

FAKULTNÍ NEMOCNICE BRNO
A LÉKAŘSKÁ FAKULTA
MASARYKOVY UNIVERZITY



**KLINIKA DĚTSKÉ
ANESTEZIOLOGIE
A RESUSCITACE**

EEG u dětí, jak a v čem pomáhá?

Michaela Ťoukálková

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**M U N I
M E D**

PAEDIATRIC ANAESTHESIA

Performance of entropy and Bispectral Index as measures of anaesthesia effect in children of different ages[†]

A. J. Davidson^{1,2,3*}, G. H. Huang³, C. S. Rebmann¹ and

Table 2 Pre-awakening values in each age group for entropy and BIS. BIS, response entropy, state entropy values are given as median (IQR). P-values represent significance of differences of medians among the age groups

Age group	BIS	Response entropy	State entropy
All children			
0–1 yr (n=7)	56 (43.8–65.2)	45 (33–62.5)	36 (32–46.5)
1–2 yr (n=9)	78 (68.8–82.3)	84 (79.8–93.3)	78 (58.8–82.3)
2–4 yr (n=16)	76.5 (68.5–82)	87 (79.5–92.5)	74 (70.5–86)
4–12 yr (n=14)	72 (66.3–76.5)	89 (82.5–95.8)	77 (72–84)
P-value	0.02	0.003	0.009
Children not receiving midazolam premedication			
0–1 yr (n=7)	56 (43.8–65.2)	45 (33–62.5)	36 (32–46.5)
1–2 yr (n=8)	78.5 (69.5–82.5)	83.5 (79.5–93.5)	78 (57.5–82.5)
2–4 yr (n=11)	76 (63.3–82)	82 (76–91.8)	72 (62.3–84.5)
4–12 yr (n=10)	73.5 (66–77)	88.5 (84–96)	78.5 (72–87)
P-value	0.02	0.005	0.01

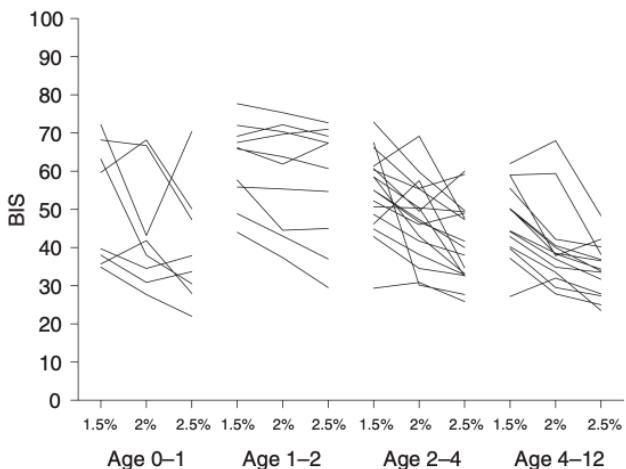


Fig 2 BIS values for each child in each age group at each sevoflurane concentration.

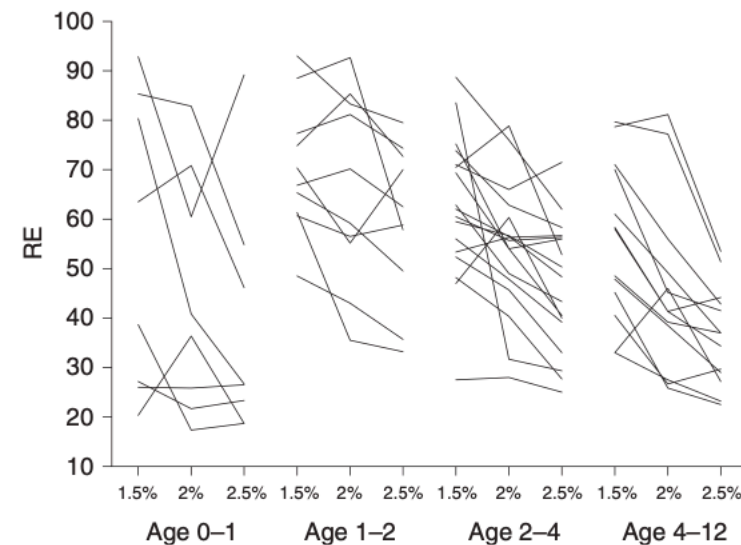
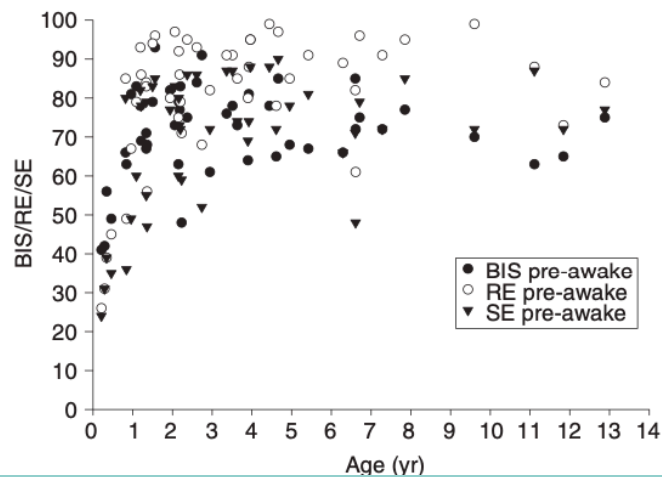


Fig 3 Response entropy values for each child in each age group at each sevoflurane concentration.

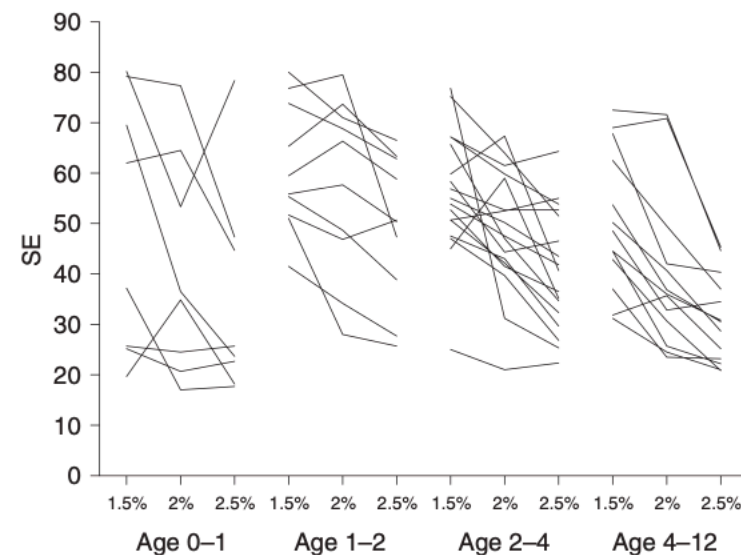


Fig 4 State entropy values for each child in each age group at each sevoflurane concentration.

Impact of age on both BIS values and EEG bispectrum during anaesthesia with sevoflurane in children

**E. Wodey^{1*}, O. Tirel¹, J. Y. Bansard², A. Terrier¹, C. Chanavaz¹, R. Harris¹,
C. Ecoffey¹ and L. Senhadji²**

Věk dítěte významně mění hodnoty BIS během anestezie při 1 MAC sevofluranu. Nekoreluje s hloubkou anestezie a proto by měl BIS u dětí používán s rozvahou

NEUROSCIENCES AND NEUROANAESTHESIA

Correlation of bispectral index with end-tidal sevoflurane concentration and age in infants and children

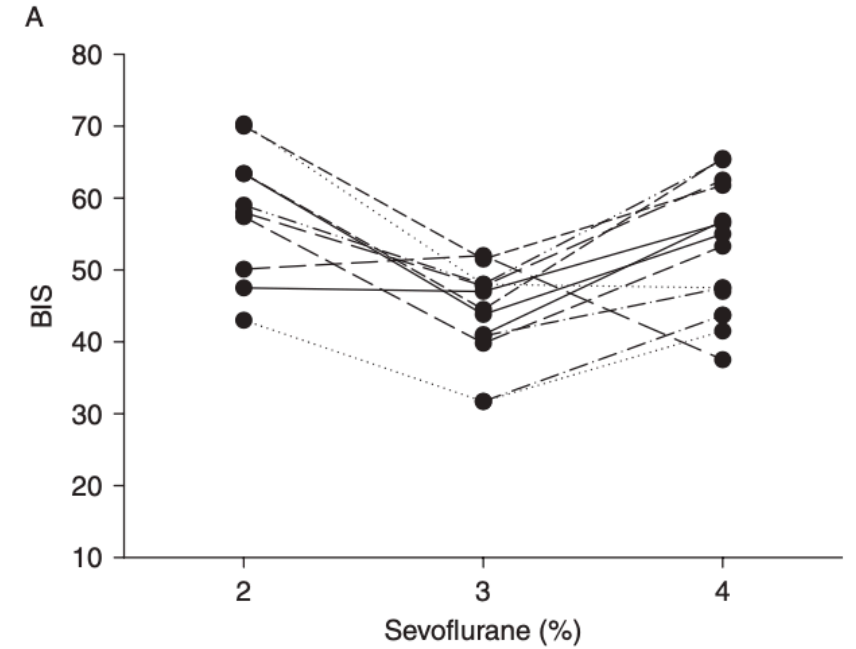
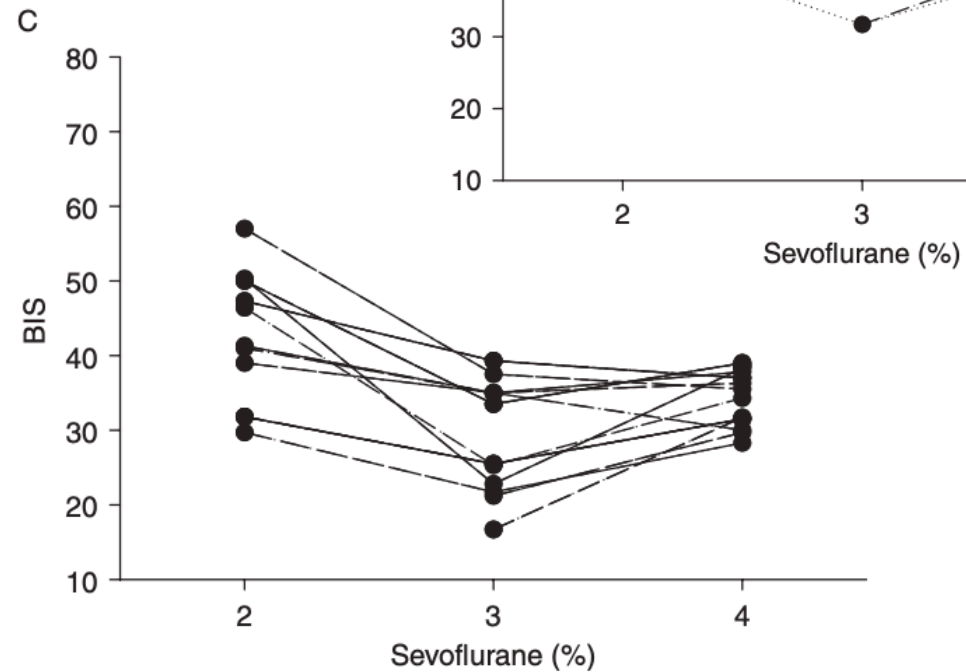
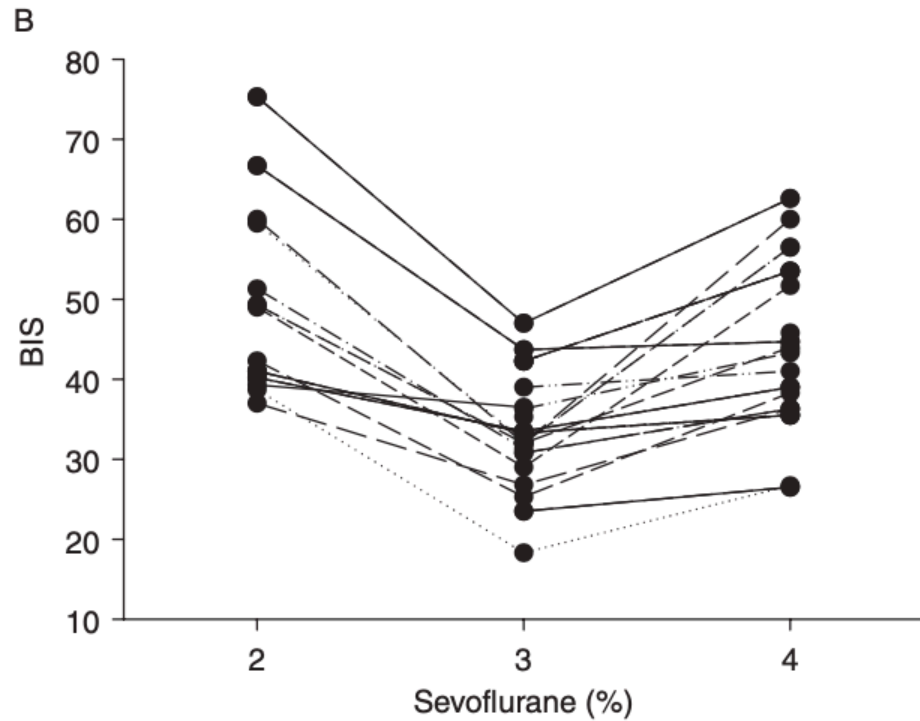


Fig 1 BIS at three end-tidal sevoflurane concentrations in each age group. (A) 6 months to 2 yr; (B) 3–7 yr; (C) 8–12 yr. BIS decreased significantly as ET_{sevo} changed from 2.0 to 3.0% and increased significantly as ET_{sevo} changed from 3.0 to 4.0% in all three age groups ($P < 0.05$).

Monitoring the anaesthetic depth in children – an update

Andrew J. Davidson

Curr Opin Anaesthesiol 20:236–243. B 2007

Fungují tedy monitory hloubky anestezie na dětech?

Zjednodušeně řečeno, by se dalo říct ANO, pokud ukazují hloubku anestezie

...ale co myslíme dostatečnou hloubkou anestezie u dětí?

??...to, že jsou v bezvědomí nebo, že se nehýbou...??

Nezbude, než se věnovat EEG křivce a spektrogramu...

...Sovy nejsou tím, čím se zdají být...

REVIEW ARTICLE

The EEG signal: a window on the cortical brain activity

Isabelle Constant & Nada Sabourdin

3 a více let: nastupuje parietooccipitálně alpha rytmus
zprvu diskrétně a pomalu (8Hz), s vysokou votáží a asymetrií
theta je stále hojně a difuzně smíšená s alpha
Mezi 3-10 lety: alpha rytmus začíná dominovat, theta je ojedinělá

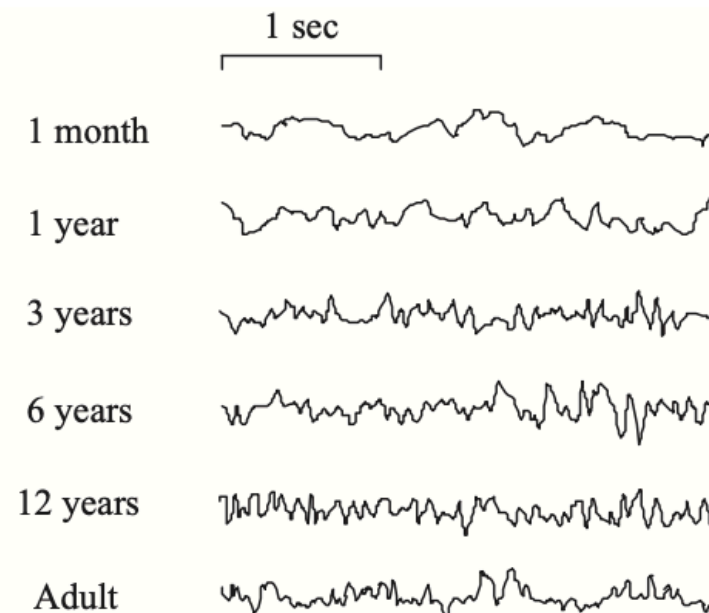


Figure 4 EEG changes with age. In the newborn, the awake trace shows slow waves of high amplitude. The latter diminishes with age, and the dominant frequency of the constituent waves increase until adolescence when it achieves the adult pattern.

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Clinical Neurophysiology 132 (2021) 2959–2964

Peri- and intraoperative EEG signatures in newborns and infants

M. Markus, H. Nagelsmann, M. Schneider, L. Rupp, C. Spies, S. Koch*

EEG-frequency-bands.

	1. Group: 0–3 month (n = 27)	2. Group: 4–6 month (n = 30)	3. Group: 7–9 month (n = 29)	4. Group: 10–12 month (n = 29)	p
Total Power [μ V ²] [M (SD)]	228.8 (226.5)	741.2 (483.1)	736.8 (475.1)	1070.7 (1019.4)	< 0.001
Relative Beta-Power [%] [M (SD)]	3.2 (2.9)	10.9 (7.4)	18.4 (13.9)	16.6 (8.2)	< 0.001
Relative Alpha-Power [%] [M (SD)]	4.6 (4.5)	14.4 (9.1)	21.3 (9.7)	22.7 (8.4)	< 0.001
Relative Theta-Power [%] [M (SD)]	11.4 (5.5)	12.4 (4.9)	13.1 (4.1)	12.8 (3.3)	0.294
Relative Delta-Power [%] [M (SD)]	80.5 (10.5)	61.8 (17.2)	47.0 (16.6)	47.5 (13.5)	< 0.001
Spectral Edge Frequency [Hz] [M (SD)]	5.0 (3.8)	13.4 (4.6)	17.5 (3.7)	17.0 (5.1)	< 0.001
Median frequency [Hz] [M (SD)]	1.9 (2.3)	2.9 (1.8)	5.7 (3.7)	5.4 (3.1)	< 0.001

Analysis of EEG frequency-bands intraoperatively (15–30 min after surgical incision), statistical testing was performed by Kruskal-Wallis-Test with Bonferroni Correction.

For all age groups the relative d-Power represents the dominating frequency band. Newborns 0–3 months show a high percentage of relative d-Power compared to infants of 4–6 months. The decreasing trend continues in the developing brain in 4–6 months and 7–9 months old infants. A further reduction in the older group was not observed and the relative d-Power remains on that level in 10–12 months infants.

Dominující rytmus: delta

Table 3
EEG characteristics 0–6 month; 7–12 month.

	Infants 0–6 month					Infants 7–12 month				
	Baseline	LOC	OP	Extubation	P	Baseline	LOC	OP	Extubation	p
Totale Power [μ V ²] [M (SD)]	1642.1 (1083.0)	2929.7 (4680.5)	912.1 (479.7)	231.7 (169.5)	0.027*	4472.8 (5265.8)	5432.0 (4959.3)	1305.2 (981.8)	1426.2 (3027.0)	0.024*
Relative Beta-Power [%] [M (SD)]	5.0 (4.5)	2.0 (2.0)	4.2 (4.1)	3.3 (3.0)	0.466	4.4 (2.5)	2.7 (1.9)	11.8 (7.4)	22.4 (20.1)	0.004*
Relative Alpha-Power [%] [M (SD)]	1.6 (0.9)	1.7 (1.8)	8.9 (10.1)	1.8 (0.9)	0.008*	1.7 (1.1)	2.4 (1.7)	18.1 (10.7)	8.5 (8.1)	0.035*
Relative Theta-Power [%] [M (SD)]	6.1 (2.9)	6.2 (5.2)	12.2 (5.6)	8.5 (7.1)	0.018*	6.7 (4.2)	5.0 (3.8)	14.4 (3.8)	8.3 (3.9)	0.012*
Relative Delta-Power [%] [M (SD)]	86.8 (7.5)	89.6 (8.3)	74.0 (17.3)	86.0 (9.7)	0.019*	84.8 (7.1)	89.2 (7.1)	54.5 (17.7)	59.6 (26.6)	0.003*
Spectral Edge Frequency [Hz] [M (SD)]	3.3 (3.9)	2.2 (2.1)	5.3 (4.9)	2.3 (2.1)	0.424	4.9 (5.4)	2.7 (1.8)	11.9 (5.9)	10.7 (8.4)	0.005*
Median Power Frequency [Hz] [M (SD)]	6.9 (8.7)	4.6 (6.1)	5.7 (5.3)	6.1 (5.1)	0.341	2.7 (4.1)	2.0 (2.3)	6.3 (6.6)	7.8 (7.4)	0.030*

LOC = Loss of consciousness; OP = intraoperative situation

Dominující rytmus: delta

Nemění se v průběhu anestezie...

LOC: lost of consciousness

...Musí být přítomen nějaký jiný mechanismus účinku anestetik na vzniku bezvědomí...

Využití EEG u dětí – jak nám může

Snižuje spotřebu sevofluranu

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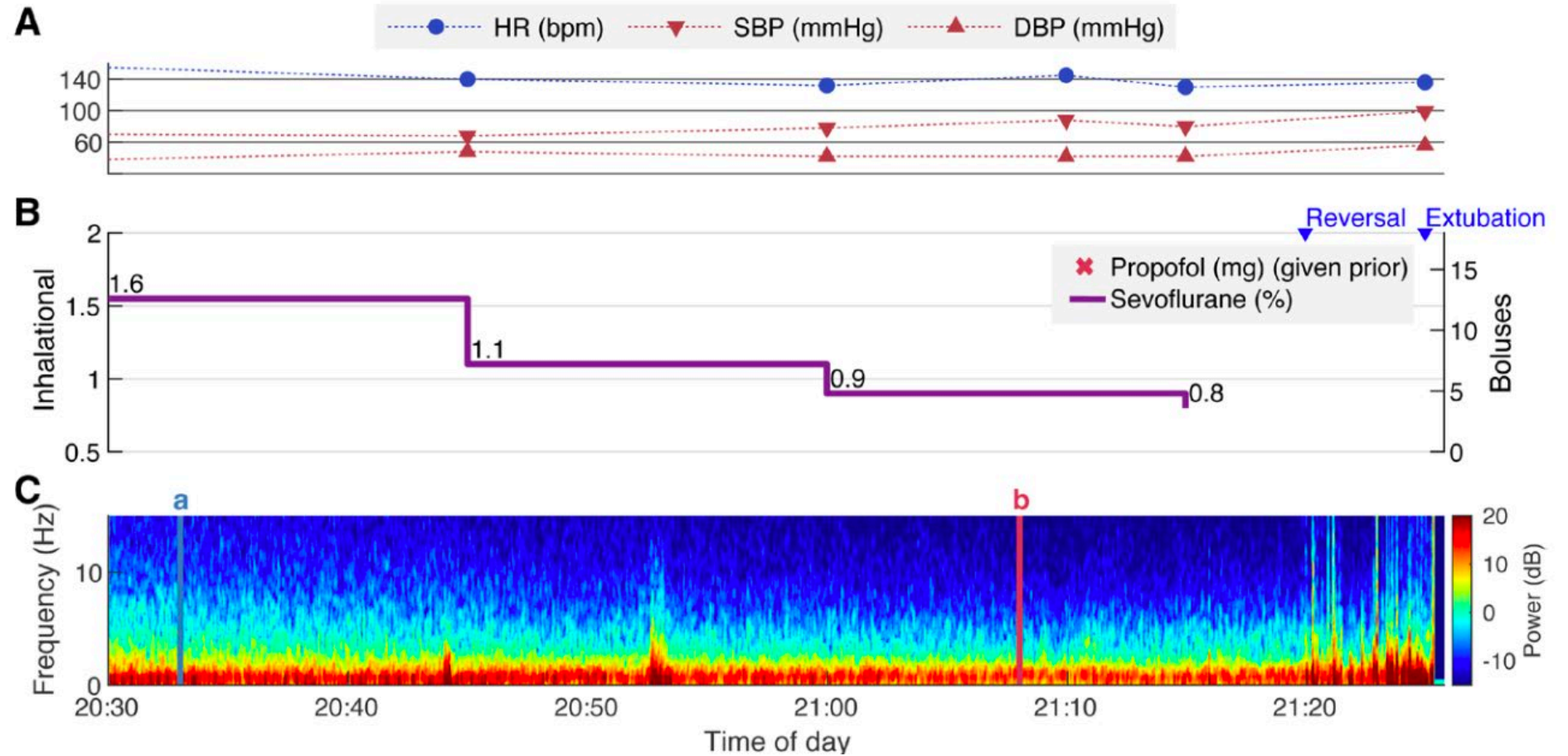
vyvojové a věkové rozdíly lépe než procesované EEG

Pediatric Anesthesiology

NARRATIVE REVIEW ARTICLE

A Narrative Review Illustrating the Clinical Utility of Electroencephalogram-Guided Anesthesia Care in Children

Kojenci

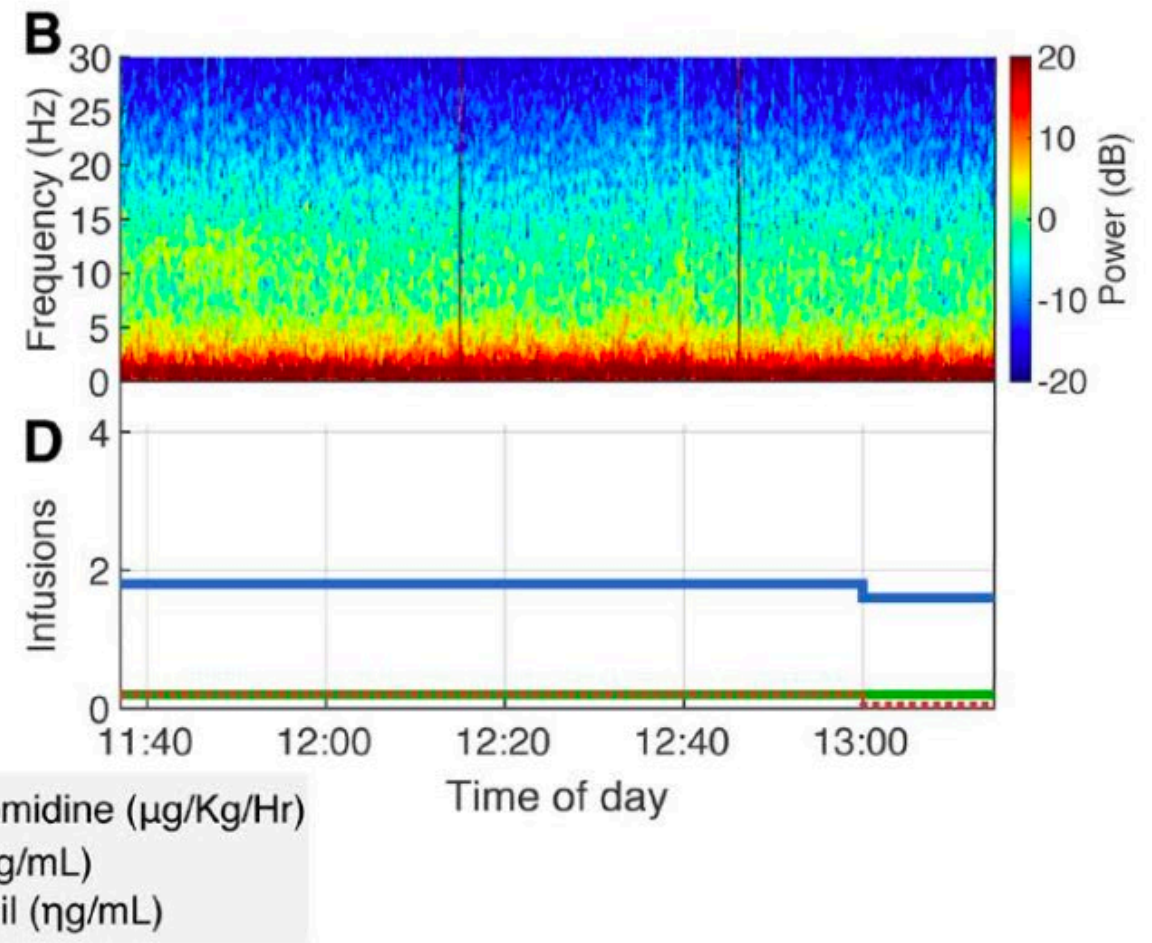
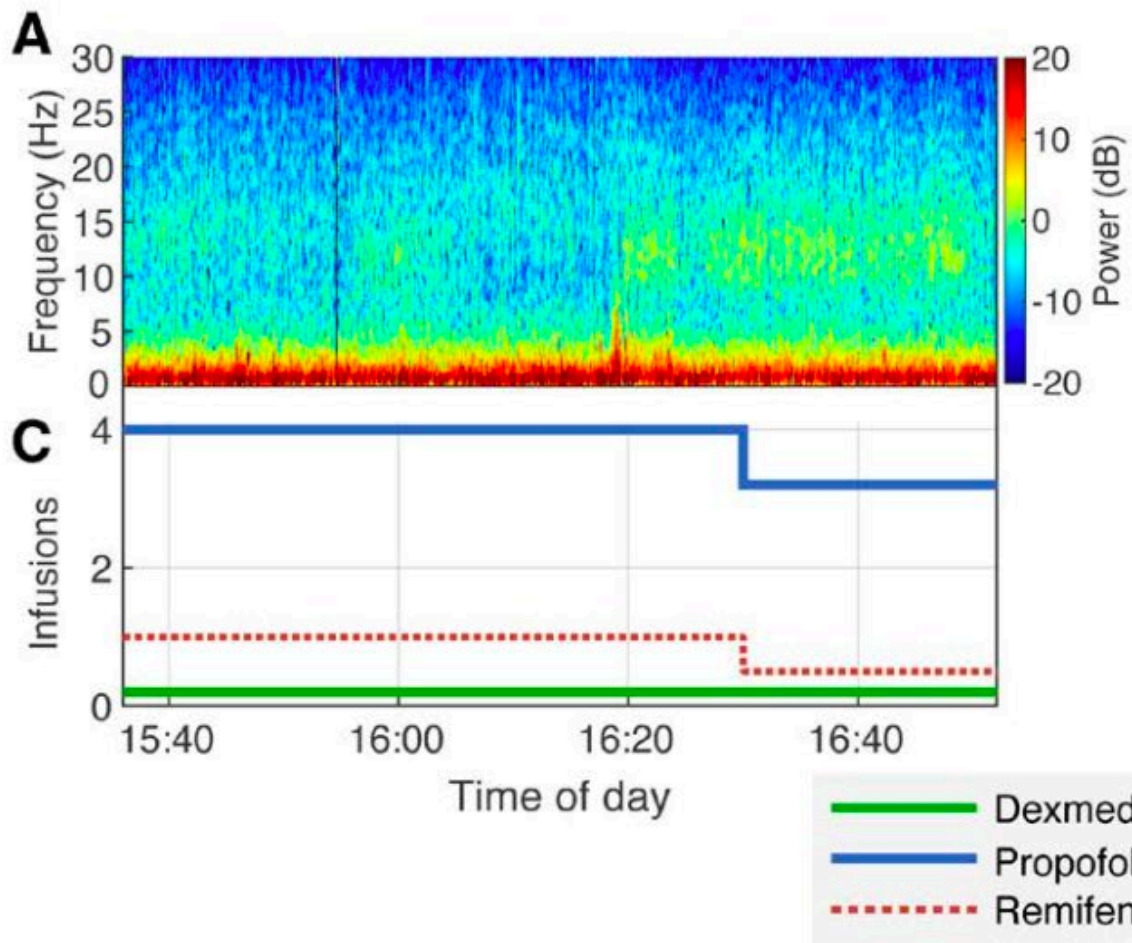


- 2-month-old, full-term, 4.5-kg infant with pyloric stenosis during laparoscopic pyloromyotomy

Pacienti s neurologickým onemocněním

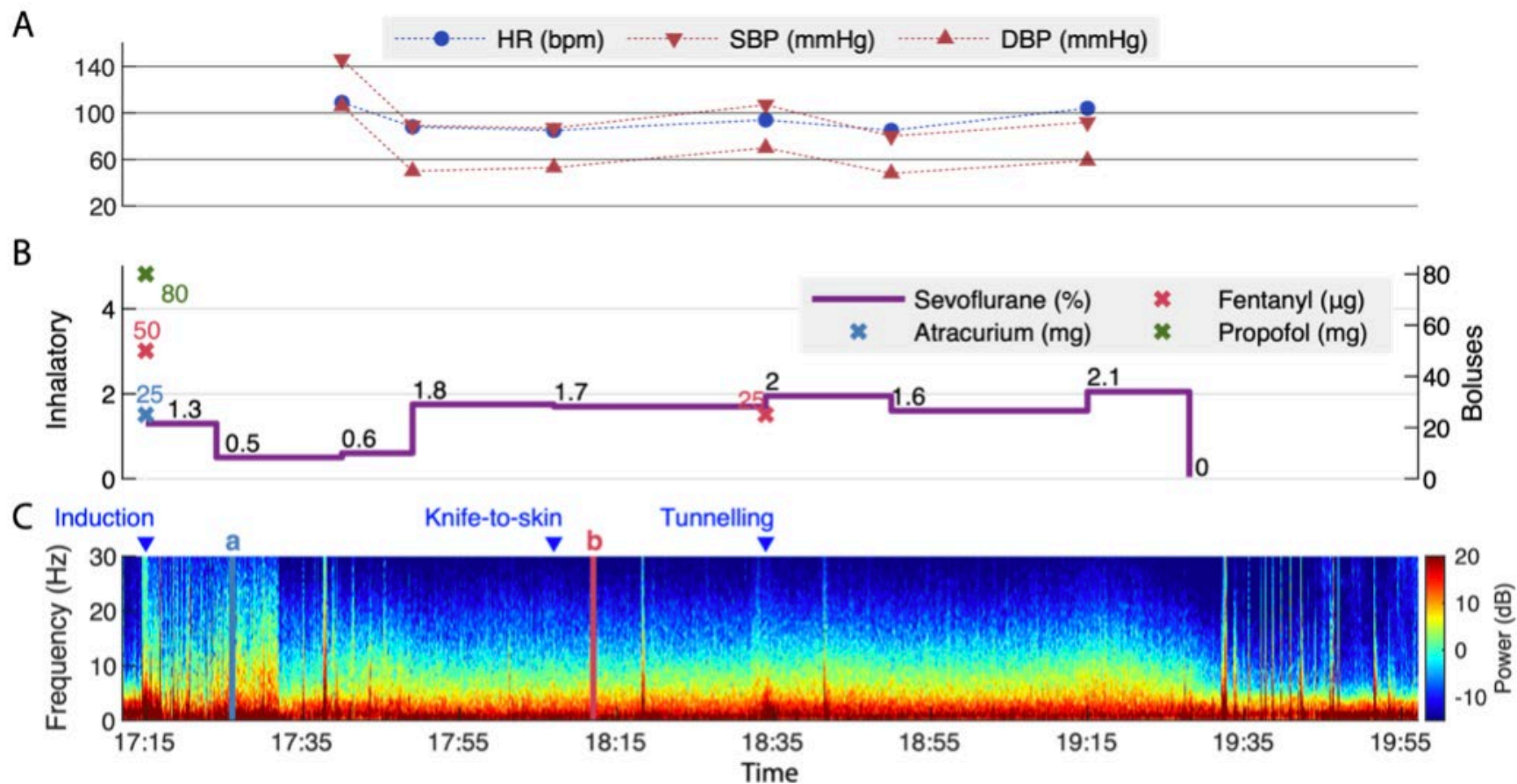
Děti s PAS (porucha autistického spektra) mají nižší sílu alfa než neurotypické děti a tím jsou náchylnější k burst suppressions při stejných dávkách Propofolu

Děti s opožděným psychomotorickým vývojem nebo **mozkovou obrnou** jsou známy menší potřebou volatilních anestetik a potřebou nižší dávky propofolu k dosažení hypnotického stavu



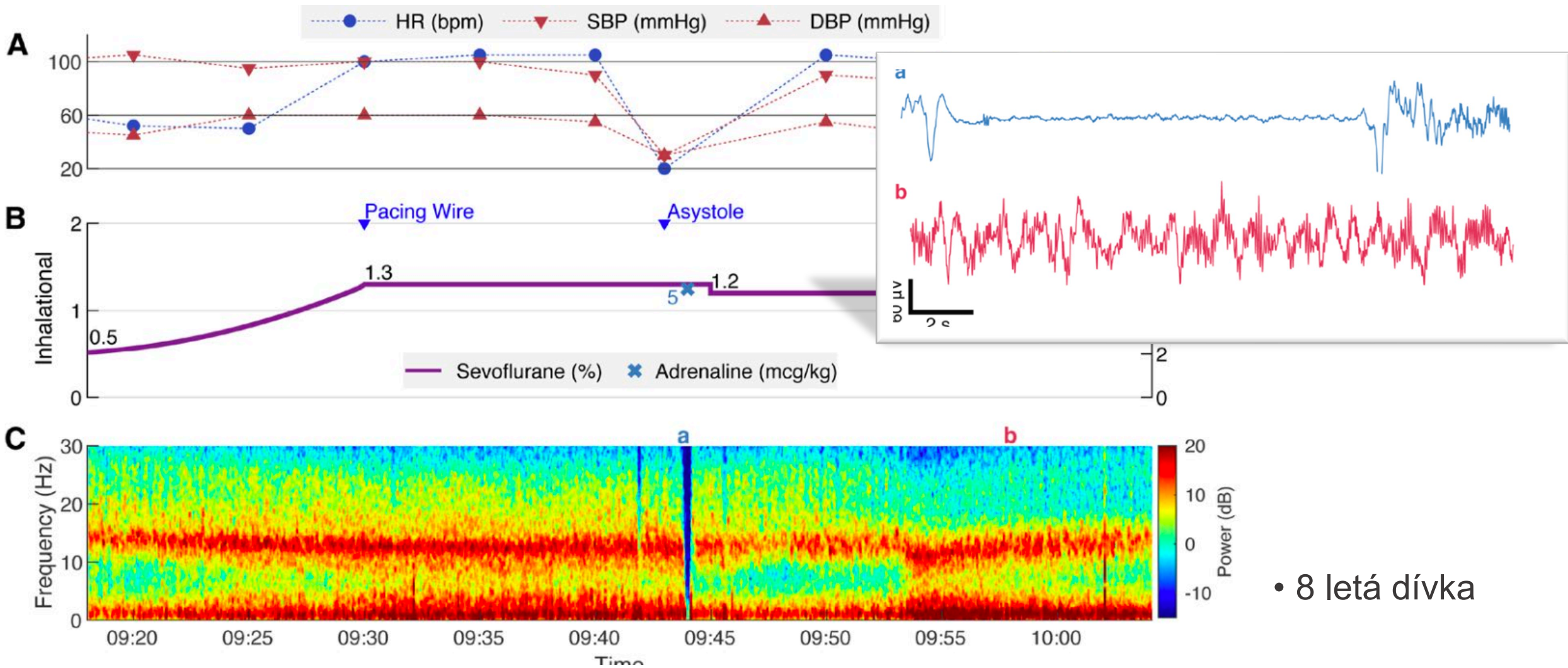
- 13-year-old, 49-kg NT girl with idiopathic scoliosis

- 13-year-old, 54-kg girl with neuromuscular scoliosis, cerebral palsy, global developmental delay, and seizures controlled on antiepileptic drugs (clobazam and levetiracetam)



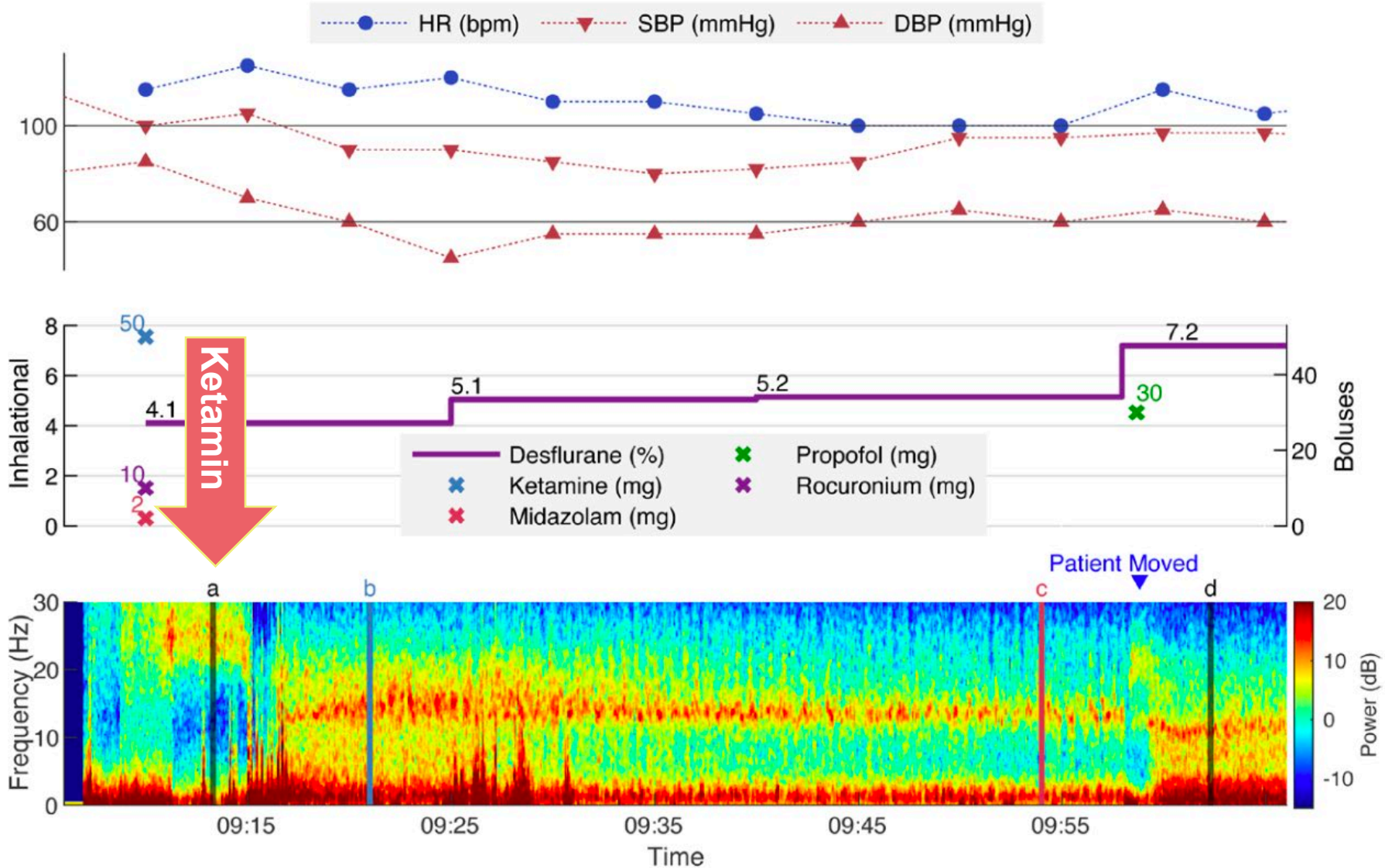
- 17-year-old, 49.6-kg girl with cerebral palsy, developmental delay presented with a blocked ventriculo-peritoneal shunt raised intracranial pressure and poor Glasgow Comma Scale (GCS) for emergency shunt revision
- **After intubation, EEG showed burst suppression (A).**

Hemodynamicky nestabilní pacienti



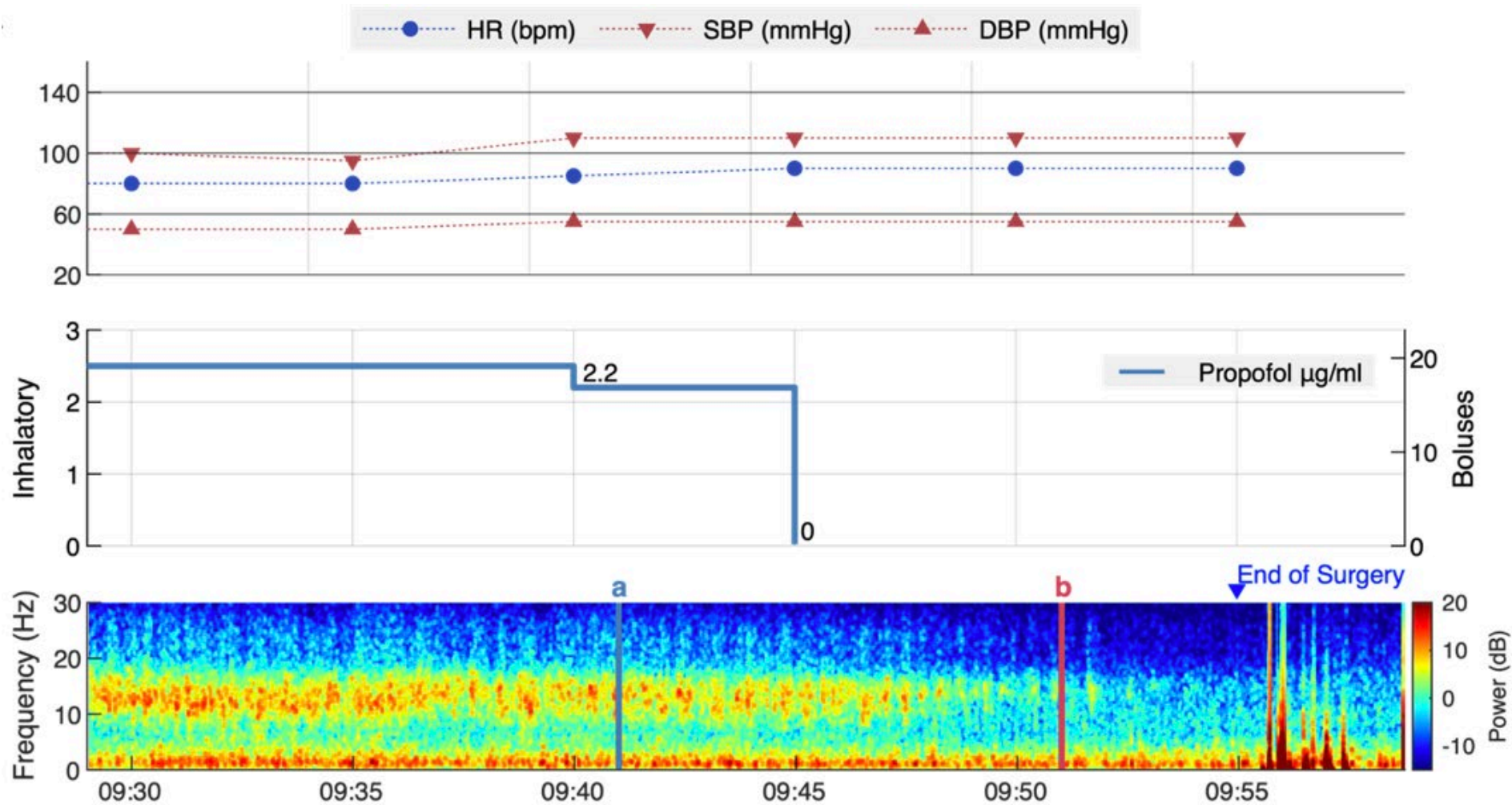
• 8 letá dívka

Posouzení účinku při kombinaci anestetik



• 10 letý chlapec

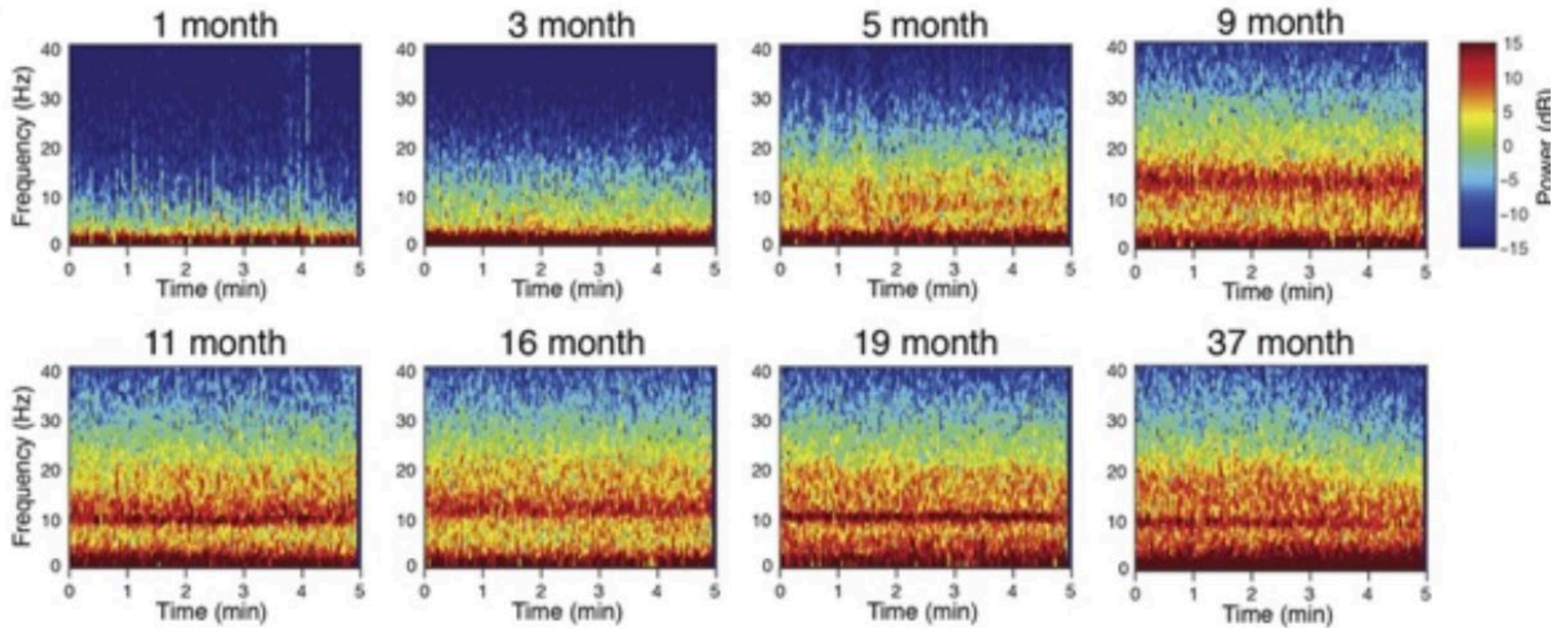
Monitorace u procedurální sedace



- 12 letý chlapec

Individual spectrograms of frontal EEG power from infants receiving sevoflurane anesthesia across the first 3 y of life (D). High-frequency power is largely absent in 0- to 4-mo-old infants, but an alpha/beta oscillation emerges around 9 mo that travels downward in peak frequency until around 1 y of age (C, D).

Sevoflurane

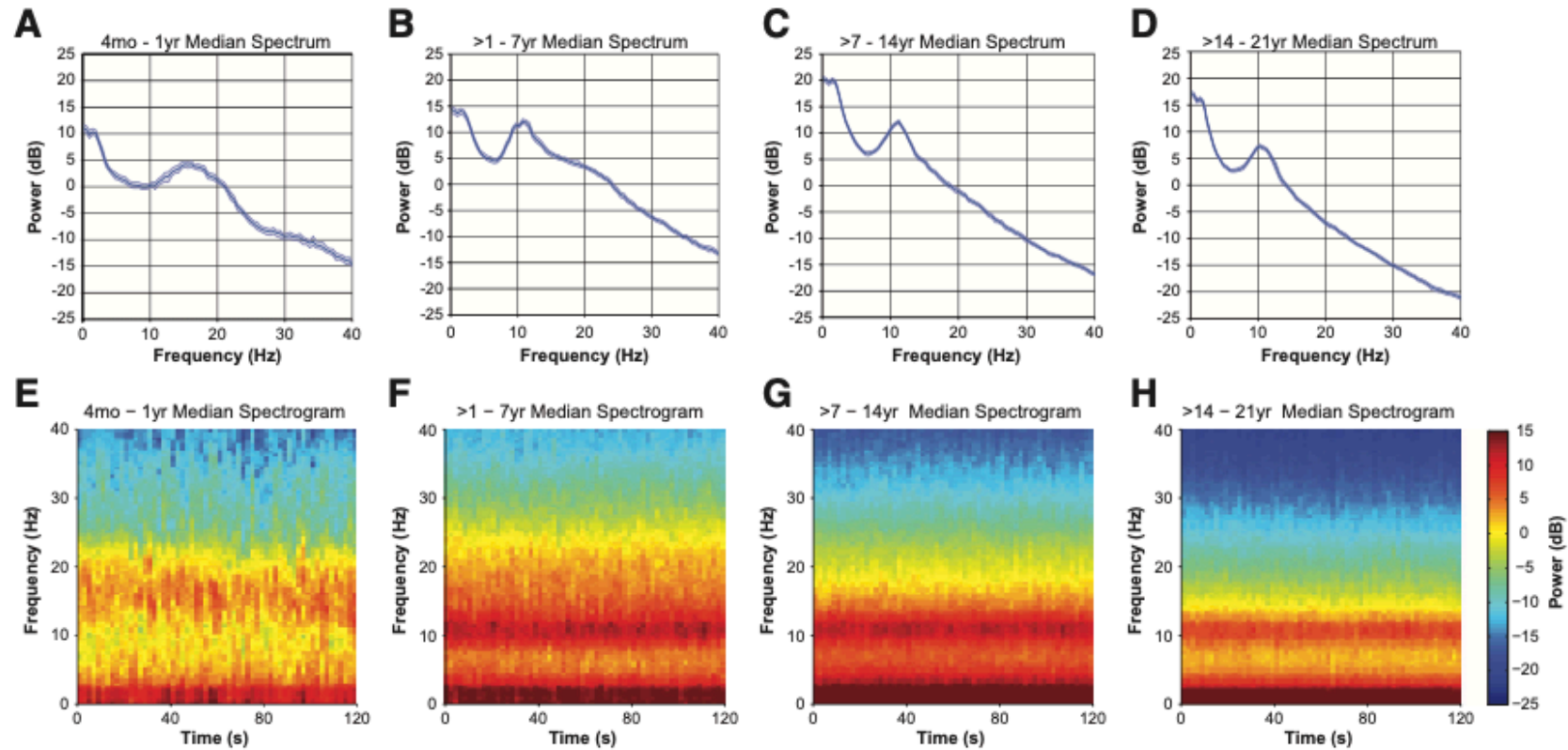


A Prospective Study of Age-dependent Changes in Propofol-induced Electroencephalogram Oscillations in Children

Anesthesiology 2017; 127:293-306

Johanna M. Lee, A.B., Oluwaseun Akeju, M.D., M.M.Sc., Kristina Terzakis, Kara J. Pavone, B.S., Hao Deng, M.B.B.S., M.P.H., Timothy T. Houle, Ph.D., Paul G. Firth, M.B., Ch.B., Erik S. Shank, M.D., Emery N. Brown, M.D., Ph.D., Patrick L. Purdon, Ph.D.

Propofol



Na závěr

Vztah mezi celkovou anestezií, mozkovými funkcemi a mechanismem vzniku bezvědomí je komplexní a není jednoduché je predikovat jen na základě samotných vitálních funkcí.

Navíc, existují specifické skupiny pacientů, včetně těch s poruchou vědomí a jiných neuropsychiatrických stavů, jež mohou mít nepredikovatelné potřeby anestetik.

EEG monitorace nám umožňuje přesněji titrovat anestetika a individualizovat péči každému dítěti v každém okamžiku a zlepšovat tak bezpečnost anestezie.