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Ventriculoperitoneal Shunt Infection Management by External Ventricular Drainage

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ABSTRACT

Background: Since hydrocephalus (HC) frequently co-occurs with other children and adult intracranial illnesses, the prevalence of the condition in the general population is unknown. The most frequent procedure used to treat hydrocephalus is the placement of a ventriculoperitoneal (VP) shunt.

Objective: The aim of the present study was to focus on the use of the anterior fontanelle ultrasound guide in ventriculoperitoneal shunt to get the best results of the surgical operation with low complication and consequently improve the clinical outcome of the patient and save the money and time.

Patients and methods: A prospective study included 50 cases ≤ 2 years suffering from hydrocephalus and were conducted to Neurosurgery Department, Faculty of Medicine, Zagazig University. Patients were divided equally into 2 groups; the first group of patients had ventriculoperitoneal shunt with anterior fontanelle ultrasound guided technique. The second group of patients had a conventional ventriculoperitoneal shunt technique. All patients were followed up for 3 months postoperatively.

Results: There was no significant difference found between ultrasound guided and conventional groups as regard clinical examination. There was no significant difference found between groups as regard preoperative imaging. There was no significant difference found between groups as regard postoperative imaging data. There was no significant difference between groups as regard complications except 20% had a proximal obstruction in conventional group.

Conclusion: Using anterior fontanelle ultrasound guided technique during cranial end insertion of the ventriculoperitoneal shunt is safe and achieves outcomes better than conventional techniques. Additional effort to improve the rate of accurate location should focus on making the ultrasound as a standard in cranial end shunt insertion.

Keywords: Ventriculoperitoneal shunt, Anterior fontanelle ultrasound, Conventional technique.

INTRODUCTION

There are numerous illness processes that can affect cerebrospinal fluid (CSF) dynamics and result in hydrocephalus. Enlargement of the cerebral ventricles can lead to additional damage to the surrounding brain tissue in addition to the underlying disease process or malformation-related brain damage [(1)].

The dysfunction and damage to the hydrocephalic brain are multifaceted. When hydrocephalus manifests acutely, mechanical straining can physically destroy axons and periventricular blood vessels. Impaired blood flow, especially in the white matter, appears to cause more progressive damage by triggering a series of oxidative and proteolytic reactions that kill axons [(2)].

The cell bodies and dendrites of neurons can change as a result of retrograde and anterograde occurrences. The extracellular environment may also be negatively affected by changes in the flow of extracellular fluid and CSF clearance. The degree of nervous system development determines the sort of brain damage [(3)].

The fimbria fornix is linked to motor and cognitive deficiencies in pediatric hydrocephalic brains, which have a reduced density of capillaries in the corpus callosum and atrophy of the corpus callosum [(4)].

At the time of the shunt placement, cerebral biopsies show extracellular edema with scattered axons, a few injured axons, and macrophages [(5)]. An electron microscopic analysis of brain samples from infants with hydrocephalus revealed degenerative alterations in oligodendrocytes. More investigations utilizing fractional anisotropy indicate that the modifications are more subtle [(6)].

In order to assess hydrocephalus, computed tomography (CT) is frequently used. It is a quick, accurate method that does not require metal screening, making it very helpful in an emergency situation. Due to the brief duration of the test, kids frequently do not need to be sedated. However, one of the risks linked with routine CT scans for children's patients with hydrocephalus is the possibility of long-term ionising radiation effects owing to frequent exams that could impair the developing brain and increase lifetime oncologic risk [(7)].

When the anterior fontanelle is patent throughout the first few months of life, ultrasound is incredibly helpful in assessing the brain and ventricles. Even though the test is adequate for a gross assessment of the ventricles, it can be difficult to visualise details related to the nearby parenchyma and the third and fourth ventricles. Ultrasound is used as a primary bedside screening test to evaluate intraventricular hemorrhage and hydrocephalus in neonates. In light of this, ultrasound is rarely used as the only diagnostic test for the assessment of hydrocephalus. Instead, it is more often used as a screening or surveillance test and for the follow-up of pediatric hydrocephalus before or after

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treatment, usually in the early years of life when the anterior fontanelle is patent [8].

Currently, the first imaging technique used to assess brain injury and its potential effects is cranial ultrasonography (US) of the newborn. The natural fontanelles, particularly the anterior one, are used for this. It is quick, non-invasive, and has no negative side effects. In situations of prematurity, especially in children with birth weights under 1500 g, an ultrasonographic examination is typically conducted since it provides crucial information concerning the potential existence of diseases including cerebral hemorrhage and hypoxic-ischemic encephalopathy [9].

The aim of the present study was to focus on the use of the anterior fontanelle ultrasound guide in ventriculoperitoneal shunt so as to get the best of the surgical operation with low complication and consequently will improve the clinical outcome of the patient on one hand, and save the money and time from other hand.

PATIENTS AND METHODS

This study included 50 patients and was carried out at Neurosurgery Department, Zagazig University Hospital.

Hydrocephalic patients, operated upon by ventriculoperitoneal shunt at Zagazig University Hospital, with age ≤ 2 years old with open anterior fontanelle. Assuming that rate of patients with ≤ 2 years old, with open anterior fontanelle, suffering hydrocephalus, those advised to do ventriculoperitoneal shunt, attending to ZUH are 50 cases in 6 months (the period of study).

Inclusion criteria:

Hydrocephalic patients were admitted to Neurosurgery Department for ventriculoperitoneal shunt in age ≤ 2 year with open anterior fontanelle. No previous shunt insertion. Peripheral cerebral brain mantel ≥ 2 cm and head circumference ≤ 50 cm.

Exclusion criteria:

Patients in age > 2 years with closed anterior fontanelle and previous shunt insertion. Peripheral cerebral brain mantel < 2 cm and head circumference > 50 cm.

All patients underwent surgery by ventriculoperitoneal shunt during the period from January 2020 to July 2020. The patients were divided equally into 2 groups as following:

- The first group (n=25), the patients underwent ventriculoperitoneal shunt with anterior fontanelle ultrasound guided technique.
- The second group (n=25), the patients had ventriculoperitoneal shunt with conventional technique.

Complete clinical history, general physical examination, neurological examination for clinical signs of hydrocephalus and neurological anomalies were done before intervention. Imaging CT brain was performed preoperatively and postoperatively.

Operative Intervention:

Patients operated upon by ventriculoperitoneal shunt at Neurosurgical Department, Zagazig University Hospital for treating hydrocephalus, one group by using trans anterior fontanelle ultrasound and the other group using traditional conventional maneuver. Both groups had the same criteria, and the choice was computer randomized. The target in all patients was to insert the cranial catheter of the ventriculoperitoneal shunt in proper position and length to end in ipsilateral frontal horn or body of lateral ventricles. Tigecycline was delivered in the external drainage.

Imaging: with computed tomography scan (CT scan) was done after 2 days from surgery and during follow up.

Follow up:

Follow up was done for 3 months postoperatively, clinically included: anterior fontanelle: tense or lax, valve condition, well function, delayed filling >30 second. The patients were examined for the presence of complications as CSF leak and Infection.

Ethical Consideration:

The Zagazig University Faculty of Medicine's Ethics Committee gave its approval for this study, which was carried out in accordance with the guidelines outlined in the Declaration of Helsinki. All the caregivers of the study participants gave their informed consent.

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures were coded, entered and analyzed using SPSS version 20.0 software for analysis. According to the type of data, qualitative data were represented as number and percentage and quantitative continues group were represented by mean ± SD. The following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X^2). Differences between quantitative independent groups by t test. P value was set at <0.05 for significant results.

RESULTS

This study had been carried out at Neurosurgery Department, Faculty of medicine, Zagazig University, for 50 cases with hydrocephaly to compare between anterior fontanelle ultrasound guided approach versus conventional cranial end insertion approach during ventriculoperitoneal shunt in children. There was no significant difference as regard sex and age distribution between both groups **(Figure 1).**

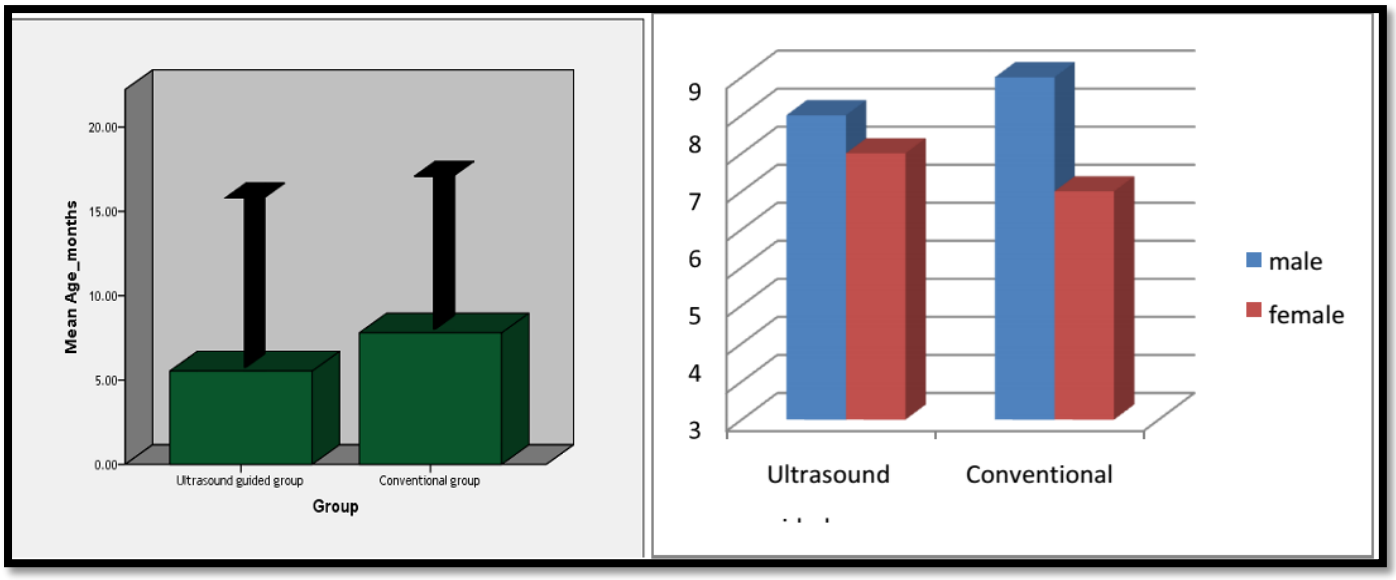

Figure (1): The gender and mean age among the studied group

There was no significant difference found between ultrasound guided and conventional groups as regard clinical examination **(Figure 2)**.

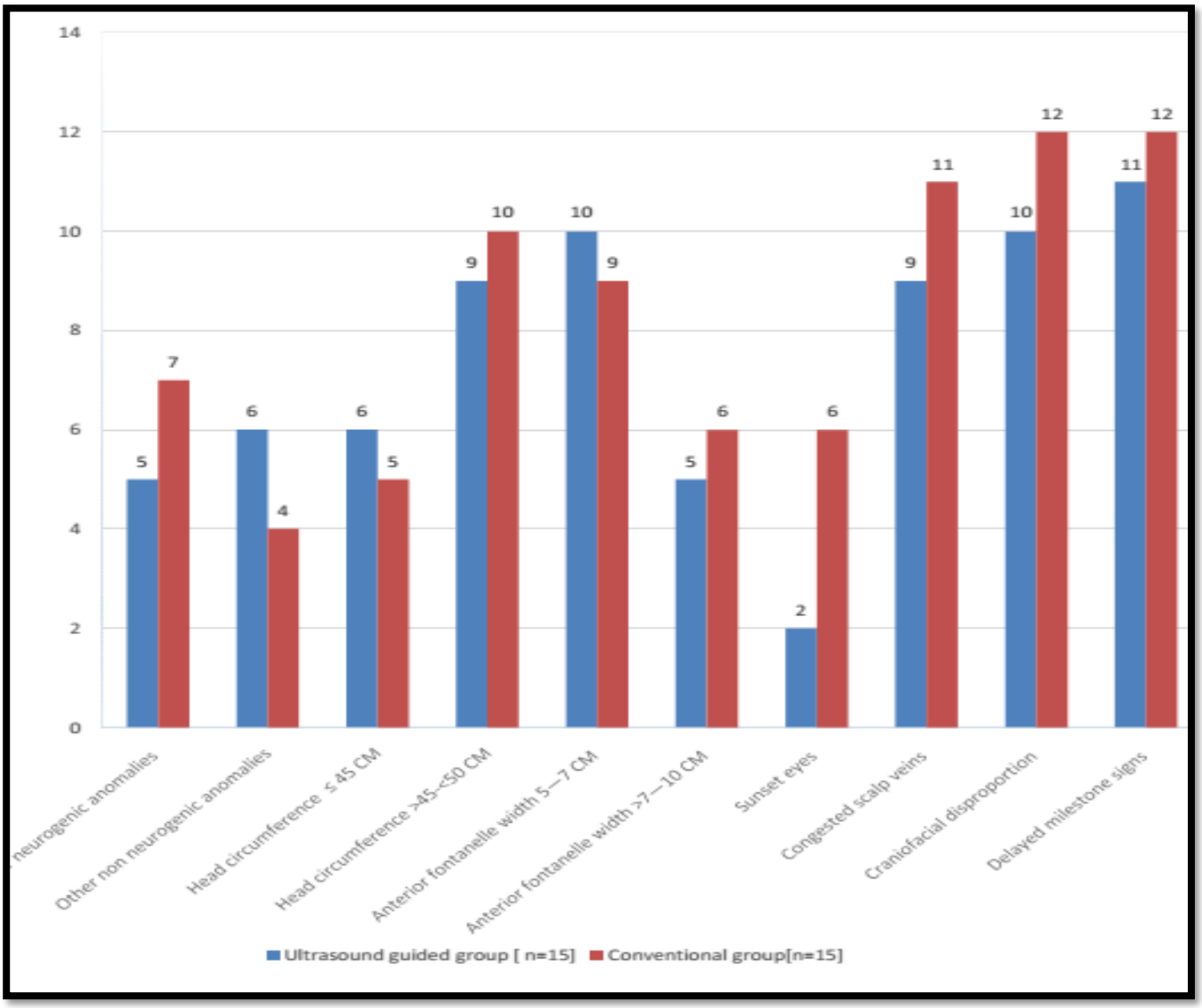

Figure (2): The clinical examination among the studied group

There was no significant difference found between groups as regard preoperative imaging **(Figure 3)**.

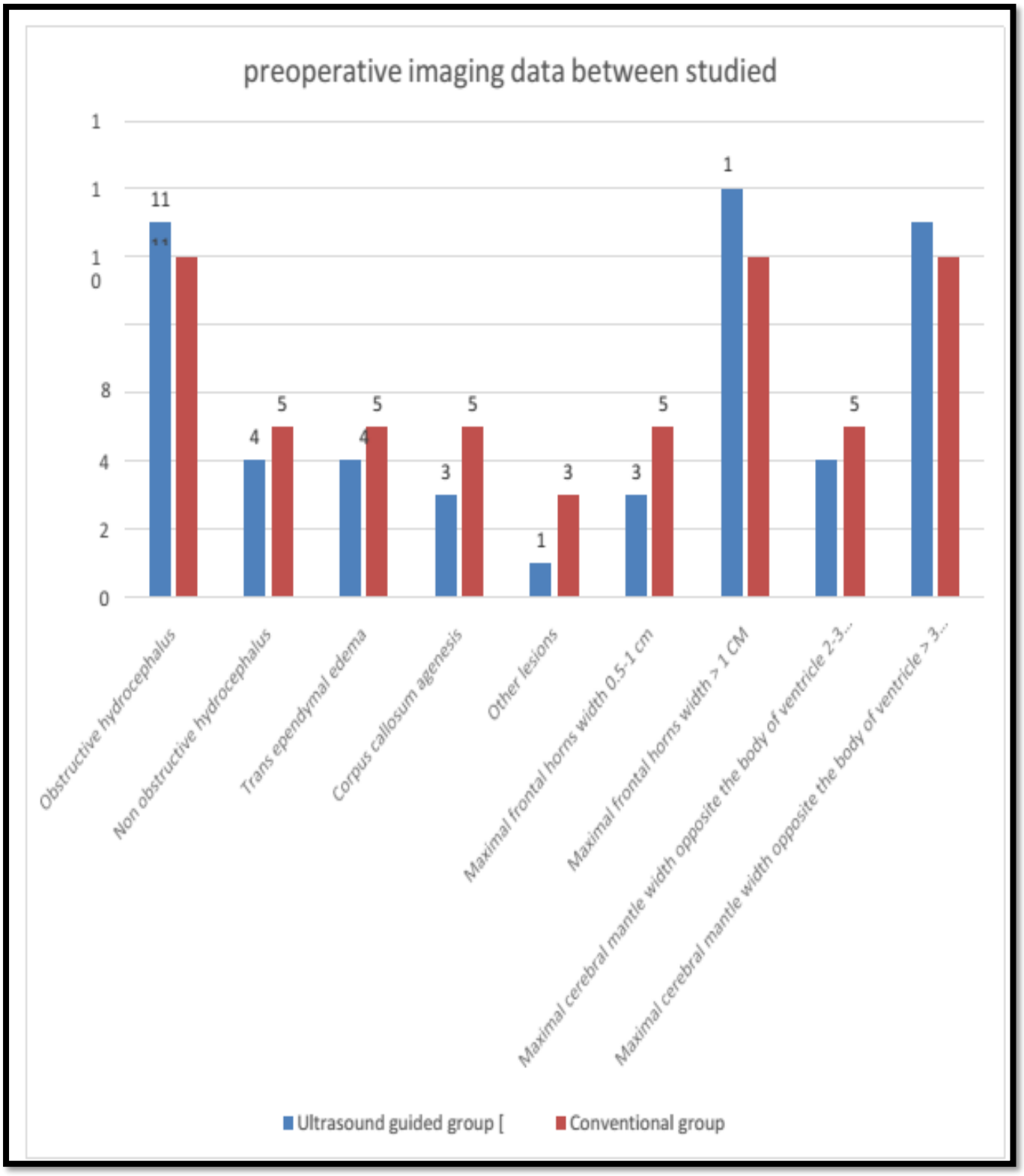

Figure (3): The preoperative imaging data among the studied group.

There was no significant difference found between groups as regard postoperative imaging data **(Figure 4)**.

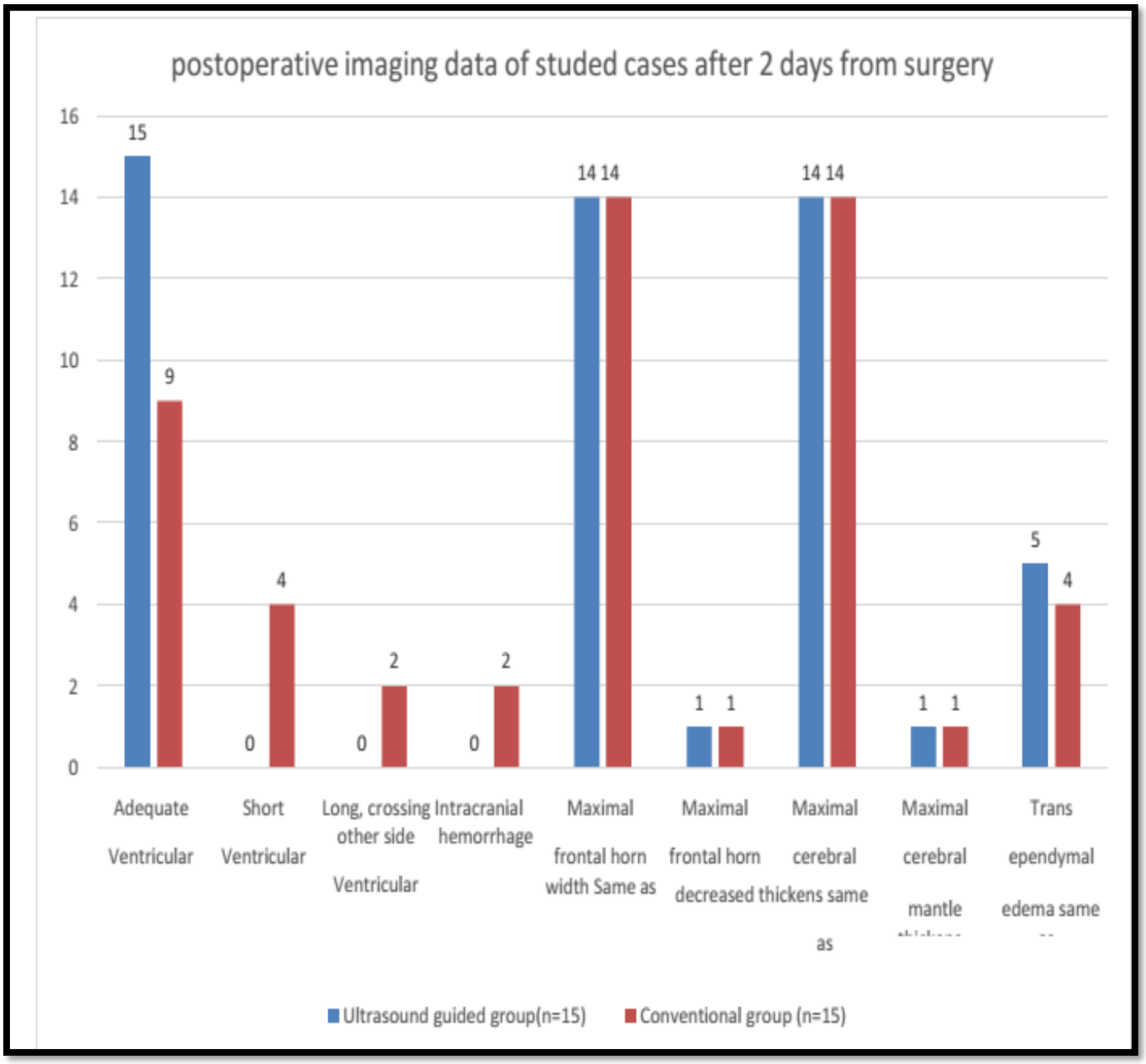

Figure (4): The postoperative imaging data among the studied group.

There was no significant difference between groups as regard complications except 20% had a proximal obstruction in conventional group **(Table 1)**.

Table (1): Operative complications during first postoperative month between studied groups

Variable	Ultrasound guided Group (n=25) No. %		Conventional Group (n=25) No. %		*P* value
Tense Fontanelle	**4**	**26.7%**	**6**	**40%**	**>0.05**
CSF Leak (Cranial)	**1**	**6.7%**	**2**	**13.3%**	**>0.05**
Proximal Obstruction	**0**	**0%**	**3**	**20%**	**>0.05**
Distal Obstruction	**2**	**13.3%**	**1**	**6.7%**	**>0.05**
Shunt infection	**2**	**13.3%**	**2**	**13.3%**	**>0.05**
Total complicated cases	**4**	**26.7%**	**6**	**40%**	**>0.05**

DISCUSSION

Despite being the most frequent procedure performed by pediatric neurosurgeons, cerebrospinal fluid (CSF) shunt placement, shunts continue to be some of the most prone to failure life-sustaining medical devices installed in contemporary medicine [(10)]. A comparative randomized prospective study performed on two groups of pediatric hydrocephalic patients, whom indicated for ventriculoperitoneal shunt at Neurosurgery Department, Zagazig University Hospital, to compare between two different methods of surgical maneuvers (anterior fontanelle ultrasound guided versus conventional technique) and to assess the improvement in the clinical outcome.

Our results showed no significant deference between the two groups regarding demographic data (age, sex), preoperative historical data, preoperative clinical examination and preoperative imaging data. Regarding postoperative imaging data after 2 days from surgery, there was no significant difference found between the two groups. During first postoperative month, we noted proximal end obstruction of the ventriculoperitoneal shunt in 3 cases (conventional group) but no case in ultrasound group, which was significantly associated with conventional group. After exclusion of 3 cases from the conventional group and 2 cases from the ultrasound group from the follow-up, because they were reoperated again, and regarding the follow-up imaging data after 3 months from surgery there was no significant difference found between groups.

These findings are consistent with multivariate analysis of population data that revealed congenital and obstructive hydrocephalus to be much more dangerous than non-communicating hydrocephalus in terms of risk. A higher incidence of shunt problems was also linked to male sex and low socioeconomic level [(11)].

Age, having undergone a previous treatment prior to the placement of the shunt, the cause of the hydrocephalus, and the kind of hydrocephalus were shown to be the independent risk factors for shunt malfunction by **Reddy *et al.*** [(12)] who examined data from a large cohort of 1015 patients.

Our results agreed with **Heussinger *et al.*** [(13)] who concluded that catheter placement with intraoperative ultrasound guidance using the sagittal approach in preterm infants of very low birth weight less than 1000 g proved superior to conventional approaches.

Shkolnik and McLone [(14)] who placed a VP shunt with the help of trans fontanelle ultrasound in seven hydrocephalic patients, one being a revision. In their practice, the proximal catheter tip was intended to be in front of the foramen Monro. Similarly, **Seçer *et al.*** [(15)] who reported that with transfontanellar ultrasound is a more minimally invasive method in infants with an open fontanelle.

There was a larger percentage of catheter tips in advantageous ventricle regions as a result of the ultrasonography approach (for example, the catheter tip within the ventricle, not penetrating the ventricular wall, surrounded by CSF, not touching the choroid plexus, and all holes in the ventricle). This might be as a result of the benefit that ultrasound offers in terms of understanding the trajectory and distance to the target spot [(16)].

Despite its link with significant complication rates and the fact that a suitable age for surgery has not yet been established, the insertion of a ventriculoperitoneal shunt is acknowledged as the current gold standard in the treatment of hydrocephalus [(17)].

Therefore, before the patient is discharged, the family must get education on how to recognise shunt failure early on and how to track the child's progress. In some situations, a home care nurse may be required to make frequent checks to make sure the VP shunt is working properly.

CONCLUSION

Using anterior fontanelle ultrasound guided technique during cranial end insertion of the ventriculoperitoneal shunt is safe and achieves outcomes better than conventional techniques. Additional effort to improve the rate of accurate location should focus on making the ultrasound as a standard in cranial end shunt insertion. Intraoperative ultrasound guidance is fast with almost no extra time and no extra cost.

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Author contribution: Authors contributed equally to the study.

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