Elsayeh and Hassan
Egypt J Neurol Psychiatry Neurosurg (2022) 58:35
https://doi.org/10.1186/s41983-022-00469-7

The Egyptian Journal of Neurology, Psychiatry and Neurosurgery

RESEARCH Open Access

Short-term outcome of intravenous methylprednisolone pulse therapy versus oral prednisolone in patients with epileptic spasms

Abdelsattar Abdullah Elsayeh[1,3,4*] and Mohammad Ali Saeed Hassan[2,3]

Abstract

Background: Infantile spasm (IS) is an age-specific epileptic disorder of early infancy that typically presents with epileptic spasms occurring in clusters. International League Against Epilepsy (ILAE) also recommends the term "IS syndrome" for clustered spasms occurring during infancy (~ 1 year, rarely after 2 years of age) accompanied by electroencephalography (EEG) hypsarrhythmia. Older clinical studies comparing efficacy of adrenocorticotrophic hormone (ACTH) and corticosteroids preferred ACTH, but recent studies did not observe a significant difference between both nor showed better efficacy of oral prednisolone compared to intramuscular synthetic one. Participants were 53 patients with epileptic spasms divided into two groups: 26 patients treated by intravenous methylprednisolone (group A) and 27 treated by oral prednisolone (group B). Both groups were matched in age, sex, and age of spasm onset. The outcome measures were spasms cessation at 7 and 14 days and recurrence at 6 weeks after tapering, EEG improvement at 2 and 6 weeks, and frequency of side effects.

Results: We found that both groups had similar results regarding frequency of children achieving spasms cessation at day 7 and day 14 (53.8% vs 51.9% and 38.5% vs 40.7%, $p = 1.000$ each), respectively. After drug tapering, there was insignificant difference between both groups regarding recurrence of spasm at 6 weeks (14.8% vs 11.5%, $p = 1.000$) and EEG improvement at 2 weeks (42.3% vs 33.3%, $p = 0.577$) with nearly similar improvement in both groups at 6 weeks (46.2% vs 48.1%, $p = 1.000$). With regard to adverse effects of both therapies, no difference observed between both groups.

Conclusions: No significant difference was found between oral prednisolone and intravenous methylprednisolone in treatment of epileptic spasm regarding short-term outcomes. The only advantage of intravenous therapy is decreased time to get response and the only advantage of oral therapy is its applicability at home without hospitalization. Further studies are warranted to explore the long-term outcomes.

Keywords: Epileptic spasm, Steroid, Methylprednisolone, West syndrome, Hypsarrhythmia

Background

An infantile spasm (IS) is an age-specific epileptic disorder of early infancy that typically presents with epileptic spasms occurring in clusters. The International League Against Epilepsy (ILAE) also recommends the term "IS syndrome" for clustered spasms occurring during infancy (~ 1 year, rarely after 2 years of age) accompanied by electroencephalogram (EEG) hypsarrhythmia [1]. A few rare forms of IS have been identified: IS without hypsarrhythmia; hypsarrhythmia without IS, and single spasms variant of IS, which lacks the clustering nature of the spasms [2].

West syndrome is characterized by the triad of IS, hypsarrhythmia, which is considered the most frequent interictal EEG pattern associated with IS, and

*Correspondence: Abomaryam.doctor@gmail.com
[1] Present Address: Pediatric Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt
Full list of author information is available at the end of the article

psychomotor regression. It is a rare syndrome, occurring in about 1 of 3200–3400 live births. There is a small male preponderance over females; about 1.6–1.4 to 1. The peak age of onset is about 6 months, with a range of 3 months to 2 years. [1].

The spasm-type seizures in order of frequency include flexion, extension or a combination of proximal and truncal muscles lasting 1–2 s and occurring in clusters ranging from a few to hundreds of spasms each day, frequently occurring during waking or feeding [3]. Hypsarrhythmia is a typical EEG pattern for IS consisting of irregular, asynchronized, large-amplitude wave forms in all EEG channels observed in between the spasms (interictally). The EEG is attenuated during the ictal phase (when spasms occur) and is referred to as "electrodecrement" [4].

The latest classification divides IS into several etiopathogenic groups: (a) structural–metabolic which includes tuberous sclerosis and many inborn errors of metabolism; (b) infectious–immune; (c) genetic and (d) unknown causes [5].

According to the United Kingdom Infantile Spasms Study (UKISS), both early spasm cessation and a short lead time to therapy minimize the overall length of the epileptic encephalopathy and improve developmental outcome [6].

The idea of direct use of corticosteroids was developed based on the fact that the action of adrenocorticotropic hormone (ACTH) is mostly enhancement of adrenal corticosteroid release and production. Usually, prednisone or prednisolone is given orally though intravenous pulse treatment is also an option [7].

Older clinical trials comparing the effectiveness of ACTH and corticosteroids favored ACTH, while subsequent research found no significant difference between the two hormones [8–10] or shown that oral prednisolone (OP) was more effective than intramuscular synthetic corticosteroids [11].

The aim of this study was to assess the use of intravenous methylprednisolone pulse (IVMP) therapy in the management of IS aiming at achieving the advantages of availability, shorter duration, less side effects and improved efficacy.

Methods

Study design

This interventional comparative study was conducted in neurology and pediatric departments during the period from December 2019 to November 2020. The study was approved by the Local Ethics Committee (Registration Number: *Ped._185Med.Research_Epileptic spasm; steroid; methylprednisolone; West syndrome; hypsarrhythmia._0000185*). Informed written parental consent was obtained prior to enrollment in the study. Confidentiality was maintained throughout the study process.

Study population

Fifty-three patients with epileptic spasm and hypsarrhythmia on EEG were included consecutively. They were divided into two groups: Group A, 26 patients (intravenous methylprednisolone group) and group B, 27 patients (oral prednisolone group). All patients were aged from 2 months up to 2 years and of both genders. Both idiopathic and secondary spasms were included.

Methods

History-taking, complete clinical examination and laboratory investigations were registered. Laboratory investigations included sepsis work-up (CSF analysis not included), metabolic work-up (serum electrolytes, blood glucose, serum ammonia and lactate and blood gases) and brain MRI. We did not perform extensive investigations to find the etiology as genetic testing or extended metabolic screen. Electroencephalography was performed (using E-Series-EEG 64 Control module, S/N 5840, Compu medics, Australia) at the time of admission, 2 weeks later, and 6 weeks after treatment.

For group A, intravenous methylprednisolone was given at 30 mg/kg once daily, for 3 consecutive days, followed by oral prednisolone 2 mg/kg/day, in three divided doses, for 2 weeks then gradually tapered over 4 weeks. For group B, oral prednisolone was given at 4 mg/kg/day, in three divided doses, for 2 weeks then gradually tapered over 4 weeks.

The outcome measures were spasms cessation at 7 and 14 days and recurrence at 6 weeks after tapering, time to response, EEG improvement (EEG improvement in follow-up means sustained resolution of hypsarrhythmia with no epileptic activity was assessed by same physicians) at 2 and 6 weeks, time to response and frequency of side effects.

Statistical analysis

It was carried out using the SPSS computer package version 25.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp., USA). The mean ± SD or median (minimum, maximum) were used for quantitative variables as appropriate while number and percent were used for qualitative variables. In order to assess the differences in frequency of qualitative variables (for example; gender, etiology, type of cases, comorbidities, spasm cessation, spasm recurrence, EEG improvement, and adverse effects of steroid), Chi-square or Fisher's exact tests were applied when appropriate. In order to assess the differences in means of quantitative variables (for example; age, age of onset, spasm frequency before treatment, and time

to respond to medications), Mann–Whitney *U*-test was used for non-parametric statistics. The statistical methods were verified, assuming a significant level of $p < 0.05$.

Results

The study included 53 patients with epileptic spasms divided into two groups: 26 patients treated by intravenous methylprednisolone (Group A) and 27 treated by oral prednisolone (Group B). Both groups were matched in terms of age, gender, and age of onset of spasm (*p* value 0.646, 1.000 and 0.971, respectively). In more than two-thirds, the etiology of epileptic spasms was unknown and other possible causes did not differ significantly between both groups. The condition was new in about 80.8% and 74.1% of both groups, respectively. Nearly half of them had associated comorbidities where developmental delay was the most frequent (28.3%) with no significant difference in both groups (Table 1).

Before treatment, the frequency of spasm was relatively similar between both groups with mean 20.55 ± 4.37 times. After treatment, the frequency of children achieving spasms cessation at day 7 and day 14 were similar in both groups (53.8% vs 51.9% and 38.5% vs 40.7%), respectively. After drug tapering, the recurrence of spasm at 6 weeks was insignificantly higher in group B (14.8% vs 11.5%). EEG showed insignificant improvement at 2 weeks in group A (42.3% vs 33.3%), with nearly similar improvement in both groups at 6 weeks (46.2% vs 48.1%) (Table 2).

The most frequent adverse effects of steroid treatment were increased appetite and weight gain (75.5% and 58.5%, respectively), less frequently GIT upsets and sleep disturbances (26.4% and 20.8%, respectively), and the least was hypertension (5.7%).

In all adverse effects, no difference observed between both groups (Table 3). Time to respond to medication in group A (median; min–max): (5; 4–8) was significantly lower than group B (median/min–max): (6/5–9) (Fig. 1).

Discussion

The current study compared the effectiveness, speed of action, and safety profile characteristics of intravenous methylprednisolone pulse therapy versus oral prednisolone in infants with epileptic spasms.

Table 1 General characteristics of the studied groups

Variables	Total (*n* = 53)	Group A (*n* = 26)	Group B (*n* = 27)	*p* value
Age (months)				0.646
Mean ± SD	6.37 ± 2.01	6.23 ± 1.92	6.49 ± 2.13	
Min–max	3–12	3–11	3–12	
Age of onset (months)				0.971
Mean ± SD	4.20 ± 1.09	4.20 ± 0.96	4.21 ± 1.23	
Min–max	3–7	3–6	3–7	
Gender				1.000
Male	29 (54.7)	14 (53.8)	15 (55.6)	
Female	24 (45.3)	12 (46.2)	12 (44.4)	
Etiology				
Unknown	37 (69.8)	19 (73.1)	18 (66.7)	0.982
HIE*	5 (9.4)	2 (7.7)	3 (11.1)	
Metabolic	2 (3.8)	1 (3.8)	1 (3.7)	
Cerebral malformation	4 (7.5)	2 (7.7)	2 (7.4)	
Post-encephalitic	5 (9.4)	2 (7.7)	3 (11.1)	
New cases	41 (77.4)	21 (80.8)	20 (74.1)	0.745
Old cases	12 (22.6)	5 (19.2)	7 (25.9)	
Comorbidities				
Microcephaly	7 (13.2)	3 (11.5)	4 (14.8)	0.901
Developmental delay	15 (28.3)	6 (23.1)	9 (33.3)	
Vision abnormality	2 (3.8)	1 (3.8)	1 (3.7)	
Hearing deficit	2 (3.8)	1 (3.8)	1 (3.7)	
No comorbidities	27 (50.9)	15 (57.7)	12 (44.4)	

Values present as mean ± SD were analyzed by Mann–Whitney *U*-test

Values present as number and percent were analyzed by Chi-square or Fisher's exact tests

*Hypoxic ischemic encephalopathy

Table 2 Efficacy of treatment between the studied groups

Variables	Total ($n=53$)	Group A ($n=26$)	Group B ($n=27$)	*p* value
Spasm frequency before treatment/day				0.842
Mean ± SD	20.55 ± 4.37	20.42 ± 3.92	20.67 ± 4.84	
Min–max	13–27	14–27	13–27	
Spasms cessation at 7 days	28 (52.8)	14 (53.8)	14 (51.9)	1.000
Spasms cessation at 14 days	21 (39.6)	10 (38.5)	11 (40.7)	1.000
Recurrence at 6 weeks	7 (13.2)	3 (11.5)	4 (14.8)	1.000
EEG* improvement at 2 weeks	20 (37.7)	11 (42.3)	9 (33.3)	0.577
EEG* improvement at 6 weeks	25 (47.2)	12 (46.2)	13 (48.1)	1.000

Values present as mean ± SD were analyzed by Mann–Whitney *U*-test

Values present as number and percent were analyzed by Fisher's exact test

*Electroencephalogram

Table 3 Adverse effects of steroids among the studied groups

Adverse effects of steroid	Total ($n=53$)	Group A ($n=26$)	Group B ($n=27$)	*p* value
Weight gain	31 (58.5)	15 (57.7)	16 (59.3)	1.000
GIT* upset	14 (26.4)	6 (23.1)	8 (29.6)	0.757
Irritability	9 (17.0)	5 (19.2)	4 (14.8)	0.728
Hyperglycemia	7 (13.2)	4 (15.4)	3 (11.1)	0.704
Sleep disturbances	11 (20.8)	5 (19.2)	6 (22.2)	1.000
Increased appetite	40 (75.5)	19 (73.1)	21 (77.8)	0.757
Hypertension	3 (5.7)	2 (7.7)	1 (3.7)	0.61

Values present as number and percent were analyzed by Fisher's exact test

*Gastrointestinal tract

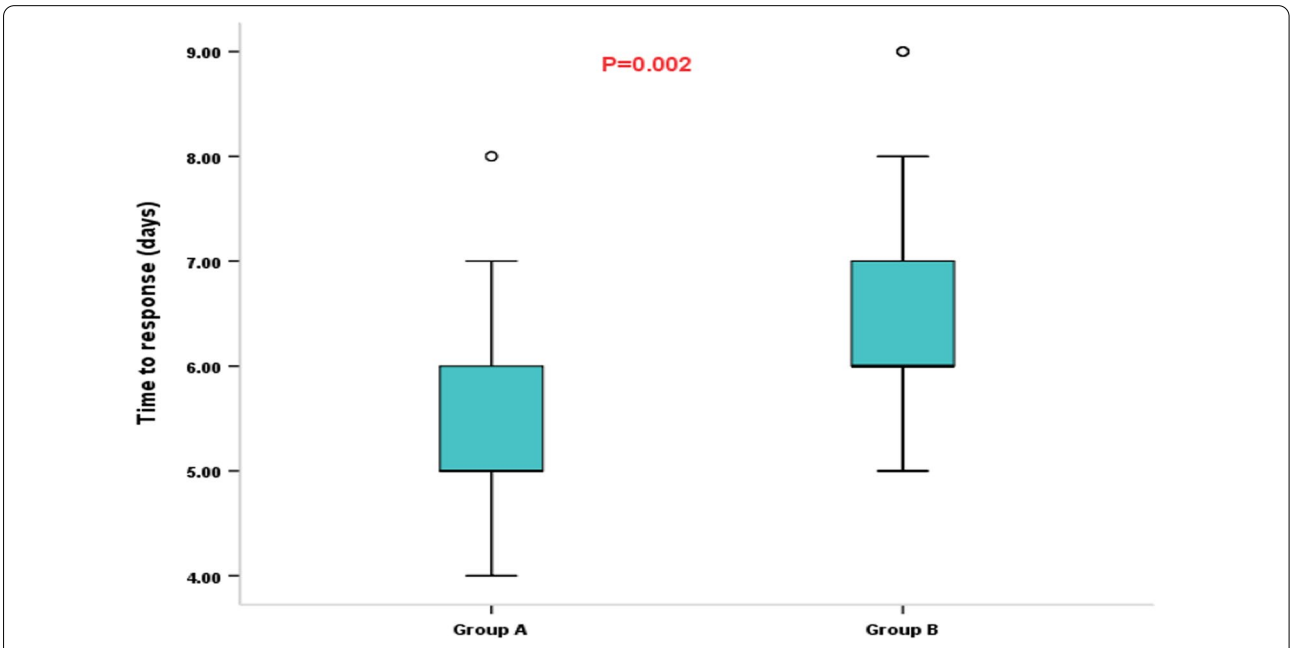

Fig. 1 Box plot demonstrating the statistically significant difference between both groups in terms of time to respond to medications

There was a minor male prevalence of IS in our study, which was previously reported by Velek and Velková in their review [1], but was more prominent in Kapoor et al. [12] and Rajpurohit et al. [13] studies. Importantly, both groups were age-matched during the 1st year of life (infancy), which corresponds to the ILAE criteria of IS.

The age of onset of spasms was between 3 and 7 months as in previous reports [1, 6]. The etiology of IS was unknown in about two-thirds of cases in our study, while it is usually unknown in only one-third of cases as stated in the review of Velíšek and Velíšková [1]. The majority of the cases in Kapoor et al. [12] and Rajpurohit et al. [13] studies were related to neonatal hypoglycemia and perinatal asphyxia. These discrepancies may be due to variable randomization and changes in diagnostic tool availability, particularly advancements in genetic testing (which is not done in our study), as numerous genes may contribute to the bulk of unknown etiologies, as noted by Velek and Velková [1].

About half of the patients have comorbidities, with developmental delay being the more prevalent which when combined with hypsarrhythmia completed the triad of West syndrome [1]. Microcephaly was in a minority of cases (13.2%) while vision and hearing deficits were the least (3.8% for each). These findings differ with findings of Kapoor et al. as in their study each of microcephaly and developmental delay was present in about two-thirds of cases, while each of hearing and vision deficit was present in about one-third of cases [12]. In Rajpurohit et al. study, developmental delay was present in more than three-fourths of cases [13]. This disparity may be explained by the fact that the etiologies in cohorts are different.

For many years, IVMP and OP were used interchangeably to treat a variety of drug-resistant epilepsies, including West syndrome, Landau–Kleffner syndrome, epileptic encephalopathies, and absence epilepsy, with varying regimens [6, 7, 14].

In our study, both groups received regimens for approximately 6 weeks, and the various clinical characteristics and etiologies were distributed nearly evenly between them.

Prior to treatment, the frequency of spasms was nearly identical in both groups.

The prevalence of spasm cessation after treatment initiation was similar in both groups at 7 and 14 days. It was 53.8% in group A and 51.9% in group B at 7 days which agrees with other studies [6, 7, 12, 14]. In their study, Hassanzadeh and Aminzadeh used intravenous IVMP in a cohort of 20 children and observed clinical remission in 60% of them at 4.41 ± 1.50 days [14]. Mytinger et al. reported their experience with use of IVMP pulse followed by an 8-week course of oral steroids in 10 participants with IS. Remission was achieved in 50% between 2 and 6 days [6]. Yeh et al. used IVMP followed by a short course of oral steroids and observed that in nine of 14 patients (64.3%), rapid cessation of spasms occurred with mean time to cessation of 3.0 days [7]. Kapoor et al. found early response in IVMP group, as 54.8% showed spasm cessation at 5.4 ± 0.9 days, while 68.9% of the OP group needed 9.5 ± 2.6 days to show spasms cessation [12]. In Rajpurohit et al. study which included 44 recently diagnosed children with WS, methylprednisolone therapy was given as intravenous infusion to 18 children at a dose of 30 mg/kg/day for 5 days followed by oral steroids 1 mg/kg gradually tapered over 5–6 weeks, by day 14 of therapy, 6/18 (33.3%) children achieved cessation of epileptic spasms [13].

With regard to resolution of hypsarrhythmia in EEG, it was also similar in our study between both groups with a total of 37.7% of infants. EEG showed improvement at 2 weeks, while 47.2% showed improving EEG at 6 weeks. In Hassanzadeh and Aminzadeh study of IVMP, resolution of hypsarrhythmia on follow-up EEG at 2 weeks was observed in 65% of patients [14] while 50% of infants in Mytinger et al. study achieved this resolution in a mean time of 23 days: range 11–38 days [6]. In Kapoor et al. study, 51.6% of IVMP group and 44.8% of OP group showed resolution of hypsarrhythmia at 2 weeks which is comparable to our study as the percentage was 42.3% in group A and 33.3% in group B [12].

At 6 weeks, the improvement of EEG was 46.2% in group A and 48.1% in group B which also coincides to a great extent with Kapoor et al. results where the percentage was 45.2% and 75.9%, respectively [12]. The similarity in EEG results in the two groups in our study, while its difference in Kapoor et al. study could be explained by the similar duration of treatment in our groups while it was shorter in Kapoor et al. study in IVMP group.

The relatively high dose in OP group may explain the higher response in our study relative to other studies with lower oral doses. Trials using 2 mg/kg/day of oral prednisone had remission rates of 8.3–28.6% [15, 16].

Lux et al., who used higher doses of oral prednisolone (ranging from 5 to 8 mg/kg/day), reported a 70% remission rate [17]

The higher response rate was in new patients in both groups than in patients receiving other medication prior to steroids which coincides with the results of Mytinger et al. [6].

The most common adverse effect was increased appetite followed by weight gain which was nearly similar in both groups. These two side effects were more common in OP group in Kapoor et al. study but as stated above the duration of treatment was longer in this group in his study than in their IVMP group [12].

Sleep disturbances were less but nearly the same in both groups followed by irritability then hypertension. This agrees with Yeh et al. and Hassanzadeh and Aminzadeh who used IVMP [7, 14] but disagrees with Kapoor et al. who noted that these three were found significantly in the first few days of treatment in IVMP group and related this to their regimen [12].

GIT disturbances were similar in both groups in our study but was more than those in Kapoor et al. study which may be explained by the relatively longer duration of treatment in our regimen especially in IVMP group and other dietary habits which may contribute to these adverse effects [12].

Hyperglycemia was similar in both groups coinciding with the results of Kapoor et al. study [12].

Study limitations

First, it was not a blind or randomized study (rational: We were afraid to lose follow-up of cases (especially with small sample size), in addition to money and time constrains, and inability to measure the long-term outcome of both therapies. Also, validity of blind and randomized trials requires multiple sites, which would be difficult to manage). Second, the response to treatment was dependent mainly on parental report and not on objective 24-h EEG monitoring. Third, the etiology was unknown in most patients while different etiologies may influence prognosis. Lastly, we did not measure the long-term outcome of both therapies.

Conclusions

This study revealed that no significant difference between oral prednisolone and intravenous methylprednisolone in treatment of epileptic spasm with regard to short-term outcomes; the only advantage of intravenous therapy is decreased time to get response and the only advantage of oral therapy is its applicability at home without hospitalization. Further studies are warranted to explore the long-term outcomes.

Abbreviations

IS: Infantile spasm; ILAE: International League Against Epilepsy; EEG: Electroencephalography; ACTH: Adrenocorticotrophic hormone; UKISS: United Kingdom Infantile Spasms Study; OP: Oral prednisolone; IVMP: Intravenous methylprednisolone pulse; GIT: Gastrointestinal tract.

Acknowledgements

We are extremely indebted to all members of Neurology and Pediatric departments at Al-Azhar University hospitals in Cairo for great help and cooperation.

Authors' contributions

AAE: conceptualization; methodology; validation; preparation; project administration; resources investigation; software; formal analysis; data curation; writing—original draft; writing—review and editing. MASH: conceptualization; methodology; writing—original draft; writing—review and editing. All authors read and approved the final manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request. Confidentiality and security of data and materials were insured through all stages of the study.

Declarations

Ethics approval and consent to participate

The study was approved by the Local Ethics Committee at Al-Azhar faculty of medicine, Cairo, Egypt. Informed written parental consent was obtained prior to enrollment in the study. Confidentiality was maintained throughout the study process. Names of the ethics committee: Prof. Dr. Moftah Mohamed Rabiea, Prof. Dr. Mosalam Mohamed El-sayed Nasser, Prof. Dr. Mahmoud Mohamed Rashad, Prof. Dr. Mohsen Taha El-Keiey, Prof. Dr. Ali Abdel-Lateif Afia. Registration Number: ***Ped._185Med.Research_Epileptic spasm; steroid; methylprednisolone; west syndrome; hypsarrhythmia._0000185***. Issuing and Expiration Dates: 19/11/2019 Valid Until 18/11/2025.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Present Address: Pediatric Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt. [2]Neurology Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt. [3]El-Hussein University Hospital, Gawhar Alqaed Street, Aldarrasa 11651, Cairo Governorate, Egypt. [4]Damanhûr, Egypt.

Received: 19 October 2021 Accepted: 4 March 2022
Published online: 21 March 2022

References

1. Velíšek L, Velíšková J. Modeling epileptic spasms during infancy: are we heading for the treatment yet? Pharmacol Ther. 2020;212: 107578. https://doi.org/10.1016/j.pharmthera.2020.107578.
2. Kelley SA, Knupp KG. Infantile spasms—have we made progress? Curr Neurol Neurosci Rep. 2018;18(5):27. https://doi.org/10.1007/s11910-018-0832-8.
3. Pellock JM, Hrachovy R, Shinnar S, Baram TZ, Bettis D, Dlugos DJ, et al. Infantile spasms: a U.S. consensus report. Epilepsia. 2010;51(10):2175–89. https://doi.org/10.1111/j.1528-1167.2010.02657.x.
4. Millichap JJ, Millichap JG. Hypsarhythmia or hypsarrhythmia? Pediatr Neurol Briefs. 2015;29(8):64. https://doi.org/10.15844/pedneurbriefs-29-8-7.
5. Scheffer IE, Berkovic S, Capovilla G, Connolly MB, French J, Guilhoto L, et al. ILAE classification of the epilepsies: position paper of the ILAE Commission for Classification and Terminology. Epilepsia. 2017;58(4):512–21. https://doi.org/10.1111/epi.13709.
6. Mytinger JR, Quigg M, Taft WC, Buck ML, Rust RS. Outcomes in treatment of infantile spasms with pulse methylprednisolone. J Child Neurol. 2010;25(8):948–53. https://doi.org/10.1177/0883073809356107.
7. Yeh HR, Kim MJ, Ko TS, Yum MS, You SJ. Short-term outcome of intravenous methylprednisolone pulse therapy in patients with infantile spasms. Pediatr Neurol. 2017;71:50–5. https://doi.org/10.1016/j.pediatrneurol.2017.03.017.
8. Gowda VK, Narayanaswamy V, Shivappa SK, Benakappa N, Benakappa A. Corticotrophin-ACTH in comparison to prednisolone in west syndrome—a randomized study. Indian J Pediatr. 2019;86(2):165–70. https://doi.org/10.1007/s12098-018-2782-1.
9. Gonzalez-Giraldo E, Stafstrom CE, Stanfield AC, Kossoff EH. Treating infantile spasms with high-dose oral corticosteroids: a retrospective review of

87 children. Pediatr Neurol. 2018;87:30–5. https://doi.org/10.1016/j.pediatrneurol.2018.06.011.
10. Song JM, Hahn J, Kim SH, Chang MJ. Efficacy of treatments for infantile spasms: a systematic review. Clin Neuropharmacol. 2017;40(2):63–84. https://doi.org/10.1097/WNF.0000000000000200.
11. Wanigasinghe J, Arambepola C, Ranganathan SS, Sumanasena S. Randomized, single-blind, parallel clinical trial on efficacy of oral prednisolone versus intramuscular corticotropin: a 12-month assessment of spasm control in west syndrome. Pediatr Neurol. 2017;76:14–9.
12. Kapoor D, Sharma S, Garg D, Samaddar S, Panda I, Patra B, et al. Intravenous methylprednisolone versus oral prednisolone for west syndrome: a randomized open-label trial. Indian J Pediatr. 2021;88(8):778–84. https://doi.org/10.1007/s12098-020-03630-3.
13. Rajpurohit M, Gupta A, Madaan P, Sahu JK, Singhi P. Safety, feasibility and effectiveness of pulse methylprednisolone therapy in comparison with intramuscular adrenocorticotropic hormone in children with west syndrome. Indian J Pediatr. 2021;88(7):663–7. https://doi.org/10.1007/s12098-020-03521-7.
14. Hassanzadeh Rad A, Aminzadeh V. Infantile spasms treated with intravenous methylprednisolone pulse. Iran J Child Neurol. 2017;11(2):8–12.
15. Baram TZ, Mitchell WG, Tournay A, Snead OC, Hanson RA, Horton EJ. High-dose corticotropin (ACTH) versus prednisone for infantile spasms: a prospective, randomized, blinded study. Pediatrics. 1996;97(3):375–9.
16. Hrachovy RA, Frost JD Jr, Kellaway P, Zion T. A controlled study of prednisone therapy in infantile spasms. Epilepsia. 1979;20(4):403–7. https://doi.org/10.1111/j.1528-1157.1979.tb04820.x.
17. Lux AL, Edwards SW, Hancock E, Johnson AL, Kennedy CR, Newton RW, United Kingdom Infantile Spasms Study, et al. The United Kingdom Infantile Spasms Study (UKISS) comparing hormone treatment with vigabatrin on developmental and epilepsy outcomes to age 14 months: a multicentre randomised trial. Lancet Neurol. 2005;4(11):712–7.

Publisher's Note