INTRODUCTION

Dyke-Davidoff-Masson syndrome (DDMS), also known as cerebral hemiatrophy, is a rare neurological condition with unknown global prevalence and incidence.\(^1,2,3\) DDMS results from an insult to the growing brain in utero or early infancy, which lead to the loss of neurons, compromising the growth of the brain. Although it has classic neuroimaging findings, it is missed due to its complex presentation. It was first described by three physicians Dyke, Davidoff, and Masson (1933), in nine hemiplegia patients. They described the neurologic features through changes seen in plain skull X-rays.\(^1,2\) The characteristic clinical features include facial asymmetry, seizures, contralateral hemiplegia, drugs resistant epilepsy, which can occur in various combinations.\(^1,2,3\) Signature neuroimaging findings include unilateral brain volume loss, ventriculomegaly, compensatory bone hypertrophy resulting in cerebral hemiatrophy, calvarial thickening and hyperpneumatization of paranasal and frontal sinuses neuroimaging.

CASE REPORT

A 4-year-old girl patient presented to our emergency department with recurrent episodes of left focal seizure lasting 40 minutes (status epilepticus). Seizure onset of involuntary movements of left limbs, her head and eyes were deviating to the left side with asymmetric posturing of the limbs, frothing of the mouth, involuntary micturition, and tongue bite. Consciousness did not improve after the seizure stopped. She had a history of seizures since 1 year ago and managed with multiple anti-epileptic drugs (phenytoin, phenobarbital, valproate acid) and was suspected atrophy. Therapy, she got multiple anti-epileptic drugs. Diagnosis of DDMS is made by a triad of hemiplegia, contralateral hemiatrophy, seizures, and classical radiological features. Imaging is important in diagnosing this rare entity and differentiating it from other causes of cerebral hemiatrophy. The long-term prognosis is good, provided the clinical entity is recognized early and managed appropriately.

ABSTRACT

**Background:** Dyke-Davidoff-Masson syndrome (DDMS) is a rare neurological condition with unknown global prevalence and incidence. The characteristic clinical features include facial asymmetry, seizures, and contralateral hemiplegia. Signature neuroimaging findings include unilateral brain volume loss, ventriculomegaly, compensatory bone hypertrophy resulting in cerebral hemiatrophy, calvarial thickening and hyperpneumatization of paranasal and frontal sinuses neuroimaging.

**Case Presentation:** 4-year-old girl patient presented seizures (diagnosed as epilepsy) and complained of left-sided hemiplegia since 1 year ago. Neurological examination revealed left-sided spastic hemiplegia with brisk tendon reflexes and extensor planter response on the left side, increased reflexes physiology in the left limb, and positive Babinskion the left leg. MRI showed right cerebral hemiatrophy with ex vacuo dilatation of the right lateral, III and IV ventricles, with hyper pneumatization of the right ethmoid sinus and right left mastoid Aircell and elevation of the right petrous ridge, and falciine displacement to the right as far as +/- 7mm and blurring right hippocampus, suspected atrophy. Therapy, she got multiple anti-epileptic drugs.

**Conclusion:** Diagnosis of DDMS is made by a triad of hemiplegia, contralateral hemiatrophy, seizures, and classical radiological features. Imaging is important in diagnosing this rare entity and differentiating it from other causes of cerebral hemiatrophy. The long-term prognosis is good, provided the clinical entity is recognized early and managed appropriately.

**Keywords:** Seizure, hemiplegia, contralateral hemiatrophy, Dyke-Davidoff-Masson syndrome.
diagnosed with intractable/refractory epilepsy.

The patient also complained of left-sided hemiplegia 1 year ago. She was born to non-consanguineous parents and had an uneventful antenatal and perinatal period. She was born by section Caesarea, a term baby, and immediately cried with a birth weight of 3000 grams. She experienced normal growth and weight gain until she was 3 years old. During the 2 first years of her age, she appeared healthy, with good weight increment and developmental progress. She could walk, run, play, and speak appropriately. After she was ill, the milestone was stopped, and she couldn't do any basic activities by herself. Her mother said she had difficulty in learning something. Vision and hearing were normal and cranial nerves were intact. There was no history of head trauma. Her family history was unremarkable, but she had no history of suffering from seizures.

The body temperature, blood pressure, heart and breathing rates, and oxygen saturation were normal on examination. Neurological examination revealed left-sided spastic hemiplegia with brisk tendon reflexes and extensor planter response on the left side. There is an increased reflexes physiology in the left limb and positive Babinski on the left leg. There was no sign of a meningeal sign.

The patient already had a CT scan with contrast last year when she got the first seizure, which revealed a hypodense lesion in the cortical-subcortical over almost the entire right cerebral hemisphere. For this period, blood samples were collected hematological and biochemical investigations, including blood sugar levels, complete blood count, electrolytes, liver function test, and renal were normal. So, she had an electroencephalogram (EEG) examination that revealed abnormal II; there was a multifocal epileptic form without hypofunction. With detailed history and examination, he was diagnosed as a case of status epilepticus and followed by an MRI scan of the brain for better evaluation. MRI of the patient showed right cerebral hemiatrophy with ex vacuo dilatation of the right lateral, III and IV ventricles, with hyperpneumatization of the right ethmoid sinus and right left mastoid Aircell and elevation of the right petrous ridge, and falcine displacement to the right as far as +/- 7 mm, suspected Dyke Davidoff Mason Syndrome and blurring right hippocampus, suspected atrophy as seen in Figure 1.

The patient was diagnosed with DDMS with his clinical and radiological findings. She got phenobarbital, phenytoin and midazolam intravenous to treat the status epilepticus and valproic acid orally; after 3 days, she did not get a seizure, and she got tapering off the dose of midazolam. But, after 5 days, she got a focal seizure again, so valproic acid was changed to ox carbamazepine. The neurosurgery department consulted her, and there was no operation if she controlled with medication. Physiotherapy was also started for the weakness of the limbs and speech therapy. She was discharged after 7 days free of seizures and was educated to continue epilepsy medication, control to pediatric neurology clinic and do physiotherapy routinely.

**DISCUSSION**

Dyke-Davidoff-Masson syndrome is a rare syndrome itself, and its presentation as epilepsy and can be status epilepticus (SE) is rarely described in the literature. Status epilepticus or recurrent seizures is one of the most common and difficult to treat in neurological emergencies. The treating neurologist is much better if the underlying is already known.1-8 Clinically, DDMS includes asymmetry facial features, seizures, contralateral hemiplegia, mental retardation, and learning disorders. Seizures can be focal or generalized. In some cases, psychiatric disorders can be found.8 Status epilepticus (SE) is one of the most common neurological emergencies in children and has a mortality of about 2 to 4%.10 Neurological sequelae of pediatric SE occur in 9%-28% of patients.11

Dyke-Davidoff-Masson syndrome can be divided into 2 types, the congenital (infantile) and acquired type. In the congenital type, structural abnormalities of the cerebral vasculature seem to be the cause of this, leading to cerebral injury during fetal life, and it could also be due to some genetic defects. The acquired type can be divided into prenatal, perinatal and postnatal. Prenatal causes are infections and vascular disorders. Perinatal causes, usually due to labor, are anoxia, hypoxia and intracranial hemorrhage. Postnatal causes are trauma, tumors, infections and prolonged febrile seizures. The emergence of clinical symptoms may occur after the adolescent or adult period.12

In normal brain development, half the brain volume is formed during the first year of life, and half is life. In brain development, the brain compresses the bones, gradually enlarging until the adult head shape and size are achieved. If one part of the brain fails to develop, the other hemisphere compresses the undeveloped tissue.13,14 Congenital brain malformations are one of the major groups responsible for epilepsy in children. The age of onset of symptoms largely depends on the time of brain injury, and specific changes may not appear until after the first decade of life.15,16 According to the degree of brain damage, the clinical findings vary from patient to patient.12,14,16 If the disease develops within the first 2 years of life and has compensatory changes,
such as homolateral skull and sinus hypertrophy, it can result may occupy the vacuum left by the cerebral hypoplasia. The concerned side has a wide sulcus replaced by gliotic cerebral tissue. In the congenital type, there is a midline shift towards the diseased side, and the sulci prominence replacing the gliotic tissue may not be present. A thorough history, detailed examination, and appropriate imaging studies are essential to reach the diagnosis.\textsuperscript{15,16} In this case, DDMS occurred in the prenatal period, namely congenital malformations in the form of cerebral hemiatrophy, because there were no signs of maternal infection during pregnancy or abnormalities and disorders during childbirth, which means there was no abnormal history of other causes.

DDMS is characterized by atrophy or hypoplasia of one hemisphere, the presence of a midline shift, bone hypertrophy with sinus hyper pneumatization, especially in the frontal and mastoid with contralateral paresis, there is widening of the ipsilateral sulci, dilatation of the ventricles and ipsilateral and internal spaces, and unilateral bone thickening.\textsuperscript{17} Clinical symptoms of DDMS vary, including facial asymmetry, seizures, contralateral hemiplegia, mental retardation, learning disorders, and speech disorders. Seizures can be focal can be general. DDMS is more common in males than females.\textsuperscript{18,19} Signature neuroimaging findings include unilateral brain volume loss, ventriculomegaly, compensatory bone hypertrophy resulting in cerebral hemiatrophy, calvarial thickening and hyperpneumatization of parasanal and fronto sinuses, the elevation of the petrous ridge, ipsilateral falxine displacement.\textsuperscript{3,4} Radiographically, unilateral cerebral volume loss appears, which causes compensatory calvarial disturbances, such as thickening and hyperpneumatization of the parasanal sinuses and mastoid.\textsuperscript{8} There are three forms of cerebral hemiatrophy on MRI of the brain, they are the presence of diffuse cortical and subcortical atrophy, the presence of diffuse cortical atrophy accompanied by a porencephalic cyst, and the presence of previous infarction with gliosis in the territorial area of the middle cerebral artery.\textsuperscript{20,21,22} In this case, the patient had a recurrent seizure, left-sided spastic hemiplegia, and difficulty learning. An MRI examination showed right cerebral hemiatrophy with ex vacuo dilatation of the right lateral, III and IV ventricles, with hyperpneumatization of the right ethmoid sinus and right left mastoid air cell and elevation of the right petrous ridge, and falcline displacement to the right as far as +/- 7mm. The drawback in this patient is that an IQ test was not performed to support the diagnosis of mental retardation in this patient. So she was diagnosed with DDMS.

Differential diagnoses of DDMS can include basal ganglia germinoma, Sturge-Weber syndrome, Fishman syndrome, Parry-Romberg syndrome, Silver Russel syndrome and Rasmussen encephalitis. With a good history and physical examination supported by radiological examination, DDMS can be established, and the differential diagnosis can be ruled out.\textsuperscript{20,23,24} Management of DDMS focuses on the management and control of seizures with appropriate anti-seizure therapy. In addition, other therapies that can be done are physiotherapy and talk therapy, which play a very important role in long-term treatment. In 2015, it was estimated that 470 000 children in the United States (US) had epilepsy. Among them, 20% - 30% were refractory to medical management. Refractory epilepsy significantly impacts childhood development and quality of life for children and their caregivers. Refractory epilepsy also confers substantial implications for healthcare use and costs. Children with refractory epilepsy also have higher medical care needs and consume substantially more healthcare resources, such as inpatient (IP) and emergency department (ED) visits, than children with good seizure control with medications. Some studies showed patients with refractory epilepsy treated with surgery had significant reductions in healthcare utilization compared with patients treated only with medications; it concluded patients to do surgical management if the medical interventions failed to control the seizure for a reduction in healthcare utilization in the future.\textsuperscript{23} Hemispherectomy is an option for cases in children with recurrent seizures and hemiplegia, with a success rate of 85% in selected cases.\textsuperscript{16,23} In this case, the patient was admitted with status epilepticus based on refractory epilepsy and was treated with 3 types of anti-epileptic drugs. On discharge, the patient does not have recurrent seizures. The patient also consulted the neurosurgery department, and there was no operation if she controlled with medication (conservative).\textsuperscript{25,26}

The prognosis will be better if hemiplegia occurs at age 2 or older and there are no prolonged or recurrent seizures.\textsuperscript{16,27} In this case, the prognosis ad vitam is ad bonam because the patient has passed his critical phase and hemiplegia when she is 3 years old. Prognosis ad function is ad malam because seizures still occurred, although the patient was already on three anti-epileptic drugs and had hemiplegia. Prognosis ad sanction is ad malam because the patient had congenital malformations in cerebral hemiatrophy, which can not be cured. Monitoring for lifetime treatment and nutritional therapy should be done continuously to ensure and maintain optimal growth.

CONCLUSION
A triad diagnoses DDMS of hemiplegia, contralateral hemiatrophy, seizures, and classical radiological features. Imaging is important in diagnosing this rare entity and differentiating it from other causes of cerebral hemiatrophy. The long-term prognosis is good, provided the clinical entity is recognized early and managed appropriately.

CONFLICT OF INTEREST
The authors declare that there is no competing interest regarding the manuscript.

ETHICAL CONSIDERATION
This case report has obtained permission from the patient's parents.

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AUTHOR CONTRIBUTION
All authors contributed to the study from the conceptual framework, data gathering, and analysis until the study’s results were interpreted upon publication.

REFERENCES
23. Irwen Pan, Melissa A, Dave F Clarke, Sandi Lam. The Effectiveness of Medical and Surgical Treatment for Children With Refractory Epilepsy. Neurosurgery. 2020;88(1):E72-E82.