The average anesthesia time for individual casting procedures was 69±31 minutes (range 16 to 225 minutes) and the average cumulative anesthesia exposure for each patient was 364±247 minutes. The mean cumulative anesthesia time for patients under three years old was 320±197 minutes with 120/161 (74.5%) patients exceeding 3 hours of cumulative anesthesia exposure. The anesthesia time per procedure was significantly lower after the FDA 2016 warning compared to procedures from 2006–2015 (71±30 vs 66±32, p=0.008). It was found that there were significant differences in the mean anesthesia time for casting procedures at each site as shown in Table 2 (p=0.001) and ranged from 59±14 (site 3) to 117±46 minutes (site 5) for the sites. Additionally, there were site specific differences in etiology (p<0.001), whether the cast was removed under anesthesia (p<0.001), whether the cast was over or under the shoulder (p<0.001), and casting tables used during each procedure (p<0.001).

When all sites were analyzed together, anesthesia time for each casting procedure varied significantly depending on the etiology of EOS. Patients with neuromuscular etiology were found to have the longest anesthesia time of 79 minutes compared to 67, 69, and 77 minutes for idiopathic, congenital, and syndromic patients respectively ($p<0.001$) as seen in Table 3. However, when sites were analyzed independently, only site 4 showed a significant difference in anesthesia time when comparing etiologies where syndromic etiology had the longest anesthesia time of 71 minutes compared to neuromuscular etiology which had the shortest time of 59 minutes ($p=0.020$). Site 1 demonstrated a trend towards a similar pattern to Site 4 ($p=0.06$), but these results did not achieve the 0.05 due to the smaller number of cases in site 1. The use of Mehta tables varied by etiology amongst all institutions; they were used most commonly among patients with congenital scoliosis followed by idiopathic, neuromuscular, and syndromic etiologies ($p<0.001$). Site 1 and Site 3 were the only sites that independently demonstrate significant differences in tables used for the different EOS etiologies.

Table 4 exhibits the differences between the sites when stratified by etiology. There was a statistically significant difference between all five sites in terms of proportion of procedures that had removal of casts under anesthesia along with application vs just application of casts under anesthesia (i.e., cast removal was not under anesthesia), $p<0.001$ in all four etiologies. Furthermore, all five sites differed significantly in the proportion of placed casts that were over the shoulder vs below the shoulder when stratified by etiology ($p<0.001$ for all four etiologies). Site 5 demonstrated longer anesthesia time for all etiologies compared to the other sites with 119, 100, 119, and 114 minutes for idiopathic, syndromic, congenital, and neuromuscular, respectively ($p<0.001$). Furthermore, site 5 only used Mehta tables for all etiologies and the anesthesia time did not differ between etiologies at that site ($p=0.73$). This site frequently molds intraoperatively for TLSOs and also does not have a dedicated casting team. In comparison, only syndromic patients in site 1 had a mean anesthesia time above 80 minutes at 83. To account for this outlier in site 5, table 5 exhibits the differences in anesthesia time between sites 1–4. Overall, there was a significant difference between the four sites, though idiopathic was the only etiology approaching statistical significance when the anesthesia times were stratified by etiology.

DISCUSSION

Mehta casting is a potentially curative, non-invasive intervention for EOS; however, the technique evolved in an era where concerns about anesthesia exposure were not prominent and factors influencing casting time were not studied [8, 18]. Following the FDA’s black box warning in 2016, surgeons have become more aware of the potential harm caused by anesthesia exposure and quantifying anesthesia times for procedures has become an important factor for surgical decision making. Interestingly, there was found to be significantly lower mean anesthesia times after the 2016 warning compared to procedures before 2016. However, it is impossible to know if this change was due to the warning, due to improved efficiency with experience, or other factors. Certainly, it should be a goal of healthcare providers to optimize procedures through standardization of protocols according to best practice. Our finding that anesthesia time for Mehta casting procedures varies almost one hour between sites indicates that there is significant room for improvement.

Furthermore, almost 75% of EOS patients under the age of three undergoing casting procedures exceeded the three-hour cumulative threshold that the FDA had stated may be associated with significant risk for developmental abnormalities. To our knowledge, no previous studies have identified the variability in anesthesia time for Mehta casting between institutions or identified factors that may contribute to excessive exposure.

While the Mehta protocol is well established, there are some institutions that have opted for non-Mehta tables including Traction Frames, Spica tables, Risser, and OSI tables due to the high costs of purchasing Mehta tables or physician preference[17, 19–21]. Physicians have reported successful applications of Mehta castings without using specialized tables, however, these results do not take anesthesia time into consideration[17, 19]. Mehta tables are specifically designed to allow for easy access to the patient's body while supporting the head and limbs[22]. In describing the Mehta casting technique, Sanders states that Risser and Cotrel frames can be used, but their large size is less than ideal for these procedures[22]. In this study, it could not be determined whether the choice of table affected the variability in anesthesia. This is most likely due to the fact that over 90% of the tables used by all sites were Mehta tables and no site used a Mehta table for fewer than 68.6% of their procedures (site 1).

Interestingly, at some institutions, patients with different etiologies received differing amounts of anesthesia for each Mehta casting procedure. When all sites were analyzed together, patients with neuromuscular EOS had the longest anesthesia times whereas idiopathic EOS patients had the shortest anesthesia times during their Mehta casting procedures. These intuitive results reproduce the findings of Baky et al [8]. However, when looking at individual sites independently, only two of 5 sites demonstrated significant differences in anesthesia time when stratifying by EOS etiology. Furthermore, patients with neuromuscular etiology were exposed to the least anesthesia during each casting procedure at site 4 which is counter to the population mean. Patients with neuromuscular etiology experienced almost an hour difference in anesthesia time depending on their treatment site.

While anesthetized patients undergoing casting procedures as described by Mehta is still standard of care at most institutions, there is a recent effort to develop alternative techniques to limit excessive exposure. Kawakami et al reports placing casts without anesthesia, instead using an iPad as a technique [4]. However, it should be noted that the patients undergoing casting in their study were older (3.0±1.1) than the patients from the five institutions reported here. Other institutions have developed alternative techniques to applying Mehta casting with the goal of reducing or eliminating anesthesia time with some evidence suggesting that awake casting may be a safe and effective alternative to general anesthesia[23].

The primary goal of this study was to evaluate the variability in anesthesia time among institutions following the Mehta casting protocol. While identifying modifiable factors would have been ideal in guiding the reduction of variability, the study is limited by the retrospective, registry based nature of this data which does not capture all potential factors. These include procedures done under anesthesia such as cast trimming, brace molding, or obtaining radiographs. There are also site-specific anesthesia protocols that may impact anesthesia time, but the registry does not contain this data. Site 5, which had the longest anesthesia times for all etiologies, was noted to have a lack of dedicated casting teams. It has been shown that having dedicated operating room units improves efficiency[24, 25]. Thus, future research may assess whether dedicated casting teams have an effect on decreasing anesthesia time in casting as well.

There were several outliers between the sites. For example, 568 (99.8%) of the cast applications at site 4 were over the shoulder, while 15 (5.7%), one (0.7%), and 0 (0.0%) of the castings were over the shoulder in sites 1, 2, and 3, respectively. Differences like these further illustrate the marked institutional variability in clinical decision making. Future studies should try to capture some of these factors, perhaps prospectively, to get a better handle on the role of some of these modifiable factors in the observed examine variability in anesthesia time. Another potential limitation may be that 74% of our patients were idiopathic which may bias the outcomes. However, this may be due to the protocol itself 73.5% of Mehta's initial study cohort was idiopathic[6].

Despite the limitations of this study, the finding that significant variability in anesthesia time exists between institutions is clinically meaningful and showing this variability was the primary goal of this study. Given the potential risks associated with prolonged pediatric anesthesia exposure, institutions should implement strategies to improve the safety of this standard procedure for the treatment of infantile scoliosis. Furthermore, these results emphasize the need to develop standardized protocols, and support the use of standardized teams, to help limit anesthesia for these patients. However, the authors acknowledge that there are currently no best practice guidelines for Mehta casting and future research should be directed at developing these guidelines. Future studies may examine modifiable factors that influence anesthesia time in order to construct best practice guidelines for this procedure. An alternative to mitigating curve progression in the growing spine is bracing which may be noninferior to casting while also eliminating the risks associated with anesthesia. A casting versus bracing trial is ongoing that may help elucidate this crucial issue.

Declarations

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Conflict of Interest:

LBO received a grant by the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant Number TL1TR001875. MSM has no conflicts of interest to disclose. JB has no conflicts of interest to disclose. MES has no conflicts of interest to disclose. HM has no conflicts of interest to disclose. PS received consulting fees from Nuvasive and Depuy Synthes Spine. JMP received consulting fees from Nuvasive, Depuy Synthes, and Zimmer Biomet. ANL consulted unrelated to this submitted work with all funds directed to Mayo Clinic Orthopedics research. MGV has received grants from the Pediatric Orthopaedic Society of North America, Orthopedic Science Research Foundation, Pediatric Spine Foundation, and Setting Scoliosis Straight Foundation and royalties from Biomet. He is a paid consultant for Stryker, Biomet, and NuVasive. MGV is on the Board of Directors of Pediatric Spine Foundation, Pediatric Spine Study Group, and C4K. He is former president of Pediatric Orthopaedic Society of North America and is a Board Member, Chair Emeritus of the International Pediatric

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Availability of Data and Material:

The data that support the findings of this study are available from the corresponding author, HM, upon reasonable request.

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Table 1.

Patient demographics and procedural details for individual castings. Means and standard deviations are reported.

Age (years)		2.6±1.4	
Sex	**Female**	540(49.2%)	
	Male	557(50.8%)	
Height (cm)		73±28	
Weight (kg)		12±3	
Anesthesia Time (min)		69±31	
Anesthesia Time Range (min)		16–255	
Procedure Time (min)		41±28	
Procedure Time Range (min)		5–225	
Etiology	**Idiopathic**	812(74.0%)	
	Congenital	111(10.1%)	
	Syndromic	110(10.0%)	
	Neuromuscular	57(5.2%)	
	Unknown	7(0.6%)	
Cast	**Under Shoulder**	463(42.2%)	
	Over Shoulder	634(57.8%)	
Procedure	**Application**	940(85.7%)	
	Application and Removal	157(14.3%)	
Table	**Non-Mehta**	108(9.9%)	
	Mehta	982(90.1%)	
Anesthesia Time (min)	**2006–2015 (n=609)**	71±30	p = 0.008
	2016–2019 (n=488)	66±32	
Procedure Time (min)	**2006–2015 (n=609)**	43±28	p = 0.02
	2016–2019 (n=488)	39±26	

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Table 2.

Site specific anesthesia time and procedural details. Means and standard deviations are reported.

		Site 1	Site 2	Site 3	Site 4	Site 5	P-Value
Anesthesia Time		**69±36**	**67±15**	**59±14**	**63±24**	**117±46**	**0.001**
Etiology	Idiopathic (n)	211(79.9%)	113(81.3%)	20(54.1%)	423(74.3%)	45(55.6%)	
	Congenital	3(1.1%)	10(7.2%)	17(45.9%)	75(13.2%)	6(7.4%)	
	Syndromic	38(14.4%)	16(11.5%)	0(0%)	47(8.3%)	9(11.1%)	
	Neuromuscular	12(4.5%)	0(0%)	0(0%)	24(4.2%)	21(25.9%)	<0.001
Procedure	Application	189(71.6%)	138(99.3%)	8(21.6%)	569(100%)	31(38.3%)	
	Application and Removal	75(28.4%)	1(0.7%)	29(78.4%)	0(0%)	50(61.7%)	<0.001
Table	Non-Mehta	83(31.4%)	6(4.3%)	9(24.3%)	10(1.8%)	0(0%)	
	Mehta	181(68.6%)	133(95.7%)	28(75.7%)	559(98.2%)	81(100%)	<0.001

Table 3.

Site specific anesthesia time and procedural details for EOS etiologies. Means and standard deviations are reported.

			Idiopathic	Syndromic	Congenital	Neuromuscular	P-Value
All Sites	**Anesthesia Time**		**67±30**	**77±33**	**69±28**	**79±42**	**<0.001**
	Procedure	Application	704 (86.7%)	102 (92.7%)	90 (81.1%)	39 (68.4%)	
		Application and Removal	108 (13.3%)	8 (7.3%)	21 (18.9%)	18 (31.6%)	<0.001
	Cast Placement	Under Shoulder	342 (42.1%)	58 (52.7%)	30 (27.0%)	26 (45.6%)	
		Over Shoulder	470 (57.9%)	52 (47.3%)	81 (73.0%)	31 (54.4%)	0.001
	Table	Non-Mehta	69 (8.5%)	21 (19.1%)	8 (7.2%)	10 (17.5%)	
		Mehta	743 (91.5%)	89 (81.9%)	103 (92.8%)	47 (82.5%)	<0.001
Site 1	**Anesthesia Time**		**67±37**	**83±31**	**71±7**	**59±6**	**0.060**
	Procedure	Application	146 (69.2%)	33 (86.8%)	1 (33.3%)	9 (75.0%)	
		Application and Removal	65 (30.8%)	5 (13.2%)	2 (66.7%)	3 (25.0%)	0.067
	Cast Placement	Under Shoulder	200 (94.8%)	34 (89.5%)	3 (100.0%)	12 (100.0%)	
		Over Shoulder	11 (5.2%)	4 (10.5%)	0 (0.0%)	0 (0.0%)	0.448
	Table	Non-Mehta	55 (26.1%)	18 (47.4%)	0 (0.0%)	10 (83.3%)	
		Mehta	156 (73.9%)	20 (52.6%)	3 (100.0%)	2 (16.7%)	<0.001
Site 2	**Anesthesia Time**		**66±14**	**68±17**	**75±20**	--	**0.180**
	Procedure	Application	112 (99.1%)	16 (100.0%)	10 (100.0%)	--	
		Application and Removal	1 (0.9%)	0 (0.0%)	0 (0.0%)	--	0.891
	Cast Placement	Under Shoulder	112 (99.1%)	16 (100.0%)	10 (100.0%)	--	
		Over Shoulder	1 (0.9%)	0 (0.0%)	0 (0.0%)	--	0.891
	Table	Non-Mehta	5 (4.4%)	1 (6.3%)	0 (0.0%)	--	
		Mehta	108 (95.6%)	15 (93.8%)	10 (100.0%)	--	0.741
Site 3	**Anesthesia Time**		**57±14**	--	**62±13**	--	**0.231**
	Procedure	Application	6 (30.0%)	--	2 (11.8%)	--	
		Application and Removal	14 (70.0%)	--	15 (88.2%)	--	0.246
	Cast Placement	Under Shoulder	20 (100.0%)	--	17 (100.0%)	--	
		Over Shoulder	0 (0.0%)	--	0 (0.0%)	--	--
	Table	Non-Mehta	1 (5.0%)	--	8 (47.1%)	--	
		Mehta	19 (95.0%)	--	9 (52.9%)	--	0.005
Site 4	**Anesthesia Time**		**62±22**	**71±35**	**66±25**	**59±11**	**0.020**
	Procedure	Application	423 (100.0%)	47 (100.0%)	75 (100.0%)	24 (100.0%)	
		Application and Removal	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	--
	Cast Placement	Under Shoulder	1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
		Over Shoulder	422 (99.8%)	47 (100.0%)	75 (100.0%)	24 (100.0%)	0.951
	Table	Non-Mehta	8 (1.9%)	2 (4.3%)	0 (0.0%)	0 (0.0%)	
		Mehta	415 (98.1%)	45 (95.7%)	75 (100.0%)	24 (100.0%)	0.319
Site 5	**Anesthesia Time**		**119±40**	**100±42**	**119±62**	**114±54**	**0.730**

			Idiopathic	Syndromic	Congenital	Neuromuscular	P-Value
	Procedure	Application	17 (37.8%)	6 (66.7%)	2(33.3%)	6 (28.6%)	0.264
		Application and Removal	28 (62.2%)	3 (33.3%)	4 (66.7%)	15 (71.4%)	
	Cast Placement	Under Shoulder	9 (20.0%)	8 (88.9%)	0 (0.0%)	14 (66.7%)	<0.001
		Over Shoulder	36 (80.0%)	1 (11.1%)	6 (100.0%)	7 (33.3%)	
	Table	Non-Mehta	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	--
		Mehta	45 (100.0%)	9 (100.0%)	6 (100.0%)	21 (100.0%)	

Table 4.

Etiology specific anesthesia time and procedural details for sites. Means and standard deviations are reported.

			Site 1	Site 2	Site 3	Site 4	Site 5	P-Value
Idiopathic	**Anesthesia Time**		67±37	66±14	57±14	62±22	119±40	<0.001
	Procedure	Application	146 (69.2%)	112 (99.1%)	6 (30.0%)	423 (100.0%)	17 (37.8%)	
		Application and Removal	65 (30.8%)	1 (0.9%)	14 (70.0%)	0 (0.0%)	28 (62.2%)	<0.001
	Cast Placement	Under Shoulder	200 (94.8%)	112 (99.1%)	20 (100.0%)	1 (0.2%)	9 (20.0%)	
		Over Shoulder	11 (5.2%)	1 (0.90%)	0 (0.0%)	422 (99.8%)	36 (80.0%)	<0.001
	Table	Non-Mehta	55 (26.1%)	5 (4.4%)	1 (5.0%)	8 (1.9%)	0. (100.0%)	
		Mehta	156 (73.9%)	108 (95.6%)	19 (95.0%)	415 (98.1%)	45 (100.0%)	<0.001
Congenital	**Anesthesia Time**		71±7	75±20	62±13	66±25	119±62	<0.001
	Procedure	Application	1 (33.3%)	10 (100.0%)	2 (11.8%)	75 (100.0%)	2 (33.3%)	
		Application and Removal	2 (66.7%)	0 (0.0%)	15 (88.2%)	0 (0.0%)	4 (66.7%)	<0.001
	Cast Placement	Under Shoulder	3 (100.0%)	10 (100.0%)	17 (100.0%)	0 (0.0%)	0 (0.0%)	
		Over Shoulder	0 (0.0%)	0 (0.0%)	0 (0.0%)	75 (100.0%)	6 (100.0%)	<0.001
	Table	Non-Mehta	0 (0.0%)	0 (0.0%)	8 (47.1%)	0 (0.0%)	0 (0%)	
		Mehta	3 (100.0%)	10 (100.0%)	9 (52.9%)	75 (100.0%)	6 (100.0%)	<0.001
Syndromic	**Anesthesia Time**		83±31	68±17	--	71±35	100±42	0.04
	Procedure	Application	33 (86.8%)	16 (100.0%)	--	47 (100.0%)	6 (66.7%)	
		Application and Removal	5 (13.2%)	0 (0.0%)	--	0 (0.0%)	3 (33.3%)	0.001
	Cast Placement	Under Shoulder	34 (89.5%)	16 (100.0%)	--	0 (0.0%)	8 (88.9%)	
		Over Shoulder	4 (10.5%)	0 (0.0%)	--	47 (100.0%)	1 (11.1%)	<0.001
	Table	Non-Mehta	18 (47.4%)	1 (6.3%)	--	2 (4.3%)	0 (0%)	
		Mehta	20 (52.6%)	15 (93.9%)	--	45 (95.7%)	9 (100.0%)	<0.001
Neuromuscular	**Anesthesia Time**		59±6	--	--	59±11	114±54	<0.001
	Procedure	Application	9 (75.0%)	--	--	24 (100.0%)	6 (28.6%)	
		Application and Removal	3 (25.0%)	--	--	0 (0.0%)	15 (71.4%)	<0.001
	Cast Placement	Under Shoulder	12 (100.0%)	--	--	0 (0.0%)	14 (66.7%)	
		Over Shoulder	0 (0.0%)	--	--	24 (100.0%)	7 (33.3%)	<0.001
	Table	Non-Mehta	10 (83.3%)	--	--	0 (0.0%)	0 (0.0%)	
		Mehta	2 (16.7%)	--	--	24 (100.0%)	21 (100.0%)	<0.001

Table 5.

Etiology specific anesthesia time for sites, without site 5. Means and standard deviations are reported.

	Etiology:	Site 1	Site 2	Site 3	Site 4	P-Value
Anesthesia Time:	Overall:	69±36	67±15	59±14	63±24	0.008
	Idiopathic:	67±37	66±14	57±14	62±22	0.06
	Congenital:	71±7	75±20	62±13	66±25	0.54
	Syndromic:	83±31	68±17	--	71±35	0.14
	Neuromuscular:	59±6	--	--	59±11	1.0