ventricular septal defect is the commonest abnormality. Association with double outlet right ventricle has also been previously reported [5].

Over 70% of patients with left ventricular diverticulum have Cantrell syndrome. The diverticulum originates from the left ventricular apex in these cases and may be associated with umbilical hernia and complex cardiac abnormalities. Ventricular aneurysm must be differentiated from diverticulum. A narrow mouth and synchronous contractility characterize a diverticulum. On the other hand, aneurysms show akinesia or paradoxic contractility of the outpouching, which is asynchronous with the rest of heart.

Early surgical repair is indicated in cases of left ventricular diverticulum, as it may rupture spontaneously, thrombose or produce arrhythmias. It is generally recommended that the midline thoraco-abdominal defect is treated first and heart defects be corrected later [6]. We present this case in view of the interesting presentation in a neonate with a pulsatile umbilical swelling and cyanosis, and a good outcome after surgery.

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Mechanical Thrombectomy for Cerebral Venous Sinus Thrombosis in a Neonate

Cerebral venous sinus thrombosis has a reported incidence of 0.35-0.67 per 100000 children per year, and about 40% of cases occur during the neonatal period [1]. In the pediatric population, standard choice of treatment is the use of low molecular weight heparin (LMWH). The indication criteria and the role of mechanical thrombectomy and other interventional procedures in infants with cerebral venous thrombosis is unknown [2,5]. Even in neonates treated with LMWH, the incidence of neurological disability is unfavorably high,especially in those with multi-sinus thrombosis [1]. We report a neonate with this disorder managed with mechanical thrombectomy.

A 10-day-old term male neonate presented to the pediatric emergency department with partial seizure of the upper extremities. The infant was born after an uncomplicated pregnancy followed by a normal spontaneous vaginal delivery and was discharged home from neonatal nursery after 72 hours, with no need of intervention and medication. At presentation, the infant was afebrile, apathetic, with feeding difficulties, and had mild tachycardia and delayed capillary refill time. A weight loss of 15% compared to the discharge weight was noted. The clinical state was evaluated as dehydration, and intravenous rehydration was started. Two hours after admission, myoclonic seizures of upper extremities occurred, along with multiple apneic spells reappeared. Anticonvulsant treatment with intravenous phenobarbital was started. Laboratory examinations (blood count, plasma minerals and serum biochemistry, C-reactive protein, procalcitonin, coagulation profile) and lumbar puncture results were unremarkable, except for lactate concentration (4.75 mmol/L), hematocrit level (61%) and hemoglobin concentration (20 g/dL). Magnetic resonance imaging (MRI) with consecutive time-of-flight (TOF) venography and contrast enhanced T1WI revealed cerebral venous thrombosis. Superior sagittal sinus, right transverse sinus, straight sinus, vein of Galen and internal cerebral veins thrombosed, along with hemorrhage from right choroid plexus, and bilateral thalamic vasogenic edema. After multi-specialty consultation, mechanical thrombectomy was planned, in view of the presence of multi-sinus thrombosis with thalamic edema and signs of neurologic deterioration with acute repetitive seizures.

After obtaining informed consent from the baby's mother, the procedure was performed under general anesthesia with ultrasound control. The right internal jugular vein was punctured and a 3F introducer (IVA, BALT) was placed by the Seldinger technique. The microcatheter (Orion, Medtronic) was navigated *via* micro-guide wires Hybrid .008" and Hybrid.1214DA (BALT) into the straight sinus as well as into the superior sagittal sinus directly without the use of a guide catheter. Mechanical thrombectomy was performed *via* a Solitaire platinum 6ã40 (Medtronic) three times per sinus. Hemostasis in the puncture site was achieved by compression with usage of HemCon Patch.

After the interventional procedure, the infant was monitored in the neonatal intensive care unit for 18 days. The newborn was extubated and could breathe spontaneously with no apneic spells 24 hours after the procedure. Neurological examination confirmed normal findings without clinical seizures, and no abnormal electrical brain activity on electroencephalography, thus anticonvulsant medication were discontinued. After the procedure, LMWH was prescribed prophylactically. Further workup after the procedure revealed low antithrombin III plasma concentrations with the need for parenteral substitution the following month, with normalization of the value. During the hospital stay and follow-up period, MRI scans confirmed a full recanalization of cerebral venous system. Neurodevelopmental outcomes at 3, 6, and 8 months assessed by general pediatrician have been favorable with normal psychomotor development. Bayley III assessment at age of 21 months was done. The composite cognitive and motor score was age appropriate.

Cerebral venous sinus thrombosis in neonates is usually multifactorial, with one risk factors identified in up to 95% of patients [6]. In the index case, the infant had dehydration with elevated hematocrit level. Antithrombin III deficiency was considered to be due to dehydration with normalization of plasma concentration before discharge.

The main pathophysiological mechanism of brain damage in cerebral sinus thrombosis is related to outflow obstruction with venous congestion producing edema and the formation of hemorrhagic infarction in most cases [6]. The presence of collateral flow and the time of recanalization is crucial for the development of parenchymal injuries. In neonates, there is an association between intraventricular hemorrhage and cerebral venous sinus thrombosis [1,2]. Thalamic and basal ganglia lesions in newborns are associated with poor neurodevelopmental outcome including dyskinetic-spastic cerebral palsy with cognitive delay, visual impairment, and the risk of post-neonatal epilepsy [2].

The ideal treatment of cerebral venous sinus thrombosis in newborns is unclear, particularly in case of coincident intracranial hemorrhage. In most guidelines, the standard treatment of cerebral venous sinus thrombosis is LMWH or unfractionated heparin. Anticoagulation therapy in the case of intracranial bleeding is not recommended during first 5-7 days [3]. The indication criteria for endovascular treatment of cerebral venous sinus thrombosis are under study. In adults, mechanical thrombectomy is reserved for patients with deep cerebral vein thrombosis, worsening clinical conditions, and failure of anticoagulation treatment [3,4]. In the pediatric population the role of endovascular intervention in presence of cerebral sinus thrombosis is not documented. The youngest child yet reported to have undergone mechanical thrombectomy was aged two years, and had an improved neurological outcome [5].

To the best of our knowledge, this is the first documented mechanical thrombectomy procedure during the neonatal period. This case report raises the question if endovascular interventions should not be reserved for newborns with multi-sinus thrombosis, especially when a deep cerebral veins are involved. This is particularly relevant if recent advances in endovascular techniques can render previously published data obsolete [4].

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