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# Radiological Parameters of Success of Endoscopic Third Ventriculostomy

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## ABSTRACT

**Introduction:** Endoscopic third ventriculostomy (ETV) is becoming the procedure of choice in the treatment of obstructive hydrocephalus.

**Aim:** Determine radiological parameters of success of ETV and changes in ventricular size that occur after an effective ETV and how these changes related to clinical outcome.

**Material and methods:** Forty eight patients with obstructive hydrocephalus surgically treated with ETV were prospectively studied with assessment of the results based on clinical and radiological criteria. Ventricular size was measured with the Evans index, third ventricle index and cella media index. , age ranged from 2-64 years, and the mean age was 22.46 years.

**Results:** The overall success rate was 77 % (37 of the 48 cases) while failure occurred in 11 cases, ventricular size diminishes moderately after a clinically successful ETV especially when measured by Evans ratio which exhibits the greatest variability post-operative with a mean reduction of 60%.

**Conclusions:** Ventricular size diminishes moderately after a successful endoscopic third ventriculostomy. The importance of ventricular size changes is very much secondary to the clinical status. This reduction is more prominent in acute forms of hydrocephalus than in chronic ones. Evans ratio provides more valuable information in assessment of ventricular size; it exhibits the greatest reduction post-operative.

**Keywords:** *Endoscopic third ventriculostomy, obstructive hydrocephalus, ventricular size, third ventricle*

## INTRODUCTION

Endoscopic third ventriculostomy (ETV) is increasingly preferred to ventriculo-peritoneal shunting when treatment for non-communicating hydrocephalus is required. ETV allows the CSF to be internally diverted to the basal cisterns and eventually be reabsorbed by arachnoid granulations, avoiding the need to implant exogenous material like shunt and subsequently avoiding their complications (Kulkarni,2016). The success rate of ETV is variable among series, with reported rates between 50% and 94 %( Deopujari,2017). The clinical status after surgery remains the cornerstone when assessing its effectiveness and the radiological changes of the ventricular system as an indicator of success in this procedure is questionable.

There is a general consensus that a successful ETV is usually followed by a decrease of ventricular size, without reaching their normal size (Santamarta, 2008).

Our study was performed to determine whether changes in ventricular size occurred after an effective ETV, how they related to clinical outcome, and whether the change in ventricular size was different in acute and chronic forms of hydrocephalus.

## PATIENTS AND METHODS

***Study design***

This is a prospective Observational study of 48 patients with non-communicating hydrocephalus that were surgical treated with Endoscopic third ventriculostomy (ETV) in Cairo university hospitals between January 2020 till June 2021.

Population of study & disease condition Non-communicating hydrocephalic patients.

***Inclusion criteria***

Patient age older than 2 years (closed cranium) including children. Young adults and adults with imaging confirmed non-communicating hydrocephalus.

***Exclusion criteria***

Patient age younger than 2 years or another procedure for CSF diversion performed just after the ETV surgery such as shunt surgery .

***Post-Operative Assessment***

During the post-operative stay in hospital all patients were treated by prophylactic broad spectrum antibiotics (3rd generation cephalosporin) in addition to analgesic antipyretics, and antiemetic as needed.

***Clinical assessment***

The patients were monitored in the early post-operative period and then at 2 weeks, 1 month and 3 months for clinical improvement of manifestations of increased intracranial tension, wound collection or CSF leak and for monitoring of possible postoperative complications.

***Radiological assessment***

All patients were subjected to control CT scan of the brain on the first postoperative day to evaluate the size of ventricles and then serial CT scans were required for a follow-up periods and MRI was done at 3 months postoperative.

***Ventricular size assessment***

The whole sample of patients were considered in the analysis of the relationship between the clinical outcome of ETV and changes in the ventricular size detected shortly after the procedure. And to which extent changes in ventricular size occurred after effective surgery, whether the change in ventricular size was different in acute and chronic forms of hydrocephalus. The ventricular size was measured pre-operatively and after surgery with three linear ratios. The following distances were measured on axial CT or T2 weighted MR slices: A (Maximum bifrontal distance of the lateral ventricle). B (Maximum width of the third ventricle). C (Ventricular span at the body of the lateral ventricle). D (Maximum inner diameter of the skull at the level of the measurement of the maximum bifrontal distance). E (Maximal outer interparietal diameter at at the level of the body of the lateral ventricle).

Evans' index = A/D (N=<0.3), the third ventricle index = B/D (N≈0.02-0.04), cella media index = C/E (N<0.2)

## RESULTS

A prospective study of 48 patients with non-communicating hydrocephalus that were surgical treated with Endoscopic third ventriculostomy (ETV) aiming to determine whether changes in ventricular size occurred after an effective ETV, how they related to clinical outcome, and whether the change in ventricular size was different in acute and chronic forms of hydrocephalus.

Among the 48 patients , twenty six cases (54.2%) were females while twenty two cases (45.8%)

were males with age ranged from 2-64 years, and the mean age was 22.46 years.

In our study, obstructive hydrocephalus occurred due to different pathologies. In eighteen cases (38%) obstructive hydrocephalus occurred due to tumoral obstruction (the tumor was Pineal in ten cases, colloid cyst in four cases, tectal glioma in two cases , thalamic tumor in one case and it was metastasis in another case). In seventeen cases (36%) it was due to aqueductal stenosis. In five cases (10%) ,it was post hemorrhagic .In three cases it was post meningitic (6%).It was idiopathic in five cases (10%).

headache was the initial presenting symptom in 20 cases (41.7%), 11 cases (22.9%) presented with vomiting, 8 cases (16.7%) presented with seizures and papilledema was detected in 40 cases (83%) intraoperatively , there were no abnormalities detected in most of cases except in 10 cases (20.8%). Intraventricular adhesions were detected in 5 cases while absence of pulsations in the floor of third ventricle was present in the other five cases. Among those 10 cases, 6 cases (60%) were within the succeeded ETV while 4 cases (40%) were within failed procedure.

The overall success rate was 77 % (37 of the 48 cases), the definition of ETV success is clinically improved patient with absence of further CSF diversion procedures. Among those 37 succeeded cases, clinical improvement was achieved early after surgery in 30 patients while it was delayed for 2 weeks in 7 cases. Failed ETV occurred in 11 cases, one case showed initial improvement after procedure with subsequent reappearance of symptoms after 10 days in the form of recurrent attacks of fits while no clinical improvement has been achieved in the other 10 cases (there have been other 5 cases required V/P shunt later on after failed ETV and excluded from our study).

In our study, ventricular size was measured using 3 ratios: Evans ratio, third ventricular ratio and cella media ratio. Pre-operative and postoperative imaging studies (during the first week, first month and three months after the procedure) were included in the assessment of the pattern of ventricular size changes after the procedure. In successful ETV cases, ventricular size remained unchanged in 27% of cases after 3 months when measured by Evans ratio, in 54.1% of cases when measured by third ventricular ratio and in 37.8% of cases when measured by cella media ratio. In failed ETV cases, ventricular size remained unchanged in 82% of cases when measured by Evans ratio, in 91% of cases when measured by third ventricular ratio and in 100% of cases when measured by cella media ratio.

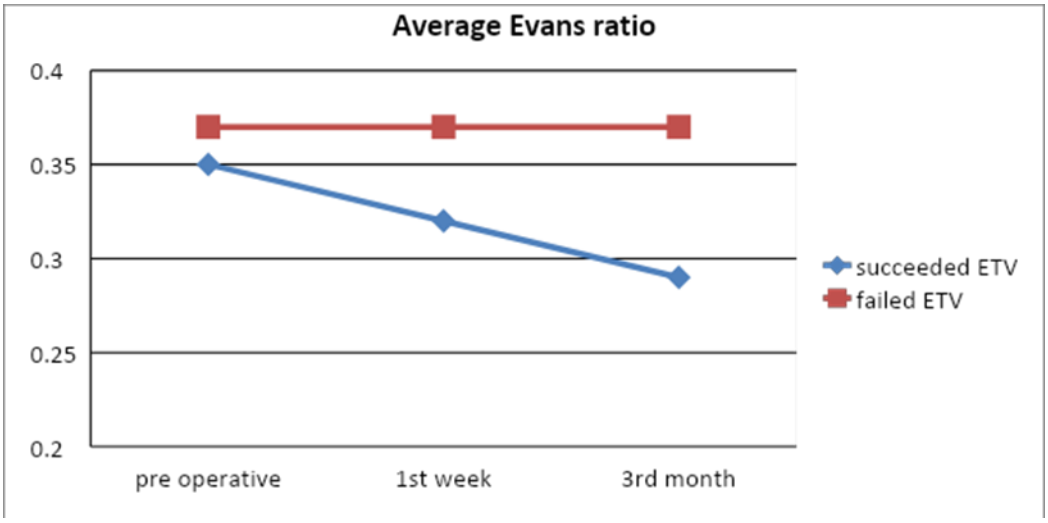
***Ventricular size when measured by Evans ratio showed the following results***

In succeeded cases: ventricular size decreased early in the first week after surgery in 22 cases (59.5%), decreased after 1 month in 2cases (5.4%) and decreased after 3 months in 3 cases (8.1%), while remained not changed in 10 cases (27%).

(The average was 0.35 preoperative, 0.32 in first week and 0.29 after 3 months)

In failed cases: ventricular size didn’t change after surgery in 9 cases (82%) while 2 cases showed slight decrease in size in the first days after surgery and then the ventricular size reincreased again to the preoperative size after 1 month (18%).

(The average was 0.37 preoperative, in first week and after 3 months)



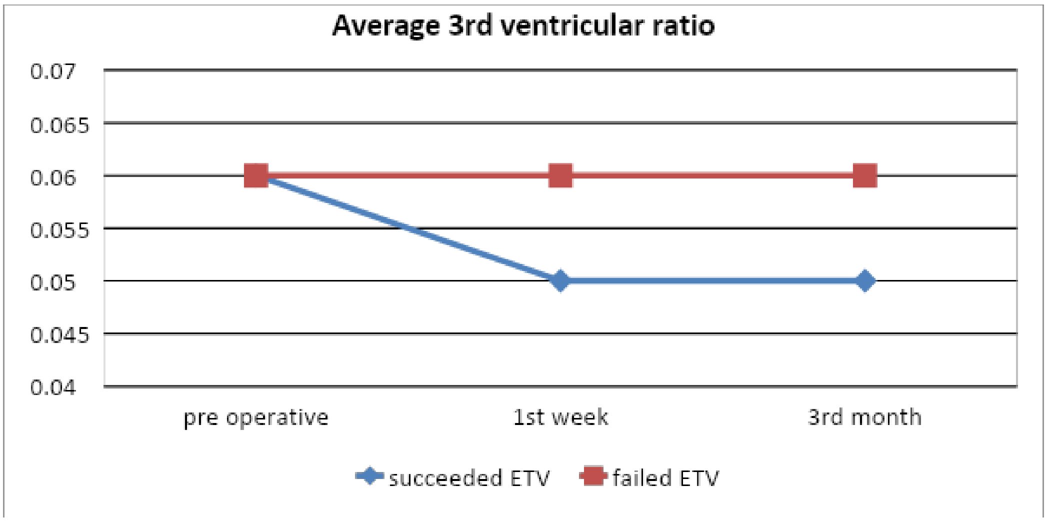

***Ventricular size when measured by third ventricle ratio showed the following results***

In succeeded cases: ventricular size decreased early in the first week after surgery in 11 cases (29.7%), decreased after 1 month in 2cases (5.4%) and decreased after 3 months in 4 cases (10.8%), while not changed in 20 cases (54.1%).

(The average was 0.06 preoperative, 0.05 in first week and 0.05 after 3 months)

In failed cases: ventricular size didn't change after surgery in 10 cases (91%) while decreased in one case (9%) within the first week.

(The average was 0.06 preoperative, in first week and after 3 months)



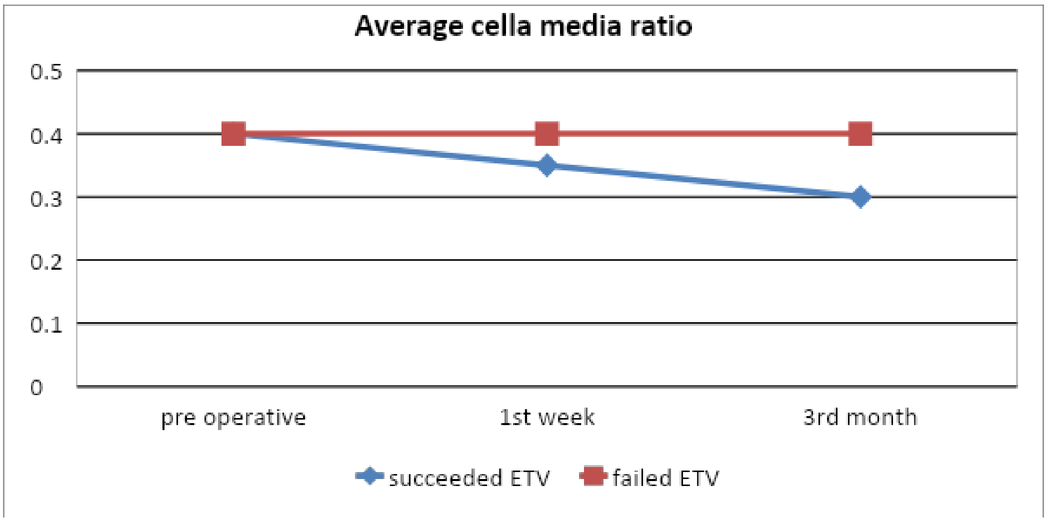

***Ventricular size when measured by cella media ratio showed the following results***

In succeeded cases: ventricular size decreased early in the first week after surgery in 16 cases (43.2%), decreased after 1 month in 3 cases (8.2%) and decreased after 3 months in 4 cases (10.8%) while not changed in 14 cases (37.8%).

(The average was 0.4 preoperative, 0.35 in first week and 0.3 at 3 months).

In failed cases: ventricular size didn't change after surgery in all cases (100%).

(The average was 0.4 preoperative, in first week and after 3 months).




***The magnitude of the change***

The Evans index exhibits the greatest variability post-operative with a mean reduction of 60%. By contrast, the third ventricular index displays the least variability with mean reduction of this ratio was 37.5%, and the mean reduction for the cella media index was 48%.

## DISCUSSION

Santamarta et al studied Changes in ventricular size after endoscopic third ventriculostomy, ventricular size was measured with the Evans index, third ventricle index and cella media index, the change in ventricular size detected shortly after surgery was related to clinical outcome for all ventricular ratios, except the cella media index .When third ventriculostomy is clinically successful, there is a gradual decrease of ventricular size over a period of more than three months and the reduction was more prominent in acute hydrocephalus than in chronic forms for all ventricular ratios. The third ventricle exhibits the greatest reduction post-operative with a mean reduction of 25 % (Santamarta, 2008). Kulkarni et al reported a study of 29 patients who underwent ETV, ventricular size was measured with frontal and occipital horn ratio ([FOR]. Among success cases, only 48% demonstrated a substantial reduction in ventricular size, that is greater than 15%, and only one achieved a ventricular size within the normal range. That confirms the general opinion that ventricles do not return to normal size even after successful ETV. However, it does suggest that ventricular reduction does occur to a significantly greater degree among successful cases compared with cases deemed failures. Interestingly, some reduction in ventricular size was seen even among the cases listed as clinical failures. The reasons for this were not clear, although it is possible that there is a threshold level of ventricular size below which cases are asymptomatic. Although the clinical failure group did have an average reduction in ventricular size, this probably did not cross that threshold, another explanation is that after ETV the obstructive hydrocephalus changes to communicating hydrocephalus which may be the cause of initial decrease in ventricular size even in failed cases (Kulkarni, 2000).

Stachura et al studied Ninety-six patients with obstructive hydrocephalus. Although ETV success were achieved in 74 (77.1%) patients, while reduction of ventricular size occurred in 52 (54.2%) cases and remained unchanged in 44 (45.8%) patients, so concluded that clinical improvement and success o ETV did not correspond with reduction of cerebral ventricle diameters, and therefore ventricle size cannot be an independent criterion in the assessment of the effectiveness of ETV treatment (Stachura, 2014). Sacko et al analyzed 350 patients, ventricular size was measured with 2 factors: bifrontal ventricular size and third ventricular diameter, and among successful ETV cases (68.5%), ventricular size decreased only in 41% of cases while remained unchanged in 59% of cases at 3 months (Sacko,2010).

In our study, ventricular size was measured using 3 ratios: Evans ratio, third ventricular ratio and cella media ratio. In successful ETV cases, ventricular size remained unchanged in 27% of cases after 3 months when measured by Evans ratio, in 54.1% of cases when measured by third ventricular ratio and in 37.8% of cases when measured by cella media ratio. In failed ETV cases, ventricular size remained unchanged in 82% of cases when measured by Evans ratio, in 91% of cases when measured by third ventricular ratio and in 100% of cases when measured by cella media ratio.We used the same ratios in assessment of ventricular size as Santamarta et al while Kulkarni et al, Stachura et al and Sacko et al used different means in assessment of ventricular size. Our findings corroborate the general opinion that ventricular size diminishes moderately after a clinically successful ETV when measured by Evans ratio similar to Santamarta et al who mentioned that with Evans ratio and 3rd ventricular ratio, the latter exhibited the greatest reduction post-operative while in our study Evans index exhibited the greatest variability and reduction post-operative. Similarly, reduction was more prominent in acute hydrocephalus than in chronic forms.

## CONCLUSION

Endoscopic third ventriculostomy is an effective and safe alternative for the treatment of obstructive hydrocephalus. Ventricular size diminishes moderately after a successful endoscopic third ventriculostomy. There is an association between the changes in ventricular size observed early after surgery and the clinical outcome suggestive of successful ETV. However, their importance is very much secondary to the clinical status. This reduction continues for at least a few months and is more prominent in acute forms of hydrocephalus than in chronic ones. Evans ratio provides more valuable information in assessment of ventricular size, it exhibits the greatest reduction post-operative

## REFERENCES

1. Kahle, K. T., Kulkarni, A. V., Limbrick Jr, D. D., & Warf, B. C. (2016). Hydrocephalus in children. The lancet, 387(10020), 788-799.
2. Deopujari, C. E., Karmarkar, V. S., & Shaikh, S. T. (2017). Endoscopic third ventriculostomy: success and failure. Journal of Korean Neurosurgical Society, 60(3), 306.
3. Santamarta, D., Martin-Vallejo, J., Díaz-Alvarez, A., & Maillo, A. (2008). Changes in ventricular size after endoscopic third ventriculostomy. Acta neurochirurgica, 150(2), 119-127.
4. Kulkarni, A. V., Drake, J. M., Armstrong, D. C., & Dirks, P. B. (2000). Imaging correlates of successful endoscopic third ventriculostomy. Journal of neurosurgery, 92(6), 915-919
5. Stachura, K., Grzywna, E., Kwinta, B. M., & Moskała, M. M. (2014). Endoscopic third ventriculostomy–effectiveness of the procedure for obstructive hydrocephalus with different etiology in adults. Videosurgery and Other Miniinvasive Techniques, 9(4), 586.
6. Sacko, O., Boetto, S., Lauwers-Cances, V., Dupuy, M., & Roux, F. E. (2010). Endoscopic third ventriculostomy: outcome analysis in 368 procedures. Journal of Neurosurgery: Pediatrics, 5(1), 68-74.
7. Sun, B. L., Wang, L. H., Yang, T., Sun, J. Y., Mao, L. L., Yang, M. F, & Yang, X. Y. (2018). Lymphatic drainage system of the brain: a novel target for intervention of neurological diseases. Progress in neurobiology, 163, 118-143.
8. Tubbs, R. S., Oakes, P., Maran, I. S., Salib, C., & Loukas, M. (2014). The foramen of Monro: a review of its anatomy, history, pathology, and surgery. Child's nervous system, 30(10), 1645-1649.
9. Vulcu, S., Eickele, L., Cinalli, G., Wagner, W., & Oertel, J. (2015). Long-term results of endoscopic third ventriculostomy: an outcome analysis. Journal of neurosurgery, 123(6), 1456-1462.
10. Waqar, M., Ellenbogen, J. R., Stovell, M. G., Al-Mahfoudh, R., Mallucci, C., & Jenkinson, M. D. (2016). Long-term outcomes of endoscopic third ventriculostomy in adults. World neurosurgery, 94, 386-393.