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Management of Pseudomeningocele Following Posterior Fossa Tumor Surgery in Children: A Single-Institution Experience in Egypt

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Abstract

Background: Management of pseudomeningocele following posteri orfossa tumor surgery in children has different conservative and surgical options. The aim of this study was to assess the management of pseudomeningocele developing after posterior fossa tumor surgery in children at a single institutionin Egypt.

Aim of Study: Is to assess the different ways of management of pseudomeningocele developing after posterior fossa tumor surgery in children.

Patients and Methods: This was a retrospective study of30 children with pseudomeningocele developed after posterior fossa tumor resection, operated in the period from April 2016 and April 2021 in the Neurosurgery Department, Abu El Reesh Japanese Hospital, Egypt. Data were reviewed for the concerned children in the study including the age at presentation, the sex, and the mode of onset, course, and duration of the pseudomeningocele following posterior fossa tumor surgery.

Results: The mean age was 7.7±3.5 (range, 1-16) years old. There were 18 males (60%) and 12 females (40%). The dura was closed primarily watertight without a graft in nine children (30%). Pericranium graft was used for dural closure in 12 children (40%), while a synthetic graft was used in nine children (30%). Twenty-four children (80%) had high grade tumors. Twenty-five children (83.3%) had midline posterior fossa surgeries. Three patients (10%) were diagnosed to have meningitis due to CSF leak. Seven children (23.3%) responded to conservative measures; their pseudomeningoceles were less than 50cc. Twenty-three patients (76.7%) required surgical intervention;their pseudomeningoceles were more than 50cc. They were managed by ventriculoperitoneal shunt (21 children),lumboperitoneal shunt (one patient), and debridement and duraplasty (one patient).

Conclusion: Pseudomeningocele following posterior fossa tumor surgery in children is not a rare complication, but could be a self limiting problem. Its management usually starts with conservative measures then proceeds according to the response of the patient. Some factors can predict the need for surgical intervention in these cases as large size of the pseudomeningocele, anatomical, and pathological criteria of the posterior fossa tumor.

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Introduction

IN pediatric age group, tumors of the nervous system are more common than other solid tumors particularly those of the posterior fossa **[1,2]**. A pseudomeningocele is an abnormal cerebrospinal fluid (CSF) collection bounded by extradural soft tissues. Its rate according to a recent systematic review is about 8% **[3]**. Pseudomeningocele formation after posterior fossa tumor surgery is a common complication which is a distressing problem to the patient, relatives and the surgeon. In addition of the cosmetic disfigurement, othercomplications may follow pseudomeningocele like wound infection, meningitis, delay of adjuvant therapy, and longer hospital stay **[4,5,6]**. There are multiple leading factors to the formation of pseudomeningocele as poor wound closure with improper dural closure, posterior fossa craniectomy as opposed to craniotomy, or underlying hydrocephalus **[4,5-7]**.

Management of postoperative pseudomeningocele has different options starting from conservative measures as head elevation, tap and rap technique, and treatment of underlying infection. However, in case of failure of conservative measures, surgical options include wound exploration, lumbar CSF drainage, and CSF diversion in case

Abbreviation list:

CSF : Cerebrospinal fluid.
CT : Computed tomography.
ICP : Intracranial pressure.
LP : Lumboperitoneal.
MRI : Magnetic resonance imaging.
MRSA : Methicillin-resistant Staphylococcus aureus.
VP : Ventriculoperitoneal.

of hydrocephalus [4,5]. Despite previous studies focused on the management of pseudomeningocele after posterior fossa surgery [8,9,10], few studies had discussed this issue in children.

The aim of this study was to assess the management of pseudomeningocele developing after posterior fossa tumor resection in children at a single institution in Egypt.

Material and Methods

This was a retrospective study of thirty children with pseudomeningocele following posterior fossa tumor surgery whowere operated upon in the Neurosurgery Department, Abu El Reesh Japanese Hospital, which is the biggest referral tertiary care center for children in Egypt, in the interval between April 2016 and April 2021 was done. Abu El Reesh Japanese Hospital is a public hospital whose referral area has a population of nearly 20 million. Pseudomeningocele was defined as a significant fluid collection under the surgical incision found on follow-up postoperative patient examination. The inclusion criteria of the study included children presenting with pseudomeningocele after posterior fossa tumor surgery in which the dura was opened either due to an intradural pathology or dural tear and the dura was closed watertight either primarily or using graft (duraplasty). Children with ventriculoperitoneal (VP) shunt before tumor excision, postoperative collection other than CSF, and spinal pseudomeningocele and were excluded from the study.

Data were reviewed from the registry for the concerned children in the study including the age at presentation, the sex, and the mode of onset, course, and duration of the pseudomeningocele following posterior fossa tumor surgery. Upon admission of the children, full general, neurological, and ophthalmological examinations were done. The general examination included examination of general appearance, pulse, blood pressure, respiratory rate, temperature, chest, abdomen, urogenital, and skeletal systems. The neurological examination included assessment of the intellectual function, cranial nerves, motor system, and sensory system. The ophthalmological examination included complete visual assessment of the visual acuity, visual field and fundus examination preoperative and postoperative. All children had routine laboratory investigations such as complete blood count and coagulation profile, CSF analysis for cell count, protein and glucose contents, and culture and sensitivity tests from blood or CSF when needed. Most of children were diagnosed depending on computed tomography (CT) of the brain which was more rapid, easy and less coasty and it was done in all patients. Intravenous contrast was used when needed as in case of suspected infection. Magnetic resonance imaging (MRI) of the brain was done in only six patients.

Conservative measures were done in all children as the first step of management for an average of 10 days during and after which assessment of the response was done. According to the response and course of pseudomeningocele, the mode of management was changed to more aggressive surgical management options or continued with conservative measures if they were effective and the collection was resolving. Conservative management was aborted before the end of 10 days in patients showing signs of increased intracranial pressure (ICP) or hydrocephalus in CT of the brain where VP shunt insertion was done. The conservative management included the positioning of the head up to 30 degrees to help venous return, tapping the collection, and crepe bandage application then follow-up with CT brain to detect ventriculomegaly or recollection. Tapping was done for diagnostic and therapeutic purposes. It was done under aseptic precautions, in none dependent site with tapping of the whole collection as possible. Samples aspirated from the collection were subjected to clinical tests as ring test andlaboratory tests. Antibiotics according to culture and sensitivity were used for treatment of infection.

The operative management was employed in 23 patients who did not respond to conservative management, showed signs of increase ICP, developed hydrocephalus, or infection not responding to antibiotic treatment. The underlying neurological condition, role of surgery, surgical technique, postoperative care, and expected morbidity and mortality were discussed with the parents. The surgical management involved VP shunt insertion, lumboperitoneal (LP) shunt insertion, and debridement with duraplasty.

The postoperative care included monitoring for the vital signs, conscious level, progression or regression of the size of pseudomeningocele, and for detection of the complications. Analgesics were employed as needed. Follow-up assessments included clinical and radiological assessment to follow the size of the collection postoperatively in the early postoperative period and then in the outpatient clinic.

Statistical analysis:

Data were statistically described in terms of mean ± standard deviation, median and range, or frequencies (number of cases), and percentages when appropriate. The computer program IBM Statistical Package for the Social Science (SPSS) (SPSS; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows was used for data processing and analysis.

Results

This study included 30 children with pseudomeningocele following posterior fossa tumor surgery. At the time of surgery, the mean age was 7.7±3.5 year ranging from one to 16 years old. There were 18 males (60%) and 12 females (40%) which provide a male/female ratio of 1.5/1. The mean follow-up period was 19.8±8.7 (range, 3-36) months.

Twenty three children (76.7%) presented with the pseudomeningocele within the first two weeks following the posterior fossa tumor surgery, while the other seven patients (23.3%) presented after two weeks and within two months following the surgery. Twenty-one children (70%) were operated upon by craniectomy, while only nine children (30%) were operated by craniotomy.

The dura was closed primarily watertight without a graft in nine children (30%). Pericranium graft was used for dural closure in 12 children (40%), while a synthetic graft was used in nine children (30%). Fibrin glue was used as a tissue sealant in seven patients (23.3%). Adjuvant therapy (radiotherapy and chemotherapy) was needed in 24 children (80%) with high grade tumors. Twenty-five children (83.3%) had midline posterior fossa surgeries. The type of posterior fossa tumor in the study group is illustrated in Table (1).

Three patients (10%) were diagnosed to have meningitis due to CSF leak. Management started with empirical broad spectrum antibiotics then modified according to the results of culture and sensitivity tests from the collection. The causative organism was methicillin-resistant Staphylococcus aureus (MRSA) in two children, while the third one had E. coli infection. Two patients improved with conservative treatment including lumbar drain and antibiotics while the other one required surgical debridement and duraplasty after failure of conservative management.

The size of pseudomeningocele in children at the time of presentation was evaluated in CT of the brain and from tapped amount. The children in the study were divided into three groups according to the size of the pseudomeningocele (Table 2). The children of the first group had a good response to conservative management. The conservative measures failed in the children of the second and third groups and they were managed surgically as large pseudomeningoceles usually indicate underlying cause as hydrocephalus which required surgical intervention.

Seven children (23.3%) responded to conservative measures, while 23 patients (76.7%) required surgical intervention.Ventriculoperitoneal shunt insertion was done in 21 children who did not respond to conservative management and thought to have non communicating hydrocephalus (Figs. 1,2). Lumboperitoneal shunt insertion done in one patient with communicating hydrocephalus. Debridement and duraplasty were done in one patient who was diagnosed to have infection and did not respond to conservative management. All patient managed surgically had a settlement of theirpseudomeningoceles.

Table (1): The type of posterior fossa tumor in the children of the study.

Type of tumor	Number	Percentage
Fourth ventricular tumor		
Medulloblastoma	14	46.7
Ependymoma	10	33.3
Lateral cerebellar tumor		
Pilocytic astrocytoma	5	16.7
Midline cerebellar tumor		
Dermoid cyst	1	3.3

Table (2): Classification of the study children according to the size of pseudomeningocele.

Group	Size of pseudomeningocele (cc)	Number of children	Percentage
I	<50	7	23.3
II	>50cc & <100	9	30
III	>100	14	46.7

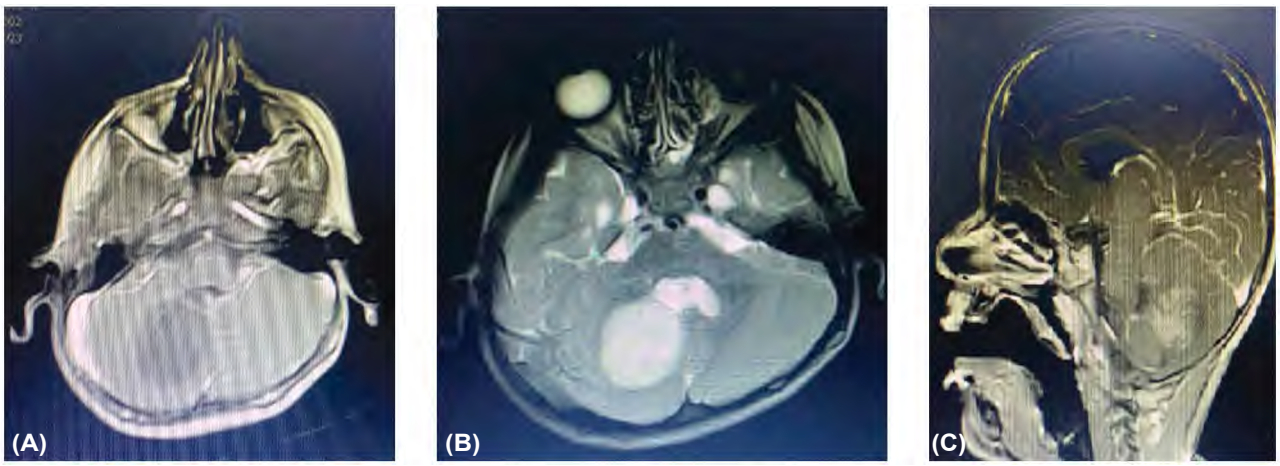

Fig. (1): A 3-year-old female child who presented with right-sided ataxia: (A) Axial T1WI brain MRI without contrast, (B) Axial T2WI, and (C) Sagittal T1WI with contrast showing a right cerebellar well-circumscribed complex cystic pilocytic astrocytoma (3.1x3.0 cm). The tumor displays low signal intensity in the axial T1WI, bright signal intensity in the axial T2WI with inhomogeneous enhancement of the intracystic solid component within in the post contrast sagittal T1WI.

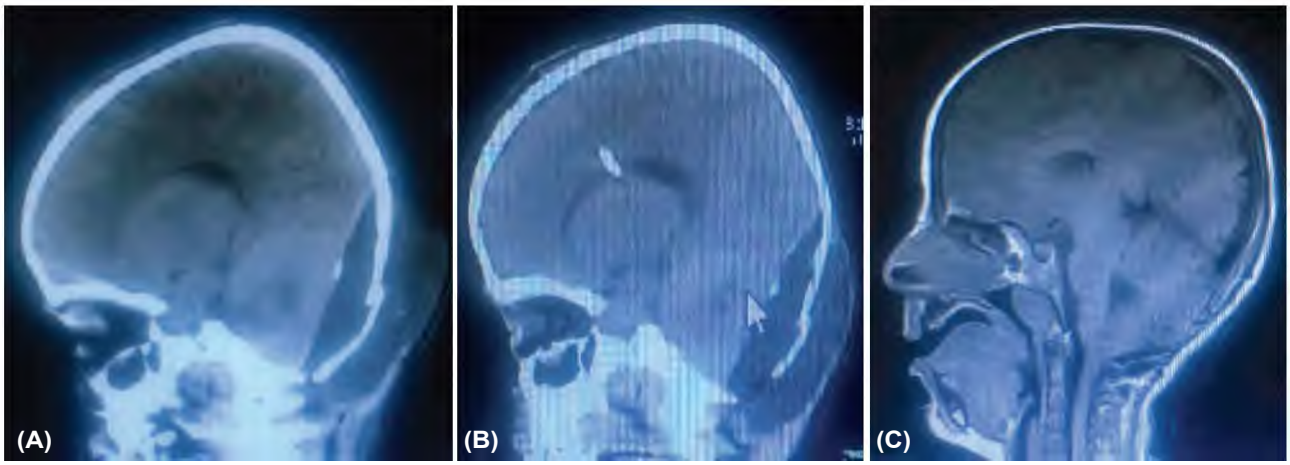

Fig. (2): (A) Sagittal CT brain of the same patient in Fig. (1) done two weeks after tumor excision showing that the patient developed a large postoperative pseudomeningocele. (B) The patient was operated by a ventriculoperitoneal shunt after failure of conservative measures to settle the pseudomeningocele. The size of the pseudomeningocele was gradually reduced. (C) Sagittal MRI T1WI done 3 months later showing total resolution of the pseudomeningocele.

Discussion

Our study was conducted upon 30 children who developed pseudomeningocele after posterior fossa tumor surgery with dural opening and watertight dural closure. Such complication with others like hydrocephalus, CSF leak, and infection can cause significant morbidity with prolonged hospital stay and more burdens to the health system **[11,12]**.

In this study, twenty-one children (70%) were operated upon by craniectomy, while only nine children (30%) were operated by craniotomy for posterior fossa tumor resection. Duraplasty was done in 70% of children and 80% of children had high-grade tumors. Some authors documented that craniotomy in posterior fossa surgery is superior to craniectomy in reducing the rate of postoperative pseudomeningocele formation **[13,8]**. Others like Norrdahl et al., found no significant difference between either craniotomy or craniotomy as this factor was difficult to evaluate due to the small number of craniectomies in their study. They found other factors to be more effective in pseudomeningocele formation and following intervention as race, duraplasty (38%, 32/84 of their cases), and surgical site being more with infratentorial surgeries (having 2.56 greater odds) **[14]**. Roth et al., in their recent study that included 163 craniotomies, found that infratentorial surgeries are associated with higher incidence of pseudomeningocele formation and CSF diversion **[15]**.

Proper wound closure starting from the dura ending with the skin passing through fascia is an important factor in pseudomeningocele prevention

[16]. This was stated by many authors as Watanabe et al. in their series on postoperative cerebellar cyst with pseudomeningocele after craniocervical junction tumor removal **[17]**. Careful dural closure may require the use of a graft. Using autologous graft is superior to synthetic one in pseudomeningocele and CSF leak prevention **[18]**. Sealants as fibrin glue may be added to the dural graft in dural closure for more effective repair as done by Lam and Kasper **[19]**. In this study, fibrin glue was used as a tissue sealant in seven patients (23.3%). The application of polyethylene glycol hydrogel dural sealant to the closed dural edges was reported by Than et al., to be effective at reducing CSF leak following posterior fossa surgery **[20]**. Menger and Connor on the other side found that it is not more beneficial in pseudomeningocele prevention (6.67 greater odds of pseudomeningocele formation) **[21]**.

One important factor in the development of pseudomeningocele is hydrocephalus which is more common in high grade tumors and will cause a delay in receiving the patients their adjuvant therapy, so management of pseudomeningocele in these cases is important **[14]**. This was the condition in most of our patients (80%). Another factor in the formation of postoperative pseudomeningocele is the tumor location as pseudomeningocele found to more common among midline posterior fossa surgeries **[9]**. Twenty-five children (83.3%) had midline posterior fossa surgeries in this study. In their study, Smith et al., stated that the rate of symptomatic postoperative pseudomeningocele was 14.1%; the highest rate was for midline posterior fossa tumor surgery (16.5%) and lowest rate was for retrosigmoid surgery (11.9%) **[9]**.

In our study, three children (10%) were diagnosed to have CSF infection due to CSF leak. CSF leak in cases with pseudomeningocele usually require early intervention to avoid added complications as infection. Lassen et al., reported a CSF leak rate of 7.3% in a consecutive series of 211 children who underwent 273 craniotomies for tumors **[22]**. They linked this complication with some variables like age less than 3 years, female sex, infratentorial surgeries, and untreated preoperative hydrocephalus. In another analysis by the same group including 381 craniotomies for tumor, they reported that younger age, infratentorial location, and new-onset postoperative hydrocephalus as being significantly associated with postoperative CSF leaks **[23]**. Norrdahl et al., stated eighteen children with pseudomeningocele in their study developed CSF leak.These patients often underwent reoperations for one or more indications in addition to long durations of intravenous antibiotics, all resulting in extended hospital stay and increased cost **[14]**.

Management of postoperative pseudomeningocele is controversial. A conservative management is usually initially done for managing postoperative pseudomeningocele hoping it will improve or completely resolve within a suitable period of time. The common indications for surgical intervention in these cases are usually CSF leak, postoperative hydrocephalus, increasing size of the pseudomeningocele, and breakdown of the wound **[14]**. We followed a stepwise approach for the management of our cases starting with conservative treatment and proceeding according to the response of the patients. One of the studies that targeted this issue was an international survey study conducted by Albert Tu et al. It included 241 responses. They concluded that pseudomeningocele after posterior fossa tumor resection, in the absence of hydrocephalus, was typically managed conservatively (like using compression dressings and positioning maneuvers) for 7 to 14 days before re-exploration. Only 0.5 % of the participating surgeons would offer surgical revision of the wound as an initial treatment. In the presence of hydrocephalus, 48% of the surgeons intervene initially with CSF diversion and would change the management if the pseudomeningocele did not resolve in 2 to 4 days **[24]**. We can find from these results that most of the neurosurgeons start usually with conservative measures and rarely start with invasive management in the beginning which is going with our plan of management.

In this study, all children were subjected to conservative measures and the use of more aggressive management was depending on patient response, progression of the collection, or development of other complications such as hydrocephalus, infection, or CSF leak. Only seven children (23.3%) had a response to conservative measures as head elevation,tapping, and head wrapping. On the other side, in a study by Mehendale NH et al., with retrospective review of 375 consecutive patients undergoing neurotologic procedures, they identified 17 patients with postoperative pseudomeningocele (4.5%). Fourteen pseudomeningoceles (82.3%) resolved with conservative management including pressure dressing, bed rest, and lumbar spinal drainage. Three patients (17.7%) failed conservative management and required surgical intervention.[25] This difference in the results could be explained by the difference in the anatomical and pathological characteristics of the cases included. The conservative management could be adequate in most of the cases with pseudomeningocele, where no hy-

drocephalus or infection were encountered. Some of our cases have had an element of hydrocephalus preoperatively which added more risk to postoperative pseudomeningocele formation. The use of preoperative lumbar drain could help in lowering ICP over the postoperative period helping arachnoid and dural healing and decreasing incidence of CSF leak, but unlikely this was not regularly done in our cases.

In our study, the size of the pseudomeningocele was an important factor in determining the management of postoperative pseudomeningocele. Seven children had a pseudomeningocele less than 50cc; all of them had a good response to conservative management with settlement of their pseudomeningocele. Twenty-three children had a pseudomeningocele more than 50cc; all of them required surgical intervention due to failure of conservative measures. This emphasizes the importance of the size of postoperative pseudomeningoceles in determining their management as a large pseudomeningocele usually indicates underlying cause as hydrocephalus which required surgical intervention.

In our study, 23 children (76.7%) required surgical intervention. VP shunt insertion was done in 21 children, LP shunt insertion done in one patient, and wound revision was done in one patient. The presence of postoperative hydrocephalusmakes the possibility of temporary CSF diversion failure more likely. Shunting should be early considered in such cases **[9,24]**. Temporary use of a lumbar drain leads to earlier clinical resolution in case of absence of ventriculomegaly, but it is rare to attain complete radiographic resolution without implantation of a permanent shunt **[9]**. Other studies as by Manley and Dillon, lumbar CSF diversion was more frequently used than VP shunt (42.8% vs. 14.2%) in their cases with pseudomeningocele after posterior fossa craniotomy **[26]**. In comparison with our study, most of children who needed CSF diversion in our study were done by VP shunt as most of them developed postoperative obstructive hydrocephalus. On the other hand, all the patients were managed surgically in other series due to failure of conservative measures **[27,28]**.

Management of pseudomeningocele is proven in this study to be quite variable whether surgical or conservative. Many factors could cause these variations including the anatomical and pathological characteristics of the tumors and the presence of hydrocephalus. Therefore further studies including larger subgroups of patients with more anatomical and pathological specification allowing more precise segmentation of the results are warranted. Further studies are needed to authenticate the results about the role of duraplasty and tissue sealant in the development of postoperative pseudomeningocele.

Conclusions:

Pseudomeningocele following posterior fossa tumor surgery in children is a self limiting problem that could resolve with conservative management unless complicated or associated with other problems as infection, CSF leak or hydrocephalus. We found that some factors can affect the management in these cases as the size of the pseudomeningocele being more than 50cc and the anatomical and pathological criteria of the tumor (high grade and fourth ventricular lesions) were more associated with surgical intervention. When surgical intervention was indicated, the options were VP shunt, LP shunt, and wound debridement with duraplasty.

Conflicts of Interest: There is no conflict of interest to disclose.

Informed Consent: Informed consent was obtained from all individual participants included in this study.

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التعامل مع القيلة السحاقية الكاذبة ما بعد عمليات أورام الحجرة الخلفية للمخ فى الأطفال خبرة معهد طبى واحد فى مصر

حالات القيلة السحاقية الكاذبة ما بعد عمليات استئصال أورام الحجرة الخلفية فى الأطفال ليست بنادرة الحدوث وقد تختفى من تلقاء نفسها. التعامل مع هذه الحالات غالباً ما يبدأ بطرق العلاج التحفظى ثم يتطور حسب الاستجابة للعلاج. هناك بعض العوامل التى قد تساعد على توقع الحاجة للتدخل الجراحى فى هذه الحالات مثل الاحجام الكبيرة وخصائص الأورام أما التشريحية أو نوع الورم. وقد أجريت هذه الدراسة لتقييم الطرق المختلفة للتعامل مع هذه الحالات. اشتملت هذه الدراسة على ٣٠ حالة من الأطفال الذين يعانون من تكون قيلة سحاقية كاذبة ما بعد عمليات أورام الحجرة الخلفية للمخ فى الفترة ما بين أبريل ٢٠١٦ وأبريل ٢٠٢١ بقسم جراحة الأطفال مستشفى ابوالريش اليابانى فى مصر. وكان متوسط عمر الأطفال ٧.٧ سنة وكان غالبية الأطفال من الذكور. فى أغلب الحالات كانت الأورام خبيثة وفى منتصف الحجرة الخلفية تشريحياً. ٧ من الأطفال استجابو للعلاج التحفظى حيث كان حجم القيلة أقل من ٥٠ سم^{3} بينما ٢٣ طفل استدعت القيلة عندهم التدخل الجراحى وكان حجمها أكبر من٥٠ سم^{3}. طرق التدخل الجراحى اشتملت على تركيب صمام مخى بريتونى أو صمام بالظهر أو تنظيف للجرح مع اصلاح الام الجافية. ومن ذلك قد نستنتج بعض العوامل التى تتو قع الحاجة للتدخل الجراحى فى بعض الحالات.