



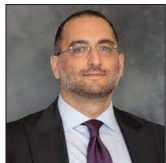
Case Report

Pediatric middle meningeal artery embolization for chronic subdural hematoma: A case report

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ABSTRACT

Background: The most common neuroradiological finding in pediatric nonaccidental trauma (NAT) is subdural hematoma (SDH). Management options for pediatric SDH range from conservative clinical surveillance to craniotomy or decompressive craniectomy. The middle meningeal artery (MMA) indirectly feeds the hematoma; thus, MMA embolization is an alternative or adjunct to current surgical treatments in adults. Herein, we present, to the best of our knowledge, the first reported case of successful MMA embolization in a pediatric patient as an adjunct to current standard treatment for chronic SDH (cSDH).

Case Description: An 18-month-old male with a history of NAT presented at 5 months of age with an acute right parietal skull fracture and bilateral SDH treated with burr hole drainage. He was lost to follow-up until 15 months of age with an increased head circumference and new dysconjugate gaze. Imaging revealed a right-sided cSDH and underwent craniotomy. Six-week follow-up revealed significant improvement in the SDH but cSDH remained at the periphery of the craniotomy's reach. The patient symptoms continued. The right-sided MMA embolization was offered as option to avoid repeat craniotomy. Follow-up CTs at 2 weeks, 3 months, and 6 months postprocedure revealed decrease of cSDH size and density. At 8-month follow-up, the patient continued to meet developmental milestones with near resolution of his dysconjugate gaze.

Conclusion: This case report details the first successful use of MMA embolization in the treatment of pediatric cSDH as an adjunct to standard treatment. Further investigation of MMA embolization in pediatrics should be made to expand options available for cSDH in this patient population.

Keywords: Chronic SDH, MMA embolization, Pediatric neurotrauma

INTRODUCTION

The most common neuroradiological finding in pediatric abusive head trauma is subdural hematoma (SDH).^[7] In the pediatric population, the tendency toward resolution of SDH tends to be higher, although repeat abusive head trauma can exacerbate the condition.^[10] The management options for SDH in the pediatric population are varied and range from conservative clinical surveillance (nonsurgical management) to subdural punctures, external subdural drainage, subcutaneous reservoirs, subdural-subgaleal shunts, subdural-peritoneal shunts, craniotomy, and decompressive craniectomy.^[6] Conversely, chronic SDH (cSDH) is one of the most common conditions requiring neurosurgical intervention in the adult population with conventional

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treatments including observation or surgical techniques such as evacuation through twist drill craniotomy, burr hole irrigation, and craniotomy.^[8]

The middle meningeal artery (MMA) has been found to provide vascular supply to capillaries that feed hematoma and membrane formation.^[5] Based on this finding, MMA embolization has been shown to potentially aid spontaneous hematoma resolution, prevent recurrence, and serve as a less invasive alternative or adjunct to current standard treatments in the adult population.^[9] At present, there are no reported cases of the utilization of this procedure to treat cSDH as an adjunct in a pediatric patient and herein we present, to the best of our knowledge, the first reported case of MMA embolization in a pediatric patient as an adjunct to current standard treatment.

CASE PRESENTATION

An 18-month-old with a history of nonaccidental trauma (NAT) originally presented at 5 months of age with an acute right parietal skull fracture and bilateral SDH treated with burr hole drainage [Figure 1]. During his follow-up visits, he was neurologically well and imaging revealed resolution of the left-sided SDH, but there was gradual enlargement of his right-sided SDH. He was lost to follow-up for several months until referral from his pediatrician at 15 months age when they noted increasing head circumferences and new intermittent dysconjugate gaze with exotropia of the left eye. Repeat imaging revealed that his right-sided cSDH had formed a membrane and some small hemorrhage concerning for potential new NAT [Figure 2]. At that time, he was admitted and underwent right-sided craniotomy for subdural evacuation without complication. Follow-up imaging 6 weeks later revealed resolution of the right-sided SDH in the area of the craniotomy but there remained cSDH with membranes at the periphery of the craniotomy's reach [Figure 3]. The patient also had continued, intermittent dysconjugate gaze with a medially deviated left eye.

The right-sided MMA embolization was offered as option to avoid repeat craniotomy as his dysconjugate gaze did not resolve during follow-up. At 18 months of age, under general anesthesia, with neurological monitoring, vascular access was achieved using a micropuncture technique in the left femoral artery and the 4-French Berenstein catheter was used. The right MMA was selectively catheterized [Figure 4] and after confirming no orbital collateral anastomoses, we proceeded with embolization using Onyx embolisate material (Medtronic, Irvine, CA). At the conclusion of embolization, there was no filling of the MMA branches while patency of all other intracranial and extracranial vessels was confirmed. The patient was monitored overnight and discharged the following day neurologically stable.

Follow-up CTs were performed at 2 weeks, 3 months, and 6 months postprocedure [Figure 5]. The size of the SDH was noted to decrease with each follow-up imaging study along with the density of the SDH. At 8-month follow-up, the patient continued to meet his developmental milestones, was talking, and had near resolution of his dysconjugate gaze.

DISCUSSION

NAT is the leading cause of fatal head injuries in children younger than 2 years of age and responsible for 53% of serious or fatal traumatic brain injury cases.^[7] SDH is the most commonly observed intracranial lesion (in up to 90%) in infants with NAT and most commonly located in a parafalcine location.^[1] Subdural collections in association with shaken baby syndrome may have additional extra-axial findings such as subarachnoid hemorrhage, arachnoid tears, or bridging vein thromboses. Often, the presence of SDH in this context has a key role as a diagnostic marker representative of child abuse, as their volumes are often small with minor mass effect.^[10] The acceleration-deceleration type forces, at times associated with impact and resultant skull fractures (as in our case), lead to tearing of convexity bridging veins (at the junction of the bridging vein and superior sagittal sinus), thus resulting in extra-axial hemorrhage.^[4]

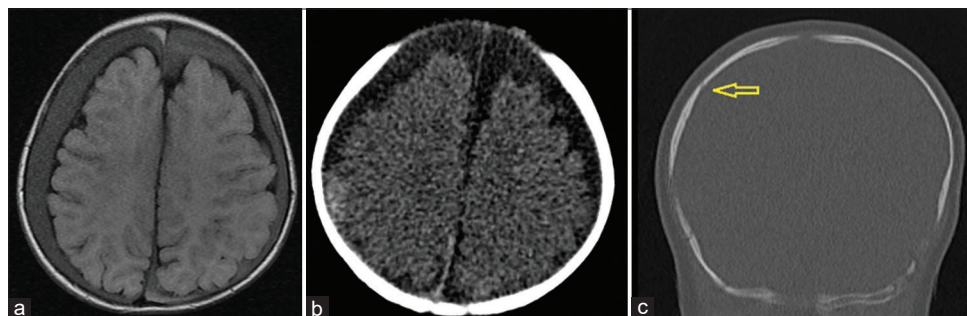


Figure 1: (a) MRI brain T1 axial demonstrating bilateral hypodense fluid collections (chronic subdural hematoma [cSDH]), (b) CT head noncontrasted axial demonstrating acute on chronic right SDH, (c) CT head coronal reconstruction demonstrating subtle nondisplaced skull fracture.

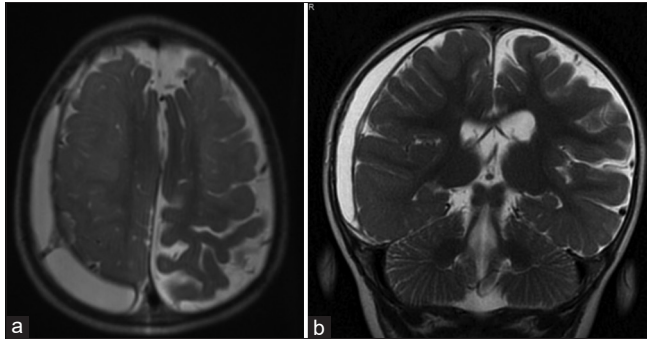


Figure 2: (a) MRI brain T2 axial and (b) coronal demonstrating resolution of the left subdural hematoma (SDH) with chronic SDH on the right with well-organized membrane compressing the underlying cortex.

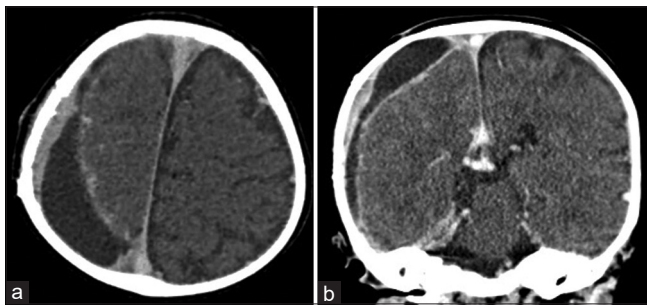


Figure 3: (a) CT head with contrast axial and (b) coronal demonstrating improvement of the subdural hematoma (SDH) in the area of the craniotomy but there remained chronic SDH with membranes at the periphery of the craniotomy's reach.

cSDH describes a serosanguinous, petroleum, or “crankcase-like” fluid collection occasionally loculated within neomembranes. After the initial occurrence of SDH, an inflammatory response occurs with proliferation of dural border cells, fibroblasts, and inflammatory cells resulting in the formation of a membrane around the SDH.^[5] Vascular angiogenic factor release leads to neovascularization with macrocapillaries that have highly permeable endothelial gap junctions. It is thought these fragile neovessels within the SDH membrane lead to growth and recurrence of cSDH.^[5] Septa formation within this subdural neomembrane is considered a consequence of repeated bleeding events from the friable neovasculature. In contrast to the situation in adults, cSDHs are relatively rare in infants.^[10]

The management options for SDH in the pediatric population are varied and range from conservative clinical surveillance (nonsurgical management) to subdural punctures, external subdural drainage, subcutaneous reservoirs, subdural-subgaleal shunts, subdural-peritoneal shunts, craniotomy, and decompressive craniectomy.^[6] cSDH in the adult population, where it is more frequently encountered, may be managed with observation or evacuated through twist drill

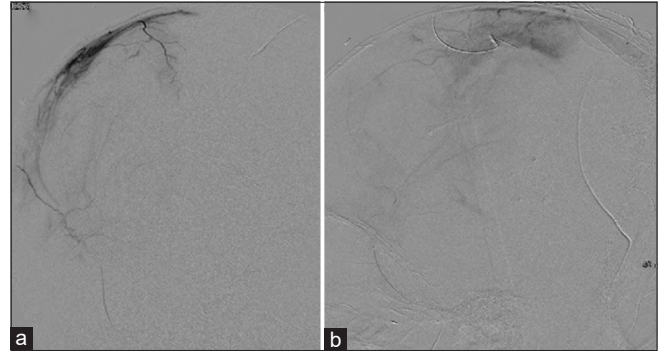


Figure 4: (a) AP and (b) lateral angiographic view of selective microcatheter injection of the right middle meningeal artery late phase demonstrated blush of the chronic subdural hematoma membrane at the convexity.

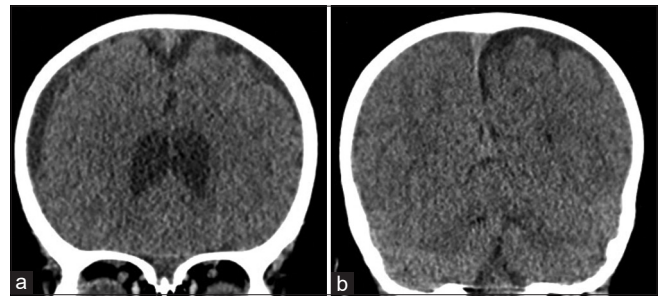


Figure 5: CT head without contrast coronal views (a and b) 6 months after the right middle meningeal artery embolization demonstrating nearly resolved right chronic subdural hematoma.

craniostomy, burr hole irrigation with or without subdural drain placement, and craniotomy.^[7] Moreover, while these surgical interventions remain the mainstay of management, they also have recurrence rates of 11.7%, 19.4%, and 28.4% for burr holes, craniotomy, and twist drill craniostomy, respectively.^[2] Based on the mechanism underlying neovascularization in cSDH, it was, therefore, surmised that eliminating the blood supply to the membrane by embolizing the MMA could halt the hematoma reaccumulating and thus allow the SDH to resorb overtime.^[5] A recent meta-analysis by Srivatsan *et al.* examined three double-arm studies comparing MMA embolization and standard treatment in adults. The authors found a statistically significant difference in recurrence rate in patients undergoing MMA embolization (2.7%) compared to standard care (27.7%).^[9] In addition to the three double-arm studies, this meta-analysis also identified six single-arm cases with two or more patients, where the composite hematoma recurrence rate for six cases of patients who underwent MMA embolization was 3.6%. Finally, the meta-analysis found no statistically significant difference for complication rates between MMA embolization (2.1%) and standard treatments (4.4%)^[9] demonstrating both benefit and safety.

Our patient was treated initially with bilateral burr hole drainage without drain placement and experienced resolution of the left SDH. The development of a cSDH with membranes on the right may be related to the parietal skull fracture and acute on chronic hemorrhage secondary to additional NAT. Unfortunately, he was lost to follow-up for several months after his burr hole drainage and presented to his pediatrician with enlarging head circumference and exotropia of the left eye, an oft noted clinical scenario,^[3] related to mass effect from the development of his large right cSDH. Our patient's reformation of SDH membranes at the peripheral ends of his craniotomy posited a unique clinical dilemma. Repeat craniotomy with membranectomy was an option but given the highly vascular nature of the membranes, (seen in their enhancement pattern on contrasted CT) [Figure 3], this was not considered ideal. Subdural-peritoneal shunting was also not ideal as the areas of the residual cSDH were nearly loculated and separate from each given the neomembranes they had developed. MMA embolization, a novel neurovascular procedure, was considered a viable, minimally invasive alternative given its success in adults in the literature^[9] and anecdotally in our own adult practice. This case report details the first successful use of MMA embolization in the treatment of pediatric cSDH as an adjunct to standard treatment options demonstrating both safety and efficacy. Further investigation of MMA embolization in pediatrics should be made in an effort to expand treatment options available for SDH and provide guidance on surgical decision-making in this patient population.

CONCLUSION

The use of middle meningeal artery embolization for treatment of our patient's chronic subdural hematoma resulted in significant size and density reduction of the cSDH on imaging and almost full resolution of clinical symptoms. To the best of our knowledge, this report details the first successful use of MMA embolization in the treatment of pediatric cSDH as an adjunct to standard treatment. Further investigation of the less invasive technique of MMA embolization in pediatrics should be made to expand options available for cSDH in this patient population.

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Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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