

# Şant Cerrahisi Geçiren Hidrosefalili Çocuklarda Zor Entübasyon Riskinin Değerlendirilmesi: Bir Prospektif Kontrollü Çalışma

## The Evaluation of Difficult Intubation Risk in Children with Hydrocephalus Undergoing Shunt Surgery: A Prospective Controlled Study

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### ÖZ

**GİRİŞ ve AMAÇ:** Hidrosefali kafa kaidesinde genişlemeye ve kafatasının anatomisinin bozulmasına öncülük ederek genellikle yenidoğan ve pediatrik hastaların havayolu yönetiminde ciddi zorluklara neden olmaktadır. Bu, başın yerleşmesini engelleyerek geleneksel laringoskopi için zorlukla sonuçlanır. Bu çalışmada şant cerrahisi geçiren pediatrik hastalarda anatomik özellikler ile zor entübasyon bulguları arasındaki ilişkiyi belirlemeyi amaçladık.

**YÖNTEM ve GEREÇLER:** Ventriküloperitoneal şant yerleştirilmesi gerektiren altmış hasta çalışmaya alındı. Hastalar üç gruba ayrıldı: hidrosefalisi olan >1 ay üzerinde (n=20), hidrosefalisi olan yenidoğan (n=20) ve hidrosefalisi olmayan yenidoğan (n=20). Baş çevresi, alt ve üst dudak-çene mesafesi, sternomental ve tiromental mesafe, Cormack-Lehane sınıflaması skoru kaydedildi. Başarılı entübasyon için girişim sayısı, optimizasyon manevralarının varlığı da kaydedildi. Entübasyonun zorluğu 10 cm'lik VAS cetveliyle ölçüldü. Tüm hastalar aynı anesteziyolojist tarafından entübe edildi.

**BULGULAR:** ASA skorları, entübasyon girişim sayıları, optimizasyon manevralarının sıklığı, hidrosefalisi olanlarla karşılaştırıldığında hidrosefalisi olmayan yenidoğanlarda anlamlı olarak daha düşüktü ( $p<0,05$ ). Hidrosefalisi olmayanlarla karşılaştırıldığında tragus-çene mesafesi hidrosefalisi olan yenidoğanlarda azalmıştı. Hidrosefalisi olan yenidoğanlarda Cormack-Lehane sınıf III anlamlı olarak artmışken, Cormack-Lehane sınıf I anlamlı olarak azalmıştı ( $p<0,05$ ). Hidrosefalisi olan yenidoğanların ikinci girişimde entübasyon oranı %45 iken bu oran kontrol grubunda sadece %10'du.

**TARTIŞMA ve SONUÇ:** Bu çalışmanın sonuçları hidrosefalisi olan çocuk hastalarda zor entübasyon riskinin arttığını göstermektedir.

**Anahtar Kelimeler:** hidrosefali, trakeal entübasyon, çocuklar

### ABSTRACT

**INTRODUCTION:** Hydrocephalus commonly cause serious challenges in airway management of newborn and paediatric patients, leading to enlarged head and distortion of skull anatomy. This result in difficulty for conventional laryngoscopy by hindering positioning of head. In this study, we aimed to determine the relationship between anatomic features and the signs of difficult intubation in paediatric patients undergoing shunt surgery.

**METHODS:** Sixty patients requiring ventriculoperitoneal shunt insertion were enrolled. Patients divided into three groups based on >1 month of age with hydrocephalus (n=20), newborn with hydrocephalus (n=20) and newborn without hydrocephalus (n=20). Head circumference, the lower and upper lip-chin distance, sternomental and thyromental distance, Cormack-Lehane Classification scores were recorded. The number of attempts for successful intubation, presence of optimization maneuvers were also recorded. The difficulty of intubation was evaluated with a 10 cm VAS ruler. All patients were intubated by the same anaesthesiologist.

**RESULTS:** The ASA scores, number of intubation attempts, and the frequency of optimization maneuvers were significantly lower in neonates without hydrocephalus as compared to patients with hydrocephalus ( $p<0,05$ ). The tragus-to-chin distance was decreased in the neonates with hydrocephalus in comparison with those without hydrocephalus. The Cormack-Lehane grade III was significantly increased while the Cormack-Lehane grade I was significantly decreased in neonates with hydrocephalus ( $p<0,05$ ). Whereas 45% of the neonates with hydrocephalus were intubated at the second attempt, the rate was only 10% in control group.

**DISCUSSION AND CONCLUSION:** The results of this study suggest that the risk of difficult intubation increases in paediatric patients with hydrocephalus.

**Keywords:** hydrocephalus, tracheal intubation, children

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## INTRODUCTION

Hydrocephalus is a condition characterized with the accumulation of excessive amount of cerebrospinal fluid (CSF) within the ventricles and subarachnoid cavity (1). Hydrocephalus developing prior to closure of cranial sutures during infancy or early childhood leads to a significant increase in head circumference (2). The effect of hydrocephalus on head size is most evident in infants whose cranial sutures are still open, and hydrocephalus is one of the major causes of macrocephaly in infancy. Paediatric hydrocephalus is generally accompanied by some diseases including meningocele, meningomyelocele, and tethered cord (3,4).

Sustainability of spontaneous breathing or artificial respiration during anaesthesia is important and needs to be determined in advance. It is generally useful to understand the difficulty in the continuity of airway for being able to take precautions and identify the necessary intubation method. Macrocephaly is one of the causes of difficult airway (5). Macrocephaly may challenge airway management, disrupting normal skull anatomy (6). Also, a large occiput can cause excessive flexion of the neck while a large forehead may limit the line of vision during laryngoscopy (7,8).

This study aimed to evaluate the role of predictive tests in identifying difficult airway and to assess the incidence of difficult airway in children undergoing shunt procedure due to hydrocephalus.

## MATERIALS AND METHODS

After obtaining the approval of the Ethics Committee (no: 14.07.2015/34-291) and parental consents, a total of 60 ASA I-III patients, who were aged 0-18 months and scheduled for surgery due to hydrocephalus were included in the study. The study protocol was registered to ANZCTR Australian New Zealand Clinical Trials Registry with no: 376711. All patients were monitored using standard techniques such as electrocardiogram, measurement of non-invasive blood pressure, peripheral oxygen saturation monitorization, end tidal CO<sub>2</sub> pressure, and body temperature. The same observer recorded the head circumference, lower lip-chin distance, upper lip-chin distance, lobe-chin distance, tragus-chin distance, sternomental distance, thyromental distance, neck extension, and the presence of

protruding teeth and macroglossia in the preoperative period for all the patients. Anaesthesia induction was achieved with 8% sevoflurane and 100% oxygen. Patients received 1 mcg/kg fentanyl and 0.5 mg/kg rocuronium IV prior to tracheal intubation. The patients divided into three groups based on >1 month of age with hydrocephalus (n=20), newborn with hydrocephalus (n=20) and newborn without hydrocephalus (n=20). The Cormack-Lehane grade of laryngoscopy was recorded after standard anaesthesia induction just before proceeding to the surgery. Additionally, the observer also recorded the number of attempts for successful intubation, the size of endotracheal tube, the need for optimization maneuver, the presence of dental trauma, and the need for video laryngoscopy during intubation. The difficulty of intubation was scaled using the Visual Analog Scale (VAS) ranging from 0 to 10. All the patients were intubated by the same three anesthesiologists participating in the study who had 5 years of experience in paediatric anesthesiology. Exclusion criteria included known history of difficult intubation, hemodynamic instability, failure to achieve intubation or a SpO<sub>2</sub> level below 90%.

### Statistical Analysis

The SPSS 22.0 program was used for the analysis of the study data. The descriptive statistics employed in the study were mean, standard deviation, median, minimum, maximum, frequency, and ratio. The Kolmogorov-Smirnov test was used to measure the distribution of variables. The Mann-Whitney U test was used to analyze quantitative independent data while the Chi-square test was used to assess the qualitative independent data. In cases where the Chi-square conditions were not met, the Fisher test was used for the qualitative data. A value of  $P < 0.05$  was considered statistically significant.

The primary outcome variable was the assessment of difficult intubation. To demonstrate a 50% difference in both the number of tracheal intubation attempts and the optimization maneuvers, we estimated that 19 patients per group would be required with a power of 0.9 ( $\alpha=0.05$ , standard effect size: 1.04).

## RESULTS

The data of 60 children were analyzed. None of the patients were excluded. No statistically significant difference was found between the neonates with and without hydrocephalus regarding the gender distribution, head circumference, lower lip-chin distance, neck extension, the presence of protruding teeth and macroglossia, the presence of dental trauma, and the need for videolaryngoscopy ( $p > 0.05$ , Table 1). Nevertheless, the ASA score, the number of intubation attempts, and the frequency of optimization maneuver were significantly lower in the neonates without hydrocephalus as compared to those with hydrocephalus ( $p < 0.05$ , Table 1).

The earlobe-to-chin and the tragus-to-chin distances were decreased in the neonates with hydrocephalus in comparison with those without hydrocephalus. Furthermore, the sternomental and thyromental distances were higher in the neonates that had hydrocephalus. The Cormack-Lehane grade III was significantly increased while the Cormack-Lehane grade I was significantly decreased in the neonates with hydrocephalus ( $p < 0.05$ ). Whereas 45% of the neonates with hydrocephalus were intubated at the second attempt, the rate was only 10% in the control group. Eighty percent of the neonates with hydrocephalus required optimization maneuver, whereas only 10% of the neonates

**Table 1. The comparison of demographics, physical examination, Cormack-Lehane Score, requirement for optimization manoeuvre and a videolaryngoscope in newborns with and without hydrocephalus**

	Group newborn without hydrocephalus			Group newborn with hydrocephalus			p	
		mean±sd/n-%	Median	mean±sd/n-%	Median			
Gender	Female	10	50.0%	13	65.0%	0.337	$\chi^2$	
	Male	10	50.0%	7	35.0%			
ASA	I	16	80.0%	6	30.0%	<b>0.001</b>	$\chi^2$	
	II	4	20.0%	14	70.0%			
Head circumference (cm)		35.29 ± 0.81	35.05	38.46 ± 7.94	35.50	0.776	m	
Lower lip-chin (cm)		21.49 ± 1.73	21.50	21.30 ± 3.57	20.00	0.426	m	
Upper lip-chin (cm)		30.46 ± 2.18	31.00	30.15 ± 3.65	30.00	0.469	m	
Ear lobe-chin (cm)		84.63 ± 4.38	84.75	66.05 ± 8.17	70.00	<b>0.000</b>	m	
Tragus-chin (cm)		91.10 ± 2.77	91.00	64.60 ± 7.85	62.50	<b>0.000</b>	m	
Sternomental (cm)		23.58 ± 2.12	23.00	57.20 ± 9.59	55.00	<b>0.000</b>	m	
Tyromental (cm)		18.01 ± 2.42	18.25	46.45 ± 9.32	45.00	<b>0.000</b>	m	
Cormack-Lehane	I	16	80.0%	10	50.0%	<b>0.017</b>	$\chi^2$	
	II	4	20.0%	5	25.0%			
	III	0	0.0%	5	25.0%			
Tracheal intubation attempt	1	18	90.0%	11	55.0%	<b>0.013</b>	$\chi^2$	
	2	2	10.0%	9	45.0%			
Optimization maneuver	(-)	18	90.0%	4	20.0%	<b>0.000</b>	$\chi^2$	
	(+)	2	10.0%	16	80.0%			
Need for Videolaryngoscopy	(-)	20	100.0%	20	100.0%	-		
	(+)	0	0.0%	0	0.0%			

<sup>m</sup> Mann-whitney u test /  <sup>$\chi^2$</sup>  Ki-kare test (Fischer test)

without hydrocephalus needed optimization maneuver.

When the neonates with hydrocephalus were compared to the patients with hydrocephalus other than neonates, no statistically significant difference was observed in the following aspects: the ASA score, the thyromental distance, the presence of

protruding teeth, the presence of macroglossia, the presence of dental trauma, tube size, and videolaryngoscopy requirements, the Cormack-Lehane score, the number of intubation attempts, and the frequency of optimization maneuver ( $p > 0.05$ , Table 2). All measurements were higher in hydrocephalus patients other than neonates (Table 2).

**Table 2. The comparison of demographics, physical examination, Cormack-Lehane Score, requirement for optimization manoeuvre and a videolaryngoscope in newborns and non newborns with hydrocephalus.**

	Group newborn with hydrocephalus					Group non newborn with hydrocephalus					p	
		mean±sd/n-%			Median	mean±sd/n-%			Median			
Gender	Female	13		65.0%		7		35.0%		0.058	x <sup>2</sup>	
	Male	7		35.0%		13		65.0%				
ASA	I	6		30.0%		2		10.0%		0.114	x <sup>2</sup>	
	II	14		70.0%		18		90.0%				
Head circumference (cm)		38.46	±	7.94	35.50	45.93	±	5.52	45.75	<b>0.001</b>	m	
Lower lip-chin (cm)		21.30	±	3.57	20.00	24.40	±	5.34	22.00	<b>0.026</b>	m	
Upper lip-chin (cm)		30.15	±	3.65	30.00	31.90	±	5.63	32.00	<b>0.046</b>	m	
Ear lobe-chin (cm)		66.05	±	8.17	70.00	78.15	±	14.39	75.00	<b>0.009</b>	m	
Tragus-chin (cm)		64.60	±	7.85	62.50	76.15	±	18.11	76.50	<b>0.045</b>	m	
Sternomental (cm)		57.20	±	9.59	55.00	62.15	±	11.85	61.50	<b>0.043</b>	m	
Tyromental (cm)		46.45	±	9.32	45.00	49.55	±	13.68	50.00	0.354	m	
Cormack-Lehane	I	10		50.0%		8		40.0%		0.757	x <sup>2</sup>	
	II	5		25.0%		7		35.0%				
	III	5		25.0%		5		25.0%				
Tracheal intubation attempt	1	11		55.0%		11		55.0%		1.00	x <sup>2</sup>	
	2	9		45.0%		7		35.0%				
	3	0		0.0%		2		10.0%				
Optimization maneuver	(-)	4		20.0%		6		30.0%		0.465	x <sup>2</sup>	
	(+)	16		80.0%		14		70.0%				
Need for Videolaryngoscopy	(-)	20		100.0%		20		100.0%		-		
	(+)	0		0.0%		0		0.0%				
<sup>m</sup> Mann-whitney u test / <sup>x<sup>2</sup></sup> Ki-kare test (Fischer test)												

## DISCUSSION

In this prospective comparative study, the incidence of intubation at the second attempt, the frequency of optimization maneuver, and the Cormack-Lehane grade III rate were significantly higher in the neonates with hydrocephalus as compared to those without hydrocephalus. These findings suggest that we should predict the difficulty of tracheal intubation in the neonates having hydrocephalus.

The anatomy and functions of the respiratory system are different in pediatric patients (9,10). Their expiratory reserve volume is limited due to decreased functional residual capacity. When it comes to the anatomical differences, young children tend to have larger tongue, omega-shaped epiglottis, and cephalic-located larynx and their vocal cords are anterior-slanting. Besides, children with hydrocephalus also have the risk for difficult intubation (11).

There are studies in the literature reporting difficult tracheal intubation due to hydrocephalus. There is a case study giving information about the intubation method for a 4-month-old infant, who had hydrocephalus and a head circumference of 70 cm (12). Vagyannavar, R. et al. (13) reported that the occipitofrontal circumference increased to 65 cm in a 9-month-old infant. In addition to a grade III laryngeal view according to the Cormack-Lehane classification, there was also a floppy epiglottis, and the initial intubation attempt failed in that case. In all the cases mentioned above, the head circumference showed a significant increase due to hydrocephalus. However, in our study, the mean head circumference was  $38.46 \pm 7.94$  cm for the neonates with hydrocephalus. Eighty percent of our hydrocephalus patients required optimization maneuver while forty percent was able to be intubated at the second attempt. Moreover, 25% of these neonates had grade 3 and another 25% has grade 2 of the Cormack-Lehane scale. In line with these results, this study clearly indicated that there is an increase in the incidence of difficult tracheal intubation in the neonates who have hydrocephalus with a median head circumference of 35.5 cm.

It has been suggested to perform a gentle laryngoscopy after the induction of sevoflurane and

then, if the epiglottis is visible, administer the muscle relaxant agent in paediatric patients that are expected to have difficult airway (14). In the present study, we achieved anaesthesia induction using sevoflurane, and then, applied the muscle relaxant with rocuronium just before the tracheal intubation. Although performing laryngoscopy without muscle relaxant can be regarded as a precaution against the risk of failed intubation, we administered a muscle relaxant agent to prevent the risk of laryngospasm.

## CONCLUSION

The results of this study suggest that the risk of difficult intubation increases in paediatric patients that have hydrocephalus without macrocephaly. Therefore, it is necessary to plan the preoperative preparations considering not only the adverse effects of increased intracranial pressure, but also the management of difficult airway in order to improve patient safety.

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