

Comparison of the Occurrence of Atelectasis between Propofol and Dexmedetomidine as a Sedative for Pediatric MRI

Pyeong Hwa Kim¹, Hee Mang Yoon¹, Yong-Seok Park², Ah Young Jung¹,
Young Ah Cho¹, Jin Seong Lee¹, Myung-Hee Song²

*Department of Radiology and Research Institute of Radiology¹ and Department of
Anesthesiology and Pain Medicine²,*

Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Disclosure

There are no conflicts of interest and nothing to disclose.

Purpose

- To compare **propofol** and **dexmedetomidine** as a sedative in regard to **occurrence of atelectasis**
- To investigate **factors associated with atelectasis** development in children imaged whole-body MRI under sedation

Introduction

- Prolonged sedation required for children d/t immobilization and noise issue
- However, sedation induces atelectasis → dyspnea, fever, lung lesion mimicker
- Propofol: commonly used, providing safe and effective sedation
 - Incidence of atelectasis in pediatric patients: 42–82%
Lutterbey G, et al. Paediatr Anaesth 2007; 17: 121-5
- Dexmedetomidine: highly selective alpha-2 agonist
 - Less respiratory depression, emerged as an alternative to conventional sedative
Koroglu A, et al. Anesth Analg 2006; 103: 63-7.
Mason KP. Paediatr Anaesth 2010; 20: 265-72.
- Relationship between dexmedetomidine and atelectasis is poorly described

Materials and Methods

Study Population

- Single tertiary referral center-based retrospective study
- Patients who underwent whole-body MRI (WBMR) under sedation using propofol or dexmedetomidine in November 2017 ~ February 2018 included

Inclusion criteria

- ✓ *Age < 18 years*
- ✓ *Underwent WBMR under sedation using propofol or dexmedetomidine*
- ✓ *American Society of Anesthesiologist Physical Status Classification I or II*
- ✓ *Available medical records*

Exclusion criteria

- ✓ *Sedated using other sedatives or both propofol and dexmedetomidine*
- ✓ *Abnormalities in the thorax that interfered with the evaluation of the presence of atelectasis*
- ✓ *Underwent WBMR not following our institution's routine protocol*

Sedation Protocol

- Followed routine protocol of pediatric sedation clinic in our institution
- Sedatives selected according to anesthesiologist's preference
- Target sedation level: level 5 on the modified Ramsey sedation scale
- HR, BP, SpO₂, partial pressure of end-tidal expiratory CO₂ were monitored

Propofol

Bolus of 1 mg/kg propofol repeatedly until the patient becomes unconscious

Followed by a continuous infusion of 100 – 200 mcg/kg/min

Adjuvant agents including midazolam and/or ketamine administered as required

Dexmedetomidine

Loading dose of 1.0 – 2.0 mcg/kg for 10 minutes

Followed by a continuous infusion rate of 1.0 – 2.0 mcg/kg/hr

Image Acquisition

- Using a 3T MR system (Ingenuia, Philips Medical Systems)
- 3-6 subsequent table positions to cover the head to the toes
- Including coronal and sagittal STIR images
- Coronal non-enhanced T1-weighted fast spin echo images and post-contrast scans with coronal three-dimensional fat-suppressed T1-weighted gradient echo images obtained if contrast enhancement required
- Coronal STIR at thoracic level acquired at initial and end of the WBMR to evaluate atelectasis

Evaluation of Atelectasis

- Assessed using initial & final coronal thoracic STIR images
- Evaluated by pediatric radiologist (5-yr experience) blinded to sedative types
- **Objectives of interest**
 - Rate of atelectasis
 - Atelectasis volume per total lung volume (%)
 - Overall image quality

Evaluation of Atelectasis

- Objectives of interest

- Rate of atelectasis

- Atelectasis grade

- Grade 1: no atelectasis
 - Grade 2: linear atelectasis along the bronchovascular bundles
 - Grade 3: crescent-like subpleural atelectasis
 - Grade 4: segmental atelectasis
 - Grade 5: lobar atelectasis

Lutterbey G, et al. Paediatr Anaesth 2007; 17: 121-5

- Atelectasis volume per total lung volume (%)

- Overall image quality

Evaluation of Atelectasis

- **Objectives of interest**

- Rate of atelectasis
- Atelectasis volume per total lung volume (%)
 - Volumetric calculation by drawing the margin of atelectasis on each image slice
 - Total lung volume also calculated by drawing the margin of both lungs
- Overall image quality

Evaluation of Atelectasis

- **Objectives of interest**

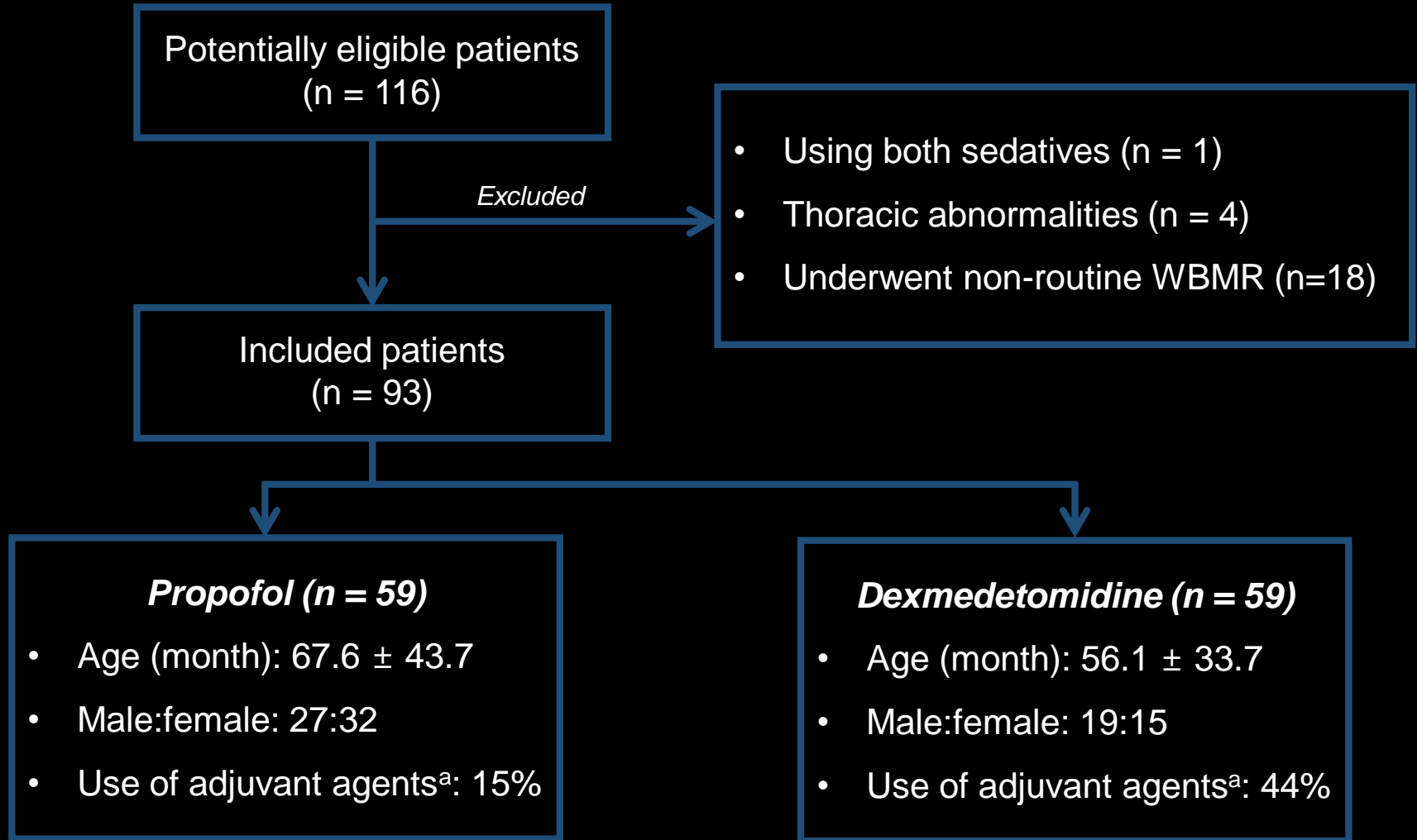
- Rate of atelectasis
- Atelectasis volume per total lung volume (%)
- Overall image quality
 - 1: unreadable
 - 2: extreme artifact
 - 3: moderate artifact
 - 4: mild artifact
 - 5: no artifact

Statistical Analysis

- Chi-square test: association between additional O₂ and atelectasis
- Bonferroni correction used for multiple pairwise comparison
- Factors associated with development of atelectasis explored using multivariable logistic regression analysis
 - Sedative types, age, sex, supplemental O₂, induction time, scan time, use of adjuvant agents
 - P-value < 0.1 in univariable analysis → entered in to multivariable analysis
- SPSS (version 21) and MedCalc (version 16.8) used

Results

Study Population



^aAdjuvant agents: midazolam and/or ketamine; more frequently used in dexmedetomidine group ($P = 0.002$)

Rate of Atelectasis

- Requirement of additional O₂: **propofol > dexmedetomidine** (64.4% vs. 2.9%; $P < .001$)
- Atelectasis: **propofol > dexmedetomidine** (47.5% vs. 17.6%; $P = .004$)

Group		n	Atelectasis Grade					Any atelectasis
			1	2	3	4	5	
I	Propofol + O ₂ (+)	38	19 (50%)	15 (39.5%)	1 (2.6%)	3 (7.9%)	NA	19 (50%)
II	Propofol + O ₂ (-)	21	18 (85.7%)	3 (14.3%)	NA	NA	NA	3 (14.3%)
III	Dexmedetomidine	34	28 (82.4%)	4 (11.8%)	2 (5.9%)*	NA	NA	6 (17.6%)
		I vs. II	0.007	0.046				0.007
<i>P</i> value		I vs. III	0.004	0.008	0.486			0.004
		II vs. III	0.750	0.789				0.750

Atelectasis Volume

- Atelectasis proportion: no statistical significance between groups
- Propofol: atelectasis proportion **tend to increase** during the imaging
- Dexmedetomidine: atelectasis proportion **tend to decrease** during the imaging

Group	Atelectasis volume per total lung volume on initial images (%)	Atelectasis volume per total lung volume on final images (%)	P value*
Propofol + oxygen (+)	1.37 (0.1-2.6) %	1.52 (0.8-4.4) %	0.095
Propofol + oxygen (-)	0.47 (0-3.8) %	1.23 (0.7-4.4) %	0.046
Dexmedetomidine	1.05 (0.3-3.2) %	0.63 (0.2-1.25) %	0.293
P value†	0.254	0.654	

* P values of Wilcoxon signed rank test for comparison between initial and last images.

† P value of Kruskal Wallis test for comparison of three groups.

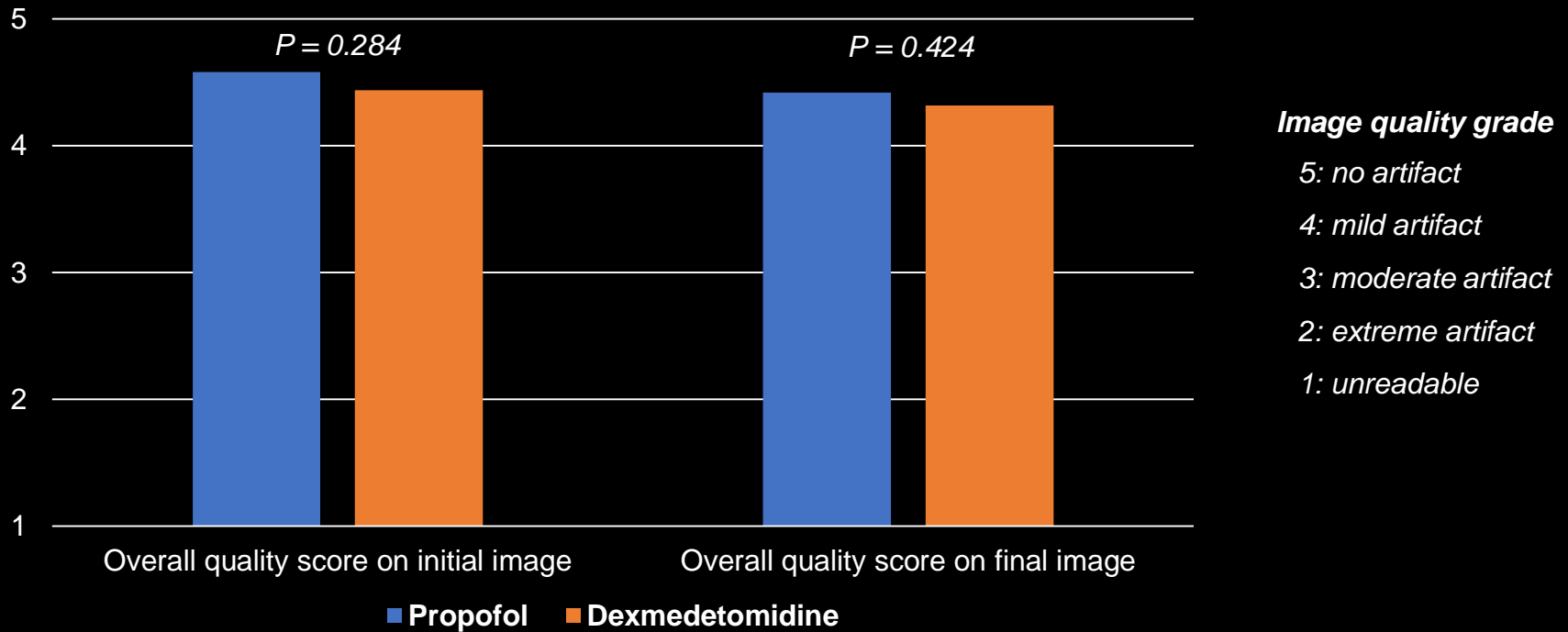
Factors Associated with Atelectasis

- **Requirement of additional O₂**: the only significant factor
(Adjusted OR, 4.215; 95% CI, 1.363-13.031; *P* = 0.012)

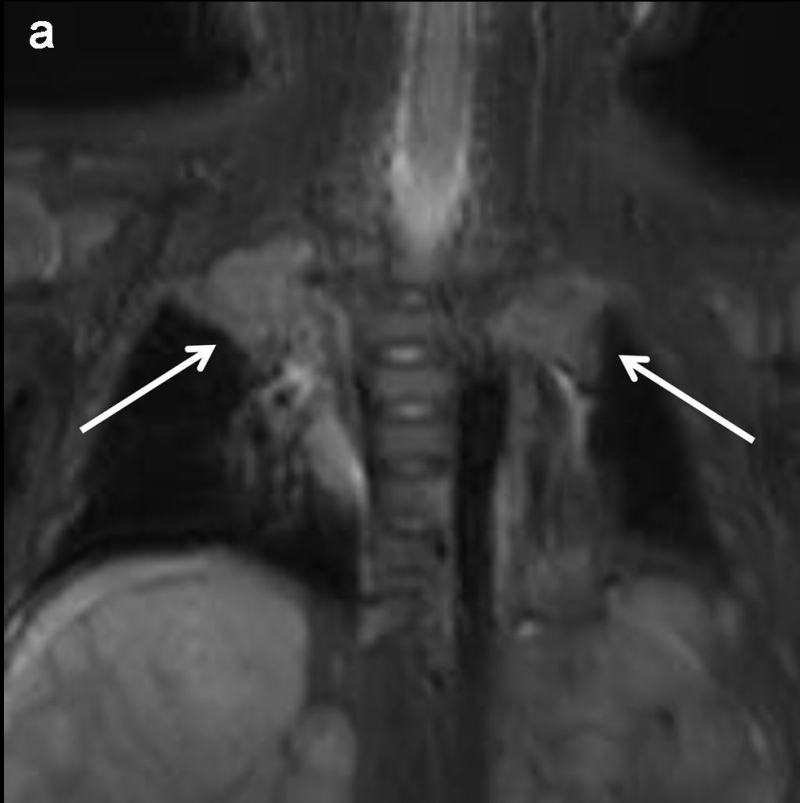
Parameters	Univariate			Multivariate		
	Odds Ratio	95% CI	P value	Odds Ratio	95% CI	P value
Age (per 1 month)	1.008	0.998-1.019	0.122			
Sex						
Female	1					
Male	0.713	0.305-1.665	0.713			
Drug						
Propofol	1					
Dexmedetomidine	0.237	0.086-0.657	0.006	0.709	0.183-2.745	0.619
Supplemental O₂ administration	5.619	2.240-14.095	< 0.001	4.215	1.363-13.031	0.012
Induction time	0.925	0.855-0.925	0.051	0.965	0.887-1.050	0.407
Scan time	1.024	0.987-1.063	0.210			
Use of adjuvant agents	0.641	0.235-1.749	0.385			

Image Quality

- Overall image quality between propofol and dexmedetomidine was **not different**



Case: propofol



A 5-month-old male with neuroblastoma

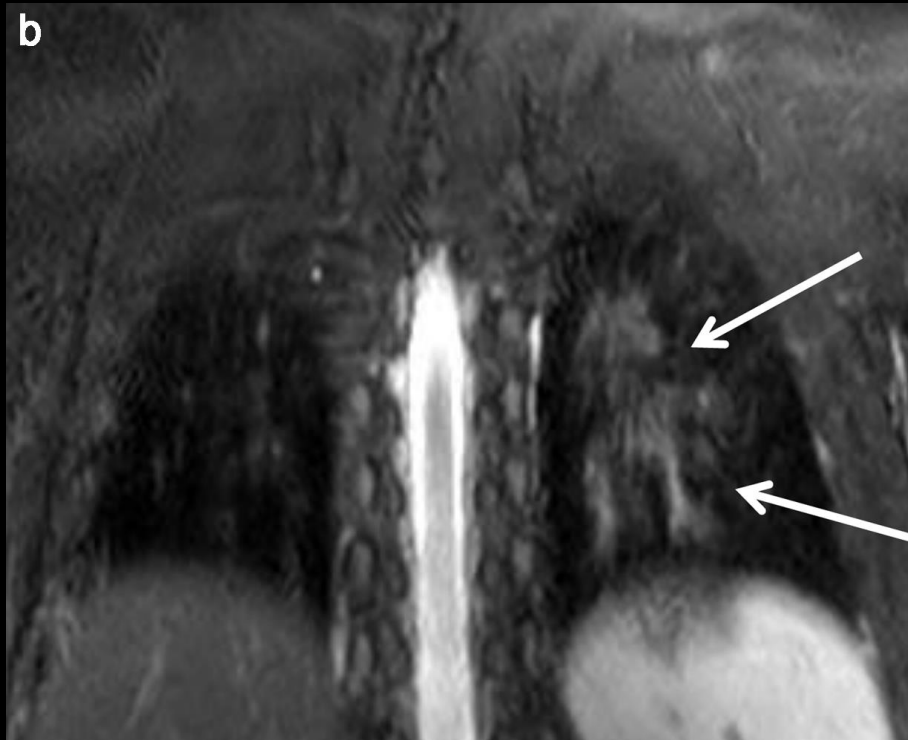
Grade 4

Segmental atelectasis in BUL

13.6 %

Estimated atelectasis volume

Case: dexmedetomidine



A 6-year-old male with neurofibromatosis I

Grade 2

Linear atelectasis in LLL

1.08 %

Estimated atelectasis volume

Conclusion

Conclusion

- *Pediatric patients sedated with **propofol** were more likely to develop atelectasis* than those sedated with dexmedetomidine during MRI.
- ***Supplemental oxygen** due to desaturation may be an important factor contributing to the development of atelectasis.*
- *To obtain pulmonary images without atelectasis in children under sedation, **dexmedetomidine** is more likely to be suitable* as a sedative agent.