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Original Article

Evaluation of Endoscopic Ventricular Lavage in Management of Infected Hydrocephalus in Infant

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ABSTRACT

Background: The management of infected hydrocephalus with bacterial ventriculitis or post-ventriculoperitoneal shunt infection in infants is an interdisciplinary challenge. Conventional surgical treatment includes external ventricular drain (EVD) and long duration systemic antibiotic therapy. However, infectious contamination of large ventricles combined with CSF protein overload often requires long treatment regimens. We study the outcome of neuroendoscopic lavage (NEL) as a new option for clearance of CSF in infants with infected hydrocephalus.

Aim of the work: This study aimed to study the outcome of use of endoscopic ventricular lavage in management of infected hydrocephalus in infants following ventriculoperitoneal shunt infection, cranial taping and bacterial ventriculitis post-surgical procedures.

Methods: This prospective study was conducted in Al- Azhar University Hospitals. This study was conducted on infants with infected hydrocephalus from June 2022 to December 2023. Patients were assessed on clinical and radiological basis with daily measurement of head circumference. Serum C-reactive Protein (CRP) and leukocyte level, CSF protein, cell count, lactate and glucose measures were performed every second day. The ongoing signs of hydrocephalus were registered daily.

Results: The study analyzed 14 patients aged 4-21 months, with 8 male patients (57.14%). NEL produced a significant improvement (p= <.001) in fever, bulging fontanel, and head circumference compared to pre-NEL. Pre-NEL Laboratory investigations revealed significant differences (p= <0.001) in ESR, CRP, TLC, CSF glucose, proteins, cellularity, and infected organism compared to post-NEL. However, no significant differences were found in infected organisms or CSF infected organisms. The study population showed significant differences in pre-NEL neurological assessment, laboratory findings, and CSF examinations compared to post-NEL

Conclusion: the use of endoscopic ventricular lavage in managing infected hydrocephalus in infants. showed significant differences in fever, head circumference percentile, ESR and CRP, TLC and CSF examinations & neurological assessments between pre and post-NEL associated with a better outcome and shorter hospital stay duration compared to current conventional lines of treatment.

Keywords: Endoscopic Ventricular Lavage; Infected Hydrocephalus; Bacterial Ventriculitis; External Ventricular Drain .

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INTRODUCTION

Meningitis and ventriculitis are two of these infections that can be either consequences or complications of neurosurgical procedures, especially those associated with placement of ventricular catheters. Although the ventriculoperitoneal shunt infection is high, management of shunt infection is still not optimal with shunt infection management protocols varying significantly between centers. Multiple review articles suggest ideal management which consists of antibiotics, complete shunt removal with external ventricular drain (EVD), and reimplantation of VP shunt after cerebrospinal fluid (CSF) sterilization [(1)].

The treatment was not effective in treating the accumulation of empyema in both ventricles. Severe pus and debris caused uneven drainage and intrathecal antibiotics, so empyema aspiration and irrigation using neuroendoscopy was considered. This method used ventriculoscope (to active aspirate and extensive ventricular irrigation using warm normal saline or ringer lactate). This ventriculoscope has two separate channels to be used simultaneously, one channel used for normal saline or ringer lactate irrigation and another channel for suction using nasogastric tube 8 Fr. A right frontal burr hole from the previous surgery was used for the neuroendoscopic approach Multiple deposits of thick yellow colored pus, blood clots and inflammatory debris of ventricle walls were observed in the lateral ventricle. Continuous irrigation with warm normal saline or ringer lactate and active aspiration of the pus using nasogastric tube (NGT) was carried out [(2)]

After lavage and aspiration, antibiotics can be distributed effectively to the affected area. Follow up imaging and cerebrospinal fluid (CSF) culture showed a good result and shorter length of stay in the hospital. Neuroendoscopy appears effective and safe for the management of bacterial ventriculitis due to shunt infection in infants [(3)]

PATIENTS AND METHODS

This prospective study was conducted on infants (14 patients) with infected hydrocephalus after shunt operation, bacterial ventriculitis, and cranial taping (surgical procedures) in Al-Azhar University hospitals in the period from June 2022 to December 2023.

Inclusion criteria included Infants with:

- Infected hydrocephalus, bacterial ventriculitis, cranial taping and post ventriculoperitoneal shunt operation.
- Not response to medical treatment by antibiotics based on culture and sensitivity test for long time (>six weeks).
- had no contraindication for general anesthesia and generally fit for surgery.

Exclusion criteria included

- Patients who had contraindications for general anesthesia or were generally unfit for surgery.
- Child, adult patients and non-infected hydrocephalus or infected ventriculitis without hydrocephalus.
- Patients who improved on medical treatment protocol.

Pre-operative assessment:

- Personal history, name, age and gender.
- Complete medical history: Including any medical condition and drug taking.
- Examination: General examination: Examination of vital signs as blood pressure, temperature, and heart rate. Signs of pallor, cyanosis and jaundice.
- Full neurological examination.
- Radiological investigation: CT brain. MRI brain.
- Routine laboratory investigations: Complete blood count. Blood sugar. Renal function tests. Liver function tests. Prothrombin time and activity. CSF culture and sensitivity tests. CRP and ESR.
- Informed consent: we educate a patient relative about the risks, benefits, and alternatives of a given procedure or intervention. The patient is competent to make a voluntary decision about whether to undergo the procedure.

Surgical technique

The patient was under general anesthesia with or tracheal intubation. The patient is positioned with the head in the midline and slightly flexed, fixed in rigid head support. Rigid endoscope Carl Storz® with optics of 0° or 30° is inserted through a right or left Kocher burr hole. A 2-dimensional endoscope was used for neuro endoscopic ventricular lavage. After entering the intraventricular area, continuous irrigation was started from the irrigation channel of the endoscope using Ringer's Lactate solution heated at body temperature (37 C). Concomitantly, fluid escape from the ventricle was ensured. In particular, the endoscope was mobilized, and irrigation was performed to clean the vegetations and clots that were attached to the lateral ventricle walls. Irrigation was performed through the endoscope irrigation cannula and continued until the intraventricular area became clear and ventricular landmarks were visible **(Figure 2).** The third ventricle was also entered to remove free-floating clots or debris by aspiration. The patency of the aqueduct was also checked. Approximately 2000–2500 ml of Ringer's Lactate solution at body temperature was used for irrigation in each operation. Some particles or clots were removed using grasping forceps**.** Irrigation continued until the blood residues and particles were washed out of the ventricular system. At the end of irrigation, new shunt catheters were inserted, and the tip of the ventricular catheter was confirmed using an endoscope. The ventricular and peritoneal catheters were connected via a new valve system and the procedure was terminated. The mean duration of each procedure was 65 minutes.

Figure (1): A) Endoscopic view of the third ventricle showing the brown infective particles on both sides. B) After the endoscopic lavage, the particles were removed. M: Mamillary bodies, *: Aquaeductus Sylvie.

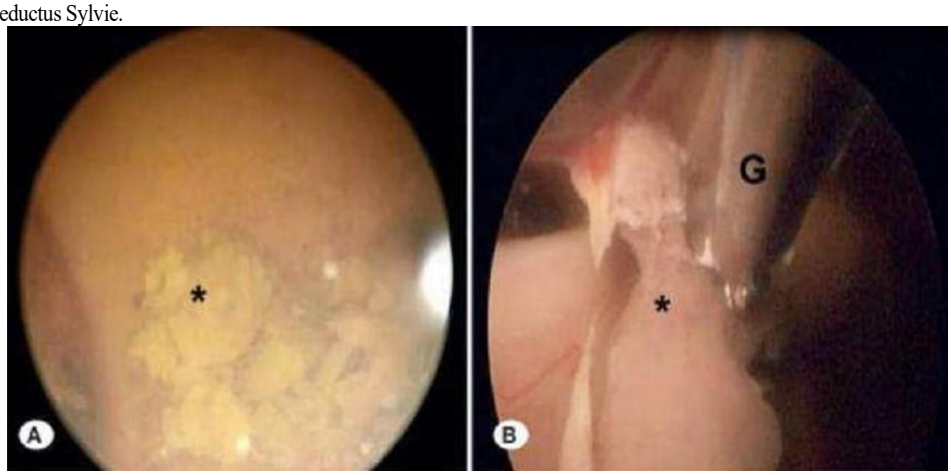

Figure (2): A) Endoscopic view of the lateral walls in a patient with previous shunt failure. The particles (*) were attached to the walls. B) The particles that could not be cleaned with lavage were removed using endoscopic grasping forceps

Postoperative follow-up

After surgery, all patients were transferred to either NICU or intermediate care. Follow-up included daily measurement of head circumference, serum CRP, TLC and CSF analysis, were performed every second day. ongoing signs of active hydrocephalus. If infective parameters in CSF and serum high with signs of hydrocephalus remain after serial CSF relieve, we need another ventricular lavage session and repeat until parameter go normalized. If infective parameters in CSF and serum normalized but active signs of hydrocephalus remained after serial CSF relieve, a permanent ventriculoperitoneal shunt (VPS) was indicated. After discharge, all patients were examined 6 weeks and 3 months after discharge and then every 3 months for children younger than 1 year or every 6 months for children older than 1 year of age until age of 2 year. A follow-up examination included head circumference measurement, clinical status, and CT or MRI scans if indicated.

Statistical analysis: Statistical analysis was performed with SPSS (SPSS Statistics 23, IBM Software Group, NY, USA). Nominal data was analyzed with the McNemar test and Chi square test; metric data was analyzed with the Wilcoxon test, Mann-Whitney U test, Friedan test and T test; and ordinal data was analyzed with the Mann-Whitney U test and Wilcoxon test. A p value of < 0.05 was considered statistically significant. Values are given as mean (range) or mean ± standard deviation as specified, accordingly.

RESULTS

This study included 14 infants; their age ranged from 4 to 21 months with mean ± SD = (10.86 ± 5.68 years). There were 8 males (57.14%). Before intervention, there were 8 patients with V-P shunt represented 57.2%, that was increased after intervention to 71.4%.

Patients with Difficulty looking upward in the study population was 10 (71.43%), Projectile vomiting 7 (50%), Irritability 10 (71.43%), fever 14 (100%), Visible scalp veins 7 (50%), progressive head enlargement 14 (100%), poor feeding 12 (85.71%), seizures 9(64.29%) & Bulging fontanel 11(78.57%).

Regarding fever, there was a highly significant difference between the pre NEL& post NEL (p= <.001), highly significant difference between pre NEL& post NEL (p= <.001) in Bulging fontanel & no statistically significant difference between pre NEL& post NEL (p= 0.094) in Head circumference percentile.

CSF examination among the study population: CSF Glucose (mg/dl) in pre-operative investigation ranged from 5 to 53 with mean ± SD = 23.14 ±6.44 while in post-operative investigation the CSF Glucose (mg/dl) ranged from 15 to 80 with mean ± SD = 41.36 ± 21.08 with statistically significant difference (p= 0.017) between pre & post NEL.

CSF Proteins (mg/dl) in pre-operative investigation ranged from 121

to 950 with mean ± SD = 442.21 ± 250.03 while in post-operative investigation the CSF Proteins (mg/dl) ranged from 38 to 832 with mean ± SD = 223.56 ± 217.89 with statistically significant difference (p= 0.021) between pre & post NEL. CSF Cellularity in Pre-operative investigation ranged from 20 to 3090 with mean ± SD = 563.86 ± 799.99 while in post-operative investigation the CSF Cellularity ranged from 9 to 390 with mean ± SD =57.29 ± 103.86 with statistically significant difference (p= 0.035) between pre & post NEL. Regarding CSF infection organism, there was a significant difference between pre & post NEL (p= 0.002).

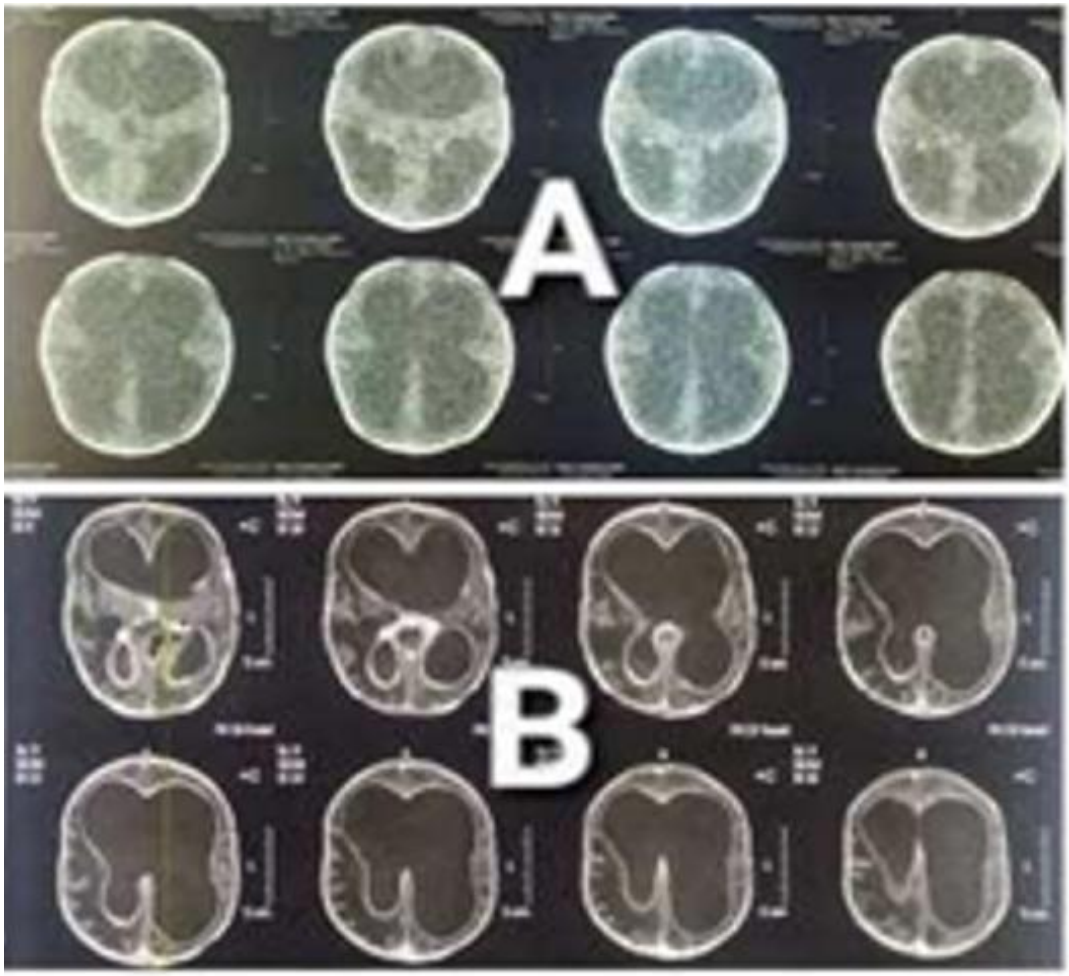

Figure (3): Non-contrast axial images of brain computed tomography where spontaneous hyperdensities are observed in the ventricular hydrocephalus, figure (A) axial view MRI brain with contrast preshow evidence of ventriculitis figure (B).

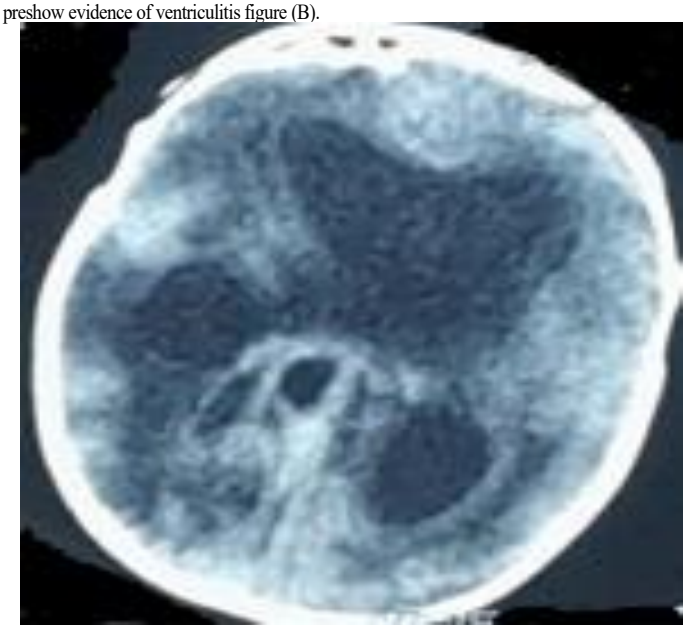

Figure (4): Non-contrast axial images of brain computed tomography postoperative follow-up was 2 months.

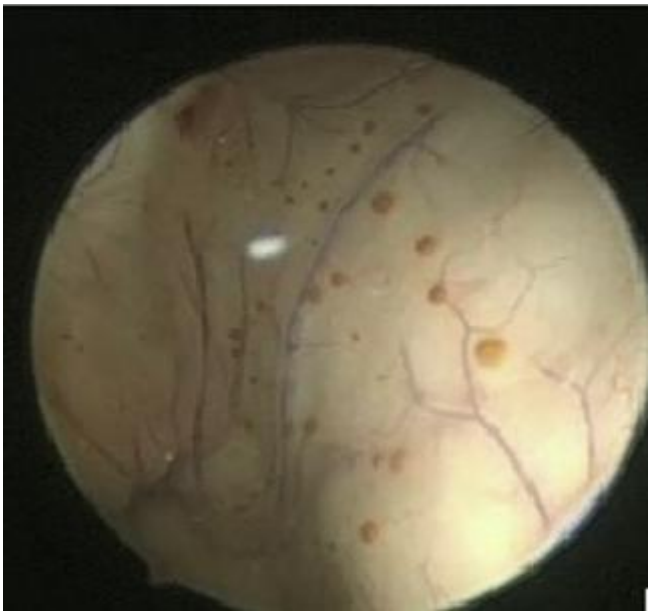

Figure (5): Yellowish plaques were detected on the wall of the lateral ventricle during the first NES

DISCUSSION

Bacterial ventriculitis remains a main cause of morbidity and mortality in patients with an infected shunt [5]. With a percentage of 5–10%, postinfectious hydrocephalus remains a common cause for acquired hydrocephalus [6]. Secondary shunt infections, which occur in 3 20%after shunt surgery, do aggravate the problems of treating hydrocephalus. The acute phase of CSF infection and hydrocephalus is a challenging condition due to contamination of CSF, protein overload, and possible debris [7].

Since shunt treatment is required in a vast majority of those patients, the common precondition of clean CSF with eliminated germs, regular cell count, and normal protein values is often hard to achieve [8]. Long-time treatment regimens are required in order to make these patients eligible for shunting without causing additional problems such as shunt occlusion or shunt re-infection [9]. The main aim of this study was to investigate the outcome of use of endoscopic ventricular lavage in management of infected hydrocephalus in infants.

In support of our results, **Al Menabbawy *et al.*** found that the mean hospital stay duration was 20.5 ± 14.2 days in the lavage group [10]. In addition, **Wang *et al.*** aimed to study retrospectively a group of pyogenic cerebral ventriculitis patients managed by neuroendoscopic surgery (NES). They reported that Forty-one patients, mEVD was performed in all patients, and mean mEVD duration in the hospital was 27.6 days. The mean hospital stay of 20.3 days (range, 15-40 days) [11].

In agreement with our results, **Ebrahim *et al.*** [12] reported that in clinical picture on admission there was increased head circumference in 7 (23.3%). All pediatric patients less than 12 years old presented with postoperative VP shunt complications were assessed clinically with proper history taking and asking about the presence of seizures and proper neurological examination. In addition, **Gaderer *et al.*** [13] reported that in NEG group (n = 23), Highest C-reactive protein (CRP) mg/l was 65.8 (17.18–158), Highest leukocytes (CC cell count) was 14.68 (7.09– 51.73), CRP prior to shunt insertion mg/l was 2.1 (0.03–64.7) and Leukocytes prior to shunt insertion CC was 8.76 (4.73–24.54). Furthermore, **Ebrahim *et al.*** found that regarding laboratory findings in CSF analysis for protein and glucose: No % High CSF total protein in13 (43.3%) and Low CSF glucose in 15 (50.0%). According to CSF culture and sensitivity results, CSF culture and sensitivity examination plays a major role in the management strategy of postoperative VP shunt complications in which it decides if there is CSF infection or not [12].

Conclusion: The use of NEL in managing infected hydrocephalus in infants is effective and minimally invasive treatment and showed significant differences in fever, head circumference percentile, ESR and CRP, TLC and CSF examinations & neurological assessments between pre & post NEL associated with a better outcome and shorter hospital stay duration compared to current conventional lines of treatment

Disclosure: No conflict of interest or financial disclosures

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