# Correlation of Evan's Ratio and Surgical Outcome of Patients with Obstructive and Communicating Hydrocephalus

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**Abstract:**

***Objective:*** *To determine the correlation between Evan's ratio and outcome after surgery in case of hypdrocephalus.*

***Method:*** *It was a observational cross-sectional study carried out in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from July 2013 to March 2014. All consecutive patients were included who were diagnosed both clinically and radiologically as hydrocephalus, admitted in the Department of Neurosurgery, BSMMU and Dhaka Medical College, Dhaka, during the study period. A total of 55 samples were included in this study. Data were collected in a pre-designed data collection sheet. Data were analysed using computer based programme of statistical package for social science (SPSS) for windows version 16.*

***Results:*** *In this study the age of maximum (80%) patients were ≤12 months. The average age was 18.06 months. Majority (56.4%) of the patients were male. The male female ratio was 1.3:1. Among the patient 67.3% had obstructive hydrocephalus and 32.7% had communicative hydrocephalus. It was found that 34.5% of patients had Evan's ratio 30-40%, 5.5% of patients had Evan's ratio 41-50% and 60% of patients had Evan's ratio >50%. It was also observed that 12.73% had excellent, 21.8% had good, 25.45% had fair, 16.36% had transient and 23.64% had poor outcome. It was also observed that lower Evan's ratio had better outcome and higher Evan's ratio had worse outcome. The difference was statistically significant (P<0.05).*

***Conclusion:*** *This study concludes that the good outcome of ventriculoperitoneal shunting to patients with hydrocephalus where Evan's ratio were <40%, which indicates more Evan's ratio higher risk of brain damage and poor outcome.*

***Key words:*** *Ventriculo peritoneal shunt, hydrocephalus, Evan's ratio, computerized tomography.*

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## Introduction:

Hydrocephalus is a medical condition in which there is an abnormal accumulation of cerebrospinal fluid (CSF) in the ventricles, or cavities, of the brain.[1,2] It is, also known as "water in the brain,". This may cause increased intracranial pressure inside the skull and progressive enlargement of the head, convulsion, tunnel vision, and mental disability. Hydrocephalus can also cause death.

The clinical presentation of hydrocephalus varies with chronicity. Acute dilatation of the ventricular system is more likely to manifest with the nonspecific signs and symptoms of increased intracranial pressure.[2] By contrast chronic dilatation (especially in the elderly population) may have a more insidious onset presenting, for instance, with Hakim's triad (Adams triad).

The **Evans index** is the ratio of frontal horns to maximal biparietal diameter (BPD) measured in the same CT slice. [3]

Evans ratio >30% of is the diagnostic criteria of hydrocephalus. It is useful as a marker of ventricular

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volume and thus the diagnosis of hydrocephalus.[4] Symptoms of increased intracranial pressure may include headaches, vomiting, nausea, papilledema, sleepiness or coma.[4] Elevated intracranial pressure may result in uncal and/or cerebellar tonsill herniation, with resulting life threatening brain stem compression.

In infants with hydrocephalus, CSF builds up in the central nervous system, causing the fontanelle (soft spot) to bulge and the head to be larger than expected. Early symptoms may also include: eyes that appear to gaze downward, irritability, seizures, separated sutures, sleepiness, vomiting, symptoms that may occur in older children can include: brief, shrill, high-pitched cry, changes in personality, memory, or the ability to reason or think, changes in facial appearance and eye spacing, crossed eyes or uncontrolled eye movements, difficulty feeding, excessive sleepiness, headache, irritability, poor temper control,[2] loss of bladder control (urinary incontinence), loss of coordination and trouble walking, muscle spasticity (spasm), slow growth (child 0–5 years), slow or restricted movement, vomiting. They may reach puberty earlier than the average child. About one in four develops epilepsy.

Hakim's triad of gait instability, urinary incontinence and dementia is a relatively typical manifestation of the distinct entity normal pressure hydrocephalus (NPH). Focal neurological deficits may also occur, such as abducens nerve palsy and vertical gaze palsy (Parinaud syndrome due to compression of the quadrigeminal plate, where the neural centers coordinating the conjugated vertical eye movement are located).[2] The symptoms depend on the cause of the blockage, the person's age, and how much brain tissue has been damaged by the swelling.

Compression of the brain by the accumulating fluid eventually may cause convulsions and mental retardation also epileptic seizures. These signs occur sooner in adults, whose skulls no longer are able to expand to accommodate the increasing fluid volume within. Fetuses, infants, and young children with hydrocephalus typically have an abnormally large head, excluding the face, because the pressure of the fluid causes the individual skull bones — which have yet to fuse — to bulge outward at their juncture points.[2]

Based on its underlying mechanisms, hydrocephalus can be classified into communicating and non-communicating (obstructive).[4] Both forms can be either congenital or acquired.

Hydrocephalous is treated by ventriculo peritoneal shunt, endodoscopic third ventriculostomy and also pharmaco therapy. Other option of treatment of hydrocephalous are ventriculo atrial shunt, ventriculo pleural shunt.

Examples of possible complications include shunt malfunction, shunt failure, and shunt infection, along with infection of the shunt tract following surgery (the most common reason for shunt failure is infection of the shunt tract). Although a shunt generally works well, it may stop working if it disconnects, becomes blocked (clogged), infected, or it is outgrown. If this happens the cerebrospinal fluid will begin to accumulate again and a number of physical symptoms will develop (headaches, nausea, vomiting, photophobia/light sensitivity), some extremely serious, like seizures.[4] The shunt failure rate is also relatively high (of the 40,000 surgeries performed annually to treat hydrocephalus, only 30% are a patient's first surgery) and it is not uncommon for patients to have multiple shunt revisions within their lifetime.

Evan's ratio is the one of the diagnostic criteria of hydrocephalus.[5] Evan's ratio >30% is the diagnostic criteria of hydrocephalus.

**Materials and Methods:**

It was a observational cross-sectional study. Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. This study was conducted from July 2013 to March 2014.All consecutive patients with clinical and radiological diagnosed cases of hydrocephalus admitted in Neurosurgery department, Bangabandhu Sheikh Mujib Medical University (BSMMU) and Dhaka Medical College, Dhaka during the study period. Total 55 sample were included in this study in the period of 9 months. Those patients who were admitted with hydrocephalus and had use of ventri-culo peritoneal shunt were included in this study. Those patients was treated by endoscopic third ventriculostomy due to homogeneity of all variable, patient with brain tumour and haemorrhagic stroke, patients with other congenital anomalies were excluded in this study. Data collection were conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University and Dhaka Medical College Hospital. The patients were included after primary screening with inclusion and exclusion criteria. Structured questionnaire were used to collect the necessary information. Informed written consent were taken from each patient or guardian before data collection. For statistical analysis, software SPSS(Statistical Package for Social Science), version 16 were used. Appropriate statistical test for data analysis (Odds ratio & Logistic regression analysis) were done. Statistical significance were set at p value <0.05. Outcome measured by "Black Shunt outcome scale".[6]

**Results:**

**Table-I**

*Age distribution of the study subjects*

| Age in months | Frequency | Percent | Mean±SD |
|---|---|---|---|
| ≤12 months | 44 | 80.0 | 18.06±40.18 |
| 13-24 months | 4 | 7.3 | |
| 25-36 months | 3 | 5.4 | |
| 37-48 months | 2 | 3.6 | |
| >48 months | 2 | 3.6 | |
| Total | 55 | 100.0 | |

Table-I shows the age of majority patients (80%) were d"12 months. The average age was 18.06±40.18 months. Age ranged from 2.5 to 252 months

**Table-II**

*Sex distribution of the study subjects*

| Sex | Frequency | Percent | Male female ratio |
|---|---|---|---|
| Male | 31 | 56.4 | 1.3:1 |
| Female | 24 | 43.6 | |
| Total | 55 | 100 | |

Table-II shows maximum (56.4%) study subjects were male. The male female ratio was 1.3:1.

**Table-III**

*Clinical presentation of the study subjects*

| | Frequency | Percentage |
|---|---|---|
| Vomiting | 28 | 50.9 |
| Limb weakness | 31 | 56.4 |
| Altered consciousness | 21 | 38.2 |
| Convulsion | 27 | 49.1 |
| Visual disturbance* | 39 | 70.9 |
| Upgaze palsy | 21 | 38.2 |
| Cranial enlargement | 54 | 98.2 |
| Irritability | 34 | 61.8 |
| Fontanelle full and buldging | 39 | 70.9 |
| $6^{th}$ nerve palsy | 21 | 38.2 |
| Hyperactive reflexes | 40 | 72.7 |
| Setting sign of eyes | 18 | 32.7 |
| Irregular respiration with apneic spell | 13 | 23.6 |
| Occipito frontal circumference increase | 54 | 98.2 |

* Note : visual assessment was done by holding red colour object in front of patient eye and was moved two and fro. Patient moved its eyeball according to the site of object.

Table-III shows the clinical presentation of the study, the most common clinical presentation were cranial enlargement (98.2%), hyperactive reflexes (72.7%), frontanelle full and buldging (70.9%), irritability (61.8%), limb weakness (56.4%), vomiting (50.9%), convulsion (49.1%), upgaze palsy (38.2%), $6^{th}$ nerve palsy (38.2%) and irregular respiration with apneic spell (23.6%) .

**Table-IV**

*Types of hydrocephalus of the study subjects (Computerized Tomography Scan and Magnetic resonance imaging)*

| Types of hydrocephalus | Frequency | Percentage |
|---|---|---|
| Obstructive | 37 | 67.3 |
| Communicative | 18 | 32.7 |

**Table-V**

*Distribution of Evan's ratio of the study subjects*

| Evans ratio | Frequency | Percentage |
|---|---|---|
| <30% | 0 | 00 |
| 30-40% | 19 | 34.5 |
| 41-50% | 3 | 5.5 |
| >50% | 33 | 60.0 |
| Total | 55 | 100 |

**Table-VI**

*Causes of hydrocephalus of the study subjects*

| Cause | Frequency | Percentage |
|---|---|---|
| Meningitis | 15 | 27.3 |
| Acquiductal stenosis | 40 | 72.7 |

**Table-VII**

*Postoperative complication of the study subjects*

| Complication | Frequency | Percentage |
|---|---|---|
| Under shunting | 3 | 5.4 |
| Shunt blocking | 13 | 23.6 |
| Shunt infection | 19 | 34.5 |
| Acute subdural haematoma | 2 | 3.6 |
| Intracerebral haematoma | 1 | 1.8 |
| New seizure cases | 3 | 5.4 |
| Shunt extrusion | 1 | 1.8 |
| No complication | 19 | 34.5 |

Total will not correspond to100% because of multiple complication in individual patients

**Table-VIII**

*Outcome of surgery of the study subjects*

| Outcome | Frequency | Percentage |
|---|---|---|
| Excellent | 7 | 12.73 |
| Good | 12 | 21.82 |
| Fair | 14 | 25.45 |
| Transient | 9 | 16.36 |
| Poor | 13 | 23.64 |

Excellent : Resumed pre-illness activity without deficit
Good : Resumed pre-illness activity with deficit, improved in two or more categories
Fair : Improved but did not return to previous work, improved in one category
Transient : Temporary major improvement
Poor : No change or worsening
Dead : Died within 6 wk of surgery or as a result of surgery[18]

**Table-IX**

*Relationship between surgical outcome according to Evan's ratio*

| Outcome | Evans Ratio | | | | P value |
|---|---|---|---|---|---|
| | ≤40%(n=19) | | ≥40%(n=36) | | |
| | No | % | No | % | |
| Excellent | 7 | 36.84 | 0 | 0 | 0.001 |
| Good | 8 | 42.11 | 4 | 11.11 | |
| Fair | 3 | 15.79 | 11 | 30.56 | |
| Transient | 0 | 00 | 9 | 25 | |
| Poor | 1 | 5.26 | 12 | 33.33 | |

P value reached from chi-square test

Excellent : Resumed pre-illness activity without deficit
Good : Resumed pre-illness activity with deficit, improved in two or more categories
Fair : Improved but did not return to previous work, improved in one category
Transient : Temporary major improvement
Poor : No change or worsening
Dead : Died within 6 wk of surgery or as a result of surgery[21]

**Table-X**

*Relationship between evan's ratio and types of hydrocephalus.*

| Type of hydrocephalous | Evans Ratio | | | | P value |
|---|---|---|---|---|---|
| | <40%(n=19) | | >40%(n=36) | | |
| | No | % | No | % | |
| Obstructive | 13 | 68.42 | 24 | 66.67 | 0.895 |
| Communicative | 6 | 31.58 | 12 | 33.33 | |

P value reached from chi-square test

**Table-XI**

*Association of type of hydrocephalus and surgical outcome according to Evan's ratio*

| Outcome | Type of hydrocephalous | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Obstructive | | | | | Communicative | | | | |
| | <40% | | >40% | | P value | <40% | | >40% | | P value |
| | No | % | No | % | | No | % | No | % | |
| Excellent (n=7) | 4 | 57.1 | 0 | 00 | - | 3 | 42.9 | 0 | 00 | - |
| Good (n=12) | 6 | 50 | 2 | 16.6 | 0.001 | 2 | 16.6 | 2 | 16.6 | - |
| Fair (n=14) | 2 | 14.3 | 6 | 42.8 | 0.001 | 1 | 7.1 | 5 | 35.7 | 0.002 |
| Transient (n=9) | 0 | 00 | 0 | 00 | - | 6 | 66.7 | 3 | 33.3 | 0.001 |
| Poor (n=13) | 1 | 7.7 | 10 | 76.9 | 0.001 | 0 | 00 | 2 | 15.4 | - |

**Discussion:**

Hydrocephalus associated with meningitis is a common problem. The time honoured treatment of this complication is ventriculoperitoneal shunt and in some cases ventriculoatrial shunts. However as shunting does not benefit all cases of hydrocephalus associated with meningitis, efforts have been made for a long time to define criteria to select patients who will benefit from shunt insertion.

In this study there was a correlation between Evan's ratio and outcome of surgery with communicating and obstructive hydrocephalus whereas in the series of Mathew JM, et al.[7] severity of hydrocephalus had an adverse impact on the outcome. Our series of 55 patients with heterogeneous clinical findings with Evan's ratio have been included in this series. We included in our study both obstructive and communicating hydrocephalous.

The clinical condition at admission was the most important predictor of good outcome and severity of hydrocephalus had an adverse impact on outcome. The rest of the variables studied (age, duration of illness, duration of altered sensorium had no affect on long term outcome. In previous study, [8-9] the age of the patient, duration of illness had no influence on the outcome.

This study found 80% were d"12 months and the mean age was 18.06±40.18. Several studies[10,11] shows youngest patient was of 3 months and 84% of the patients were in the first three decades of life.

We included all the patients who were treated by ventriculoperitoneal shunt. Lamprecht D et al.[10] and van Toorn R et al.[11] treated their patients with the policy of ventriculoperitoneal shunting in the acute stage if the hydrocephalus was of non communicating variety or following failed medical therapy if the hydrocephalus was communicating of communicating type.

In our study shows 67.3% were obstructive hydrocephalus and 32.7% were communicating hydrocephalus. Previous studies[12] shows non communicating hydrocephalus was present in 38 of 65 patients and communicating in 27 patients.

In our study shunt infection was 34.5% of patient, shunt blocking was 23.6% of cases, acute subdural haematoma 3.6% of patients, under shunting 5.4%, intracerebral haemorrhage was 1.8% and seizure was 5.3% had shunt extrusion through anus. Previous study shows the shunted patients had a high complication rate of 32.3% with shunt infection and shunt obstruction each occurring in 9 out of 65 patients.[12] This may perhaps be due to the better quality of the shunts available and improved peroperative care.

We believe that classification of hydrocephalus into two distinct groups, obstructive (non communicating) and non obstructive (communicating) varieties is difficult as in most cases there is a combination of the two elements. Hence a policy based solely on this criterion alone is not sufficient. However, early shunting in patients with clear cut non communicating hydrocephalus is still indicated.

In our study observed that 12.73% had excellent outcome, 21.8% had good, 25.45% had fair, 16.36% had transient and 23.64% had poor. In previous studies patients was good 33.3%.[6] Similar results were seen our study where there was a positive co-relation between the Evan's ratio and the outcome. This results was significant with the p value of 0.001. The results showed that most important factor affecting the outcome was the Evan's ratio more outcome is worse. It also documented that lower Evan's ratio had better outcome and higher Evan's ratio had worse outcome. The difference was statistically significant ($P<0.05$).

## Conclusion:

This study concludes that the good outcome of ventriculoperitoneal shunting to patients with hydrocephalus where Evan's ratio was <0.40. Which indicates more Evan's ratio more brain damage and poor outcome. Focus is aimed at identifying a set of diagnostic criteria that can be evaluated in studies to determine which set of criteria yield the highest success after shunt implantation. So we recommend in social programme in school, college, religious or other mass gathering, media included the protocol where increase of head circumference send the patient to the specialist for early surgery. Community monitoring system and surveillance system should develop through country wide for early identifying hydrocephalus and refer the patients to specialized centre.

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