ANESTHESIA FOR THIRD VENTRICULOSTOMY

- A Report of 128 Cases -

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Abstract

Background: Endoscopic third ventriculostomy (ETV) has become the standard surgical procedure for treatment of non-communicating hydrocephalus. The aim of this study is to report our results over the past ten years with reference to perioperative complications of ETV with a review of some specific anesthetic issues.

Methods: The computerized database (in the Department of Neurosurgery) and the medical records of 128 patients who underwent ETV between February 1998 and February 2007 at our Hospital, were reviewed. Data collected were, age, sex, weight, height, preoperative biochemical analysis, duration of the procedure, anesthetic drugs used, amount of irrigation fluid used, blood loss, postoperative biochemical analysis and perioperative complications.

Results: Preoperative biochemical analysis for all patients was

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within normal ranges. Normal saline 0.9% was used as irrigation fluid for all patients. The volume during the procedure used ranged from 2 to 6 L (mean 3 L). When correlating postoperative serum sodium mean values to the volume of irrigation fluid used, it showed non significant correlation ($r = 0.07$). Serum potassium level has shown significant decrease postoperatively compared to preoperative levels ($P < 0.05$). The other biochemical analysis parameters showed non-significant changes postoperatively compared to preoperative data ($P > 0.05$).

Conclusion: Anesthesiologists should be aware of the intra and postoperative complications secondary to ETV. Intraoperative bradycardia is the commonest arrhythmia occuring during the procedure. Precautions, like alerting the surgeon and pulling out the scope, are enough to revert bradycardia if it occurs. Though postoperative electrolyte imbalance occurs we believe it has no clinical significance. We believe that either normal saline or lactated Ringer solutions could be safely used for intraoperative irrigation with minimal postoperative impact. Though the procedure is a minimally invasive procedure, close observation of vital signs, serum electrolytes as well as volume and temperature of the irrigation fluid and close communication between anesthesiologist and surgeon, are prerequisites for better outcome.

Introduction

Endoscopic third ventriculostomy (ETV) has become the standard surgical procedure for treatment of non-communicating hydrocephalus[1]. ETV is quick, simple, minimally invasive procedure with less morbidity and mortality compared to standard ventriculoperitoneal (VP) shunt placement[2]. This procedure, however, requires a general anesthetic and necessitates manipulation of the brain neural structures to access the floor of the third ventricle.

At our Hospital we started to perform ETV in February 1998 and we have recently reached a total of 128 cases. Since that period we have published few articles about the anesthetic management and the complications of neuroendoscopy in small series of patients. In our first and original publication we focused on the incidence of bradycardia during ETV[3] and postulated that the bradycardia recorded in a small series studied was due to direct stimulation of the floor of third ventricle[4]. We have also reported a negative correlation between the bradycardia and the third ventricular pressure during ETV. In another study on small number of patients who underwent ETV, we reported postoperative electrolyte disturbances, namely hypokalemia, related to ETV[5], contrary to Anandh et al, who reported postoperative hyperkalemia following ETV[6].

The aim of this study is to report our results over the past ten years with reference to perioperative complications of ETV with a review of some specific anesthetic issues.

Patients & Methods

The study was approved by local hospital Ethics Committee. The computerized database (in the Department of Neurosurgery) and the medical records of 128 patients who underwent ETV under general anesthesia between February 1998 and February 2007 at King Khalid University Hospital, Riydh, Saudi Arabia, were reviewed. The data entry was made on a prospective case-by-case basis. All the variables included in this study were present in the database. The diagnosis of obstructive hydrocephalus was based on clinical features besides signs and symptoms of raised intracranial pressure. Moreover, the diagnosis was confirmed with CT brain. Patients with anemia, electrolyte imbalance, hormonal dysfunction, or cardiovascular or respiratory system problems, were excluded from the study. Data collection for each case consisted of age, sex, weight, height, preoperative biochemical analysis, duration of the procedure, anesthetic drugs used, amount of irrigation fluid used, blood loss, postoperative biochemical analysis and perioperative complications.

Statistical Analysis

Descriptive analysis was done using the SPSS statistical package version 13.0. Data presented as mean (± SD), number (percentage), or ratio as appropriate. Groups were compared using the parametric or the nonparametric versions of *t* test or Wilcoxon's matched paired test as appropriate. Nominal data were compared using the Chi-square test or alternatively by Fisher's exact test, as appropriate. P values < 0.05 were considered significant. Correlations were analyzed using a statistical software package (Graph Pad In Stat® version 3.00 for Windows, Graph Pad Software Inc., San Diego, California, USA). Correlation was done using the linear Pearson or the non parametric spearman correlation as appropriate, and significance of correlation was tested by the F test where P < 0.05 was considered significant.

Anesthetic Management

Patients with depressed mental status received no premedication. Otherwise, vallergan syrup 0.5 ml/kg b.w 30 minutes preoperatively, was given to children less than 2 years. Older children received oral midazolam 0.5 mg/kg b.w 30 minutes preoperatively. Adults received oral lorazepam 2 mg 2 hours preoperatively as premedication.

In the operation room, routine monitoring was used. Anesthesia for children up to 2 years was induced with isoflurane or sevoflurane inhalation and for older children and adults with i.v. thiopental 4 mg/kg b.w. Tracheal intubation was facilitated with i.v. atracurium 0.3 mg/kg b.w. Maintenance of anesthesia was achieved with inhalation anesthetic in 50% nitrous oxide in oxygen for all patients. Analgesia was achieved with 1 mcg/kg b.w of fentanyl, and muscle relaxation was maintained with incremental doses of atracurium when required. At the end of surgery i.v. reversal agents for muscle relaxants were given in usual doses (atropine 20 mcg/kg b.w and neostigmine 80 mcg/kg b.w) and the trachea was extubated. Patients then were sent to recovery room and later to the ward.

Surgical procedure

The procedure was performed with the patients in supine and the head in neutral position. A rigid pediatric nephroscope (Karl Storz, Tuttlingen, Germany) size 17F was used. The scope was introduced through the anterior fontanelle with or without creation of burr-hole (depending on patient's age) just anterior to the coronal suture in the midpupillary line. The scope then was advanced from the lateral ventricle through the foramen of Monro toward the floor of third ventricle. Following visualization and confirming the relevant anatomical structures, the floor of third ventricle was perforated posterior to the interfundibular recess with the tip of the scope. The fenestration was enlarged slightly either by using the scope tip or by using a pediatric Foley's catheter with inflated balloon. Irrigation with normal saline 0.9% at body temperature at different rates as required was used for the clarity of the field. The irrigation fluid was allowed to vent out through the side channel of the scope without accumulating in the ventricles to avoid any increase of intracranial pressure. The cerebrospinal fluid (CSF) was then allowed to drain into the basal cistern, bypassing the aqueductal stenosis to the surface of the brain.

Results

The 128 patients ranged in age from 1 month to 43 years (Table 1). There were 68 male patients (53%). The preoperative Glasgow coma score ranged from 10 to 15 (mean 13).

Table 1
Classes of patient's age

Age	Number	Minimum	Maximum	Mean	SD
<1 year	52	1 month	12 month	6.6 month	3.8
1-12 year	59	2	11	4.9	2.6
>12 year	17	13	43	24	7.6

Preoperative biochemical analysis for all patients was within normal ranges (Table 2). Normal saline 0.9% was used as irrigation fluid for all patients. The volume during the procedure used ranged from 2 to 6 L (mean 3 L) and the mean temperature of the irrigation fluid was 24°C.

Table 2

Preoperative biochemical analysis data

	Minimum	Maximum	Mean	SD
Hemoglobin	8.4	19	11.8	1.7
Hematocrit	25	84.7	36	7
Sodium	125	148	138	5
Urea	.6	8	3	1
Creatinine	4	141	42	18.6
Chloride	85	117	102.6	4.5
Platelets	42	843	357.8	140.6
Potassium	3	7	4.5	.7

The mean duration of surgery, intraoperative blood loss and intraoperative patients temperature, are given in Table 3. Postoperative biochemical analysis results are given in Table 4.

Table 3

Duration of surgery (min), blood loss (ml) and temperature (°C)

	Minimum	Maximum	Mean	SD
Duration/min	15	200	84.6	39.8
Blood Loss/ml	5	200	58.5	18
Temp	36	37.6	36.5	.2

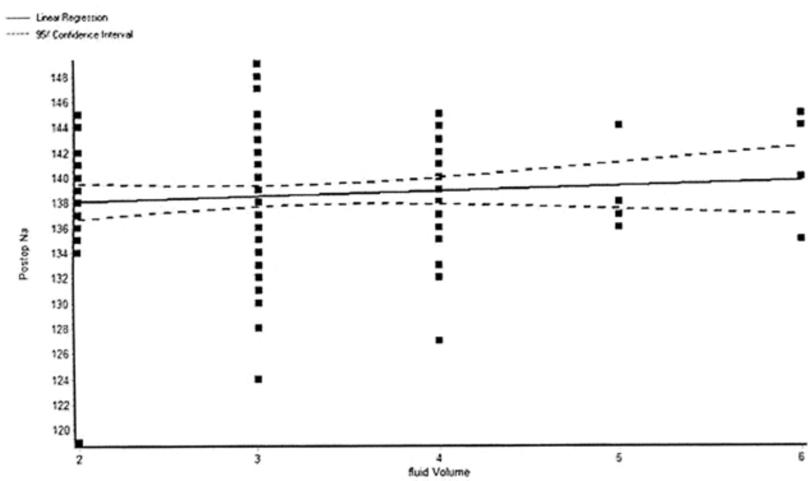
Table 4

Postoperative biochemical analysis data

	Minimum	Maximum	Mean	SD
Hemoglobin	7	19	11	1.8
Hematocrit	21	65	33.9	6.8
Sodium	128	149	138.5	4.5
Urea	.2	7.6	2.7	1.5
Creatinine	12	170	39.6	20
Chloride	78	115	102	4.7
Platelets	60	822	341	125.6
Potassium	2	6.6	4	.7

When correlating postoperative serum sodium mean values to the volume of irrigation fluid used, it showed non significant correlation (r = 0.07). Correlation confidence was $r^2 = 0.005$ indicating poor correlation. The same trend remained the same when adding the preoperative sodium level as a contributing factor (Fig. 1).

Fig. 1
Correlation between postoperative serum sodium level and volume of irrigation fluid



Serum potassium level has shown significant decrease postoperatively compared to preoperative levels (P < 0.05). The other biochemical analysis parameters showed non-significant changes postoperatively compared to preoperative data (P > 0.05). Sixty two patients received premedication (48.4%). Intravenous induction of anesthesia was the method of choice for the majority of cases (82%). Only 4 patients were admitted to pediatric intensive care unit (PICU) postoperatively (3.1%). Postoperative mortality presents an incidence of 1.5%. Patients who need insertion of ventriculoperitoneal shunt (VP) postoperatively present an incidence of 28.9%. One patient had transient III cranial nerve palsy postoperatively with complete recovery later on.

Discussion

ETV was introduced early in this century[7-9]. However, only recently have reports begun to surface indicating some success with the management of hydrocephalus using ventriculosopic methods as opposed to permanent shunt placement[10].

The surgical complications of ETV are well documented. Patients might develop transient fever due to aseptic irritation of the ependyma or to manipulation of the hypothalamus. A group of investigators reported hemiparesis, others observed a transient third cranial nerve paresis[11,12]. In our series we reported mortality in 2 patients due to bleeding directly related to neuroendoscope. Also, we have reported in this study postoperative wound infection in 15 patients and postoperative insertions of VP shunt in 37 patients. McLaughlin et al, reported a case of near mortality due to traumatic basilar artery during ETV[13]. Fabregas et al. reported 1% mortality rate among 100 neuroendoscopy cases. Also they reported intraoperative complications in 36 patients with arterial hypertension being the most frequent (53%) and postoperative complications in 52 patients; anisocoria (31%) and delayed arousal (29%)[14].

Intraoperative hemodynamic changes during ETV have been extensively studied with conflicting results. On one study tachycardia was found more frequently than bradycardia and was attributed to an increase in intracranial pressure (ICP) and systemic hypertension and was caused by high-speed fluid irrigation or kinking of the outflow tube[15]. Atypical Cushing response was given to explain the frequency of tachycardia during ETV. The classic response as described by Cushing includes apnea, hypertension and bradycardia. However, in the literature tachycardia consistently preceded bradycardia in the Cushing response and was attributed to compression of hypothalamus by dilated third ventricle[16,17]. Baykan et al, reported bradycardia intraoperatively alone in 28.1% and the respective rates for asystole and for bradycardia following tachycardia as 0.5% and 12.4% with an overall incidence of arrhythmia involving bradycardias as 41%[18]. Derbent et al, encountered bradycardia in only 1 of the 24 patients for a short period during balloon inflation with possible temporary brain stem ischemia and subsequent bradycardia[19]. In our first report on hemodynamic changes during ETV published in 1999, we reported bradycardia with incidence of 43% among 14 patients. In the same study we reported negative correlation between third ventricle pressure and intraoperative bradycardia. Since we were using saline for irrigation in an open system, we postulated that the bradycardia was due to direct stimulation of the floor of the third ventricle by the tip of the endoscope[14]. This has been further supported by another study on 49 patients underwent ETV where an incidence of bradycardia of 41% was reported[3]. Based on these studies we suggested that the possible absence of other arrhythmias found in other studies may be due to the protocol that allowed the irrigation fluid to vent out during the procedure without noticeable accumulation in the third ventricle. Using this technique we failed to observe significant blood pressure changes during ETV. We think that the guided approach adopted was instrumental in avoiding major hemodynamic changes. Obviously increasing ICP indefinitely would lead to cardiac arrest. We suggested that bradycardia may be one of the first indicators of bending cardiac arrest during ETV which can be easily treated by pulling the scope away from the floor of the third ventricle[20]. Leach et al, reported in two occasions during ETV a profound bradycardia leading to short-lived, spontaneously resolving episode of asystole. Both patients, in their series of over 140 patients, awoke unharmed. On both these occasions, it was noted that the event followed irrigation, not routinely used in their practice, and the irrigation fluid was at room temperature. Therefore, they advocated that if irrigation is to be used, care should be taken to keep the fluid strictly at body temperature[21].

Another issue of interest following ETV is the postoperative electrolytes imbalance. Postoperative hyperkalemia has been reported following ETV[6]. The authors attributed hyperkalemia to a disturbance related to the hypothalamic nuclei situated in the floor of the third ventricle. However, the hyperkalemic response in these patients has been noticed in isolation, without any change in the serum sodium level. Also it was transient and late in onset which suggests a hormonal dysfunction. In that report we found that the authors were using lactated ringer solution for irrigation, which we believe has contributed to the hyperkalemic response following ETV. Derbent et al, reported that although they were using lactated ringer solution for irrigation and 0.9% normal saline for intravenous fluid replacement during ETV, there was no significant difference between the pre and postoperative serum sodium and potassium[19]. Van Aken et al, noted that when normal saline is used for irrigation during ETV, hypertension and reflex bradycardia occurred and they recommend use of lactated ringer solution instead[15]. In our setup we are using normal saline and not lactated ringer for irrigation, and in spite of that, we have reported hypokalemia and hypernatremia in the second and third postoperative days following ETV with no clinical significance[5]. In the current study we have reported same trend of postoperative hypokalemia and hypernatremia and again with no clinical significance. Also we have reported negative correlation between the serum sodium level postoperatively and the volume of irrigation fluid (normal saline) used.

We conclude that ETV has become the most common neuroendoscopic surgery done for treatment of obstructive hydrocephalus. Anesthesiologists should be aware of the intra and postoperative complications secondary to ETV. Intraoperative bradycardia is the commonest arrhythmia occurring during the procedure. Precautions, like alerting the surgeon and pulling out the scope, are enough to revert it. Though postoperative electrolyte imbalance occurs, we believe it has no clinical significance. We believe that either normal saline or lactated ringer solutions could be safely used for intraoperative irrigation with minimal postoperative impact. Though the procedure is minimally invasive procedure close observation of vital signs, serum electrolytes as well as volume and temperature of the irrigation fluid and close communication between anesthesiologist and surgeon, are prerequisites for better outcome.

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