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Validity of Ultrasound Guided Placement of Ventriculoperitoneal Shunts in Patients with Idiopathic Intracranial Hypertension

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Abstract

Background: Idiopathic intracranial hypertension is a pressure-related brain disorder strongly linked to obesity, with potential for progressive or sudden vision loss.

Aim of Study: To evaluate the accuracy and clinical validity of ultrasound-guided placement of ventriculoperitoneal (VP) shunts in patients with idiopathic intracranial hypertension.

Patients and Methods: This prospective research has been performed on 20 consecutive cases with the diagnosis of idiopathic intracranial hypertension, who were admitted to Neurosurgery Department, Alexandria University, Alexandria, Egypt.

Results: Magnetic resonance imaging (MRI) revealed that partial empty sella was the majority of frequent finding among cases. Preoperative cerebrospinal fluid (CSF) opening pressure, measured in the lateral decubitus position, ranged from 27 to 39 cmH_2O, with 50% of cases falling between 30.0 and 34.9 cmH_2O. Most surgeries proceeded smoothly; however, a few cases faced intraoperative difficulties, including challenging ventricular access or obesity-related issues that prolonged operative time. Postoperative imaging assessed ventricular catheter positioning using a grading system. Optimal placement (Grade 1), defined as the catheter tip ending in the ipsilateral frontal horn or third ventricle, was associated with better long-term function and was achieved in the majority of patients.

Conclusion: Ultrasound-guided VP shunt is an efficient and safe treatment for idiopathic intracranial hypertension. It improves catheter placement and most patients show clear postoperative improvement, though some may need revision.

Key Words: Ventriculoperitoneal shunt – Idiopathic intracranial hypertension – Ultrasound guidance – Catheter placement.

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Introduction

IDIOPATHIC intracranial hypertension is a clinical disorder of unknown etiology that is defined by signs and symptoms of raised intracranial pressure (ICP) in the absence of dilated ventricles, with normal cerebrospinal fluid (CSF) composition, and no other cause of raised ICP identified on neuroimaging **[1].**

Idiopathic intracranial hypertension has a strong association with obesity, with even moderate weight gain increasing the risk of developing the condition. In patients with IIH, weight gain often leads to symptom recurrence. Additionally, a higher body mass index (BMI) is linked to poorer visual outcomes. For every 10-unit increase in BMI, there is a 1.4-fold greater risk of developing severe visual loss. With the increasing prevalence of obesity, cases of IIH are rising among children and males. This suggests that obesity is likely the primary contributing factor for IIH, rather than age or sex **[2].**

Vision loss is the most significant complication of IIH and may be evident at the time of the initial assessment. Although it often develops gradually, it can also occur suddenly. Patients who experience rapid vision loss typically have a more severe disease course and a greater risk of permanent vision impairment. This can be caused by retinal vascular occlusion, ischemic optic neuropathy, or intraocular hemorrhage resulting from peripapillary subretinal neovascularization linked to chronic papilledema **[3].**

Magnetic resonance imaging along with magnetic resonance venography constitutes the diagnostic modality of choice for evaluating IIH. In patients with contraindications to MRI, such as those with pacemakers, metallic cranial clips, or metallic foreign bodies, contrast-enhanced computed tomography (CT) may be required as an alternative.

The addition of contrast enhancement improves diagnostic sensitivity, especially for detecting intracranial lesions. Furthermore, supplementary MR or CT venography is essential to exclude venous sinus occlusions, which can mimic or contribute to increased ICP **[4]**.

Cerebrospinal fluid diversion remains the standard neurosurgical approach for managing papilledema and vision loss in IIH... VPS has largely replaced LPS as the preferred technique, primarily due to its reduced risk of complications **[5]**.

Ultrasound guided VPS placement has been described as a reliable alternative to stereotactic navigation, offering the advantage of not requiring head fixation, preoperative planning, or registration **[6-8]**.

This research aimed to evaluate the accuracy and clinical validity of ultrasound-guided placement of ventriculoperitoneal shunts in cases with idiopathic intracranial hypertension.

Patients and Methods

This prospective research was carried out on 20 consecutive cases with the diagnosis of idiopathic intracranial hypertension, who have been admitted to Neurosurgery Department, Alexandria University, Alexandria, From January 2024 – January 2025.

Inclusion criteria: Patients aged ≥18 years, including males and females, patients with documented failure of medical treatment (i.e. ineffective or not tolerated), patients with a CSF opening pressure of 25 cmH_2O or more, measured via lumbar puncture in the lateral decubitus position, and Patients with previously failed lumboperitoneal shunt.

Exclusion criteria: Patients with good response to medical treatment, cases with a CSF opening pressure less than 25 cmH_2O, measured via lumbar puncture in lateral decubitus position, patients with documented dural venous sinus thrombosis on neuroimaging, and Patients who refused surgery.

Methods:

Patients underwent clinical evaluation including history of symptoms (e.g. headache, visual changes, tinnitus), neurological and ophthalmological exams, lumbar puncture to measure CSF pressure, routine labs, and neuroimaging (MRI/MRV or CT/CTA if MRI contraindicated). The case has been positioned supine with the head rotated to the contralateral side and supported on a horseshoe headrest. The neck and trunk were extended using a shoulder roll. The scalp and abdomen were marked, then both regions were aseptically prepared and draped. A skin incision was made over Kocher's point, followed by creation of a burr hole and opening of the dura. An abdominal incision was then made to access the peritoneal cavity, and a subcutaneous tunnel was created to pass the distal shunt catheter. Intraoperative real-time ultrasound guidance (BK Medical 5000) was used to aid accurate placement of the ventricular catheter. A bur hole probe with a sterile guiding channel was employed to direct the needle under ultrasound visualization toward the ipsilateral frontal horn, anterior to the foramen of Monro. Catheter insertion was confirmed both visually and by tactile feedback, avoiding contact with the choroid plexus. If malpositioning was noted, the catheter was repositioned accordingly. Once the proximal catheter was satisfactorily placed, the ultrasound probe was removed, the catheter was connected and trimmed to the burr hole reservoir. The distal catheter has been inserted into the peritoneal cavity, and the system was assembled. The surgical wounds were closed in layers, and the case has been awakened and transferred to the neurosurgical floor for postoperative care.

Postoperative assessment: Clinical evaluations, including neurological and ophthalmological examinations, were conducted both immediately after surgery and at three months postoperatively to assess patients' clinical outcomes Radiological assessments, including CT scans and plain X-rays of the head, chest, abdomen, and pelvis, were carried out after surgery and at 3 months' post-surgery to assess the integrity of the shunt components, especially the ventricular catheter and the adequacy of the shunt function.

Ethical consideration: The research has been approved by the Ethics Committee of the Faculty of Medicine, Alexandria University. Informed written consent has been attained from all patients. Participant confidentiality was strictly maintained, and data were used solely for research purposes. Patients had the right to withdraw at any time, and any unexpected risks were promptly reported to both participants and the ethics committee.

Statistical analysis:

Data were analyzed utilizing SPSS v26 (IBM, USA). Normality was assessed using the Shapiro-Wilks test and histograms. Quantitative data were presented as mean ± standard deviation (SD) for parametric variables and as median with interquartile range (IQR) for non-parametric ones. Categorical data were summarized as counts and percentages. Graphs were used for data visualization.

Results

This descriptive cross-sectional study was conducted on a total of 20 patients who underwent ultrasound guided ventricular shunting procedures for IIH. None of these patients had ventriculomegaly. The standard valve in all patients was Medtronic PS Medical CSF-Flow Control Valve (Burr Hole type, 16 mm, Medium Pressure). The cases' ages ranged from 24 to 45 years, with an average age of 34.8±6.48 years. All 20 (100%) patients were females. The body mass index (BMI) ranged from

25.3 to 35.4 kg/m^2, with an average of 30.1±2.7 kg/m^2.

The MRI findings in cases with IIH are summarized in Table (1), with partial empty sella being the most prevalent radiological feature.

Preoperative opening CSF pressure, measured in the lateral decubitus position, ranged from 27 to 39 cmH_2O. Notably, half of the patients (50%) had pressures between 30.0 and 34.9 cmH_2O. (Table 2).

The majority of the surgeries were standard procedures with minimal delays. However, a small subset of cases experienced intraoperative challenges, such as difficult ventricular access requiring multiple attempts or obesity that made the peritoneal incision difficult and prolonged the operative time. (Table 3).

After postoperative imaging, ventricular catheter placement was graded. Grade 1, with the tip in the ipsilateral frontal horn or third ventricle, was considered optimal due to better long-term function. Other positions may allow initial drainage but carry a higher risk of failure and revision. (Table 4).

Table (1): Preoperative MRI findings in studied patients.

MRI Finding	Patients (Number and Percentage)
Partial Empty Sella	16 (80.0%)
Flattening of the Posterior Aspect of the Globe	5 (25.0%)
Optic Hydrops (Optic Nerve Sheath Distension)	2 (10.0%)
Attenuated Transverse Sinus (Venous Sinus Narrowing)	4 (20.0%)

Table (2): Preoperative opening CSF pressures.

Opening CSF Pressure (cmH_2O)	Number of Patients
25-29.9	2 (10%)
30-34.9	10 (50%)
≥35.0	8 (40%)

Table (3): Operative Time and Number of Ventricular Tapping Attempts.

Surgery time from skin to skin	Patients (n %)
75-90 mins	16 (80%)
>90 mins	4 (20%)
Number of Attempts:	
1st Attempt	18 (90%)
2nd Attempt	2 (10%)

Table (4): Proposed grading system for the accuracy of ventricular catheter placement on initial postoperative cranial CT.

Placement grade based on termination of ventricular catheters	Patients (n %)
Grade I: - (Optimal position with the catheter tip within the ipsilateral frontal horn or third ventricle near foramen of Monro)	15 (75%)
Grade II: - (Suboptimal position, where the catheter tip is located in the contralateral frontal horn or lateral ventricle)	4 (20%)
Grade III: - (Malpositioned catheter, with the tip located within brain parenchyma or failure to reach the intraventricular space)	1(5%)

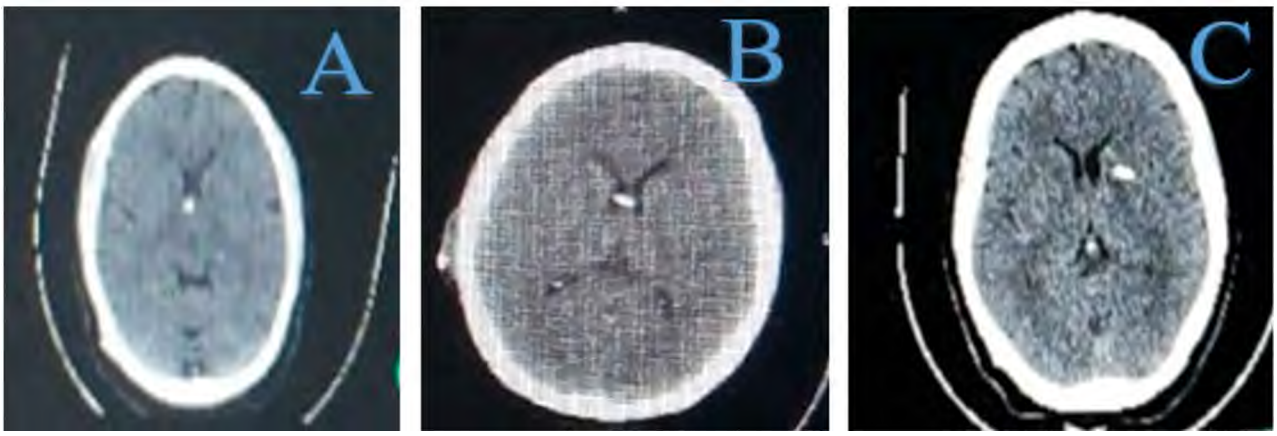


Fig. (1): (A) Grade 1, (B) Grade II and (C) Grade III.

Clinical and radiological outcomes:

Immediate postoperative period:

Nineteen patients (95%) reported marked relief from pressure-related symptoms such as tinnitus and blurred vision based on self-reports. One patient (5%) with headache, dizziness, and diplopia improved in the former two symptoms immediately, with gradual resolution of diplopia over two months. Of 20 patients with preoperative headaches, 17 (85%) experienced significant relief postoperatively, while 3 (15%) continued to have transient headaches managed medically. Fundus examination showed no immediate changes in all patients (100%), although subjective visual improvements were noted within three days. Radiologically, CT and plain X-rays confirmed proper shunt placement in 19 patients (95%) (Fig. 1.I). In one case (5%), the catheter tip was in brain parenchyma, but functioned initially. Symptoms later recurred, and revision surgery was performed at three months, with correct repositioning of the catheter.

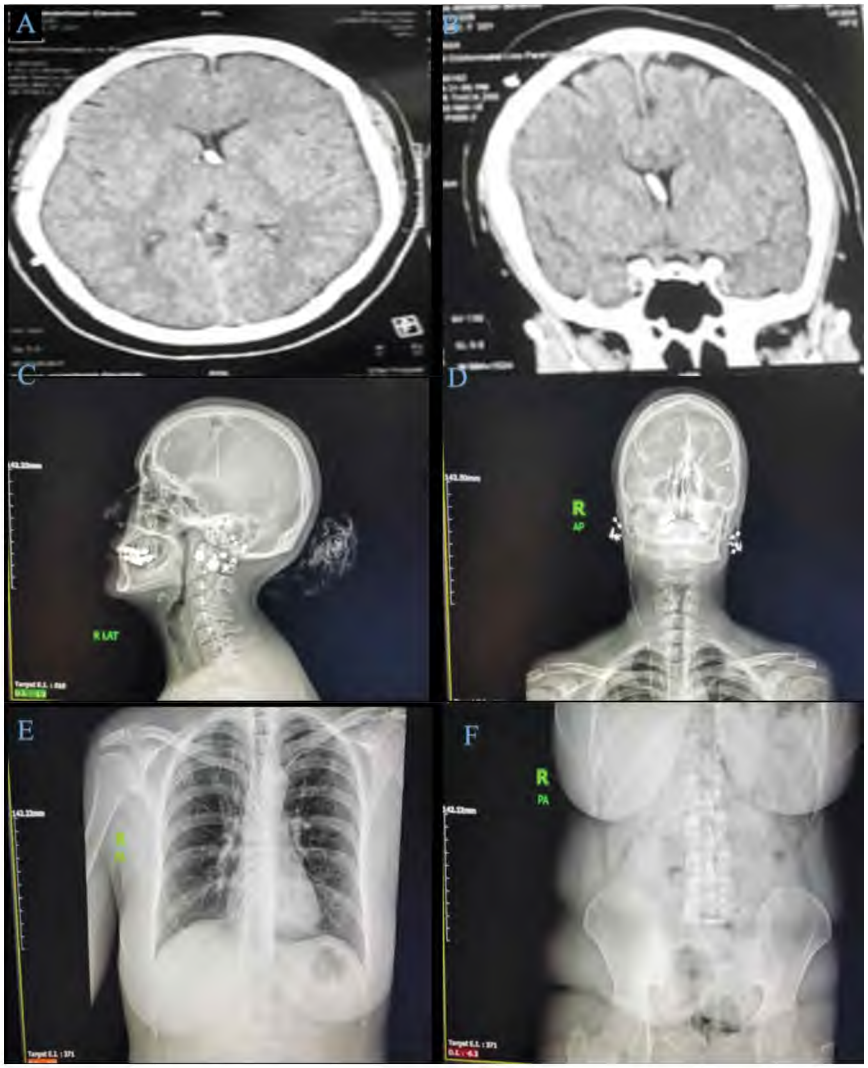


Fig. (2-I)

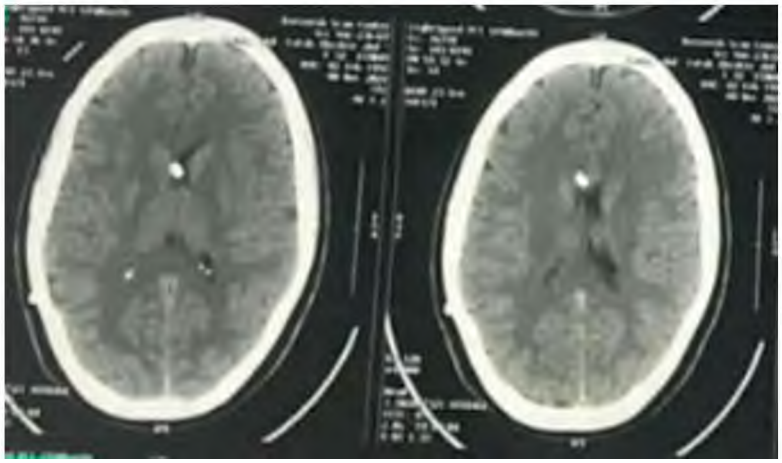
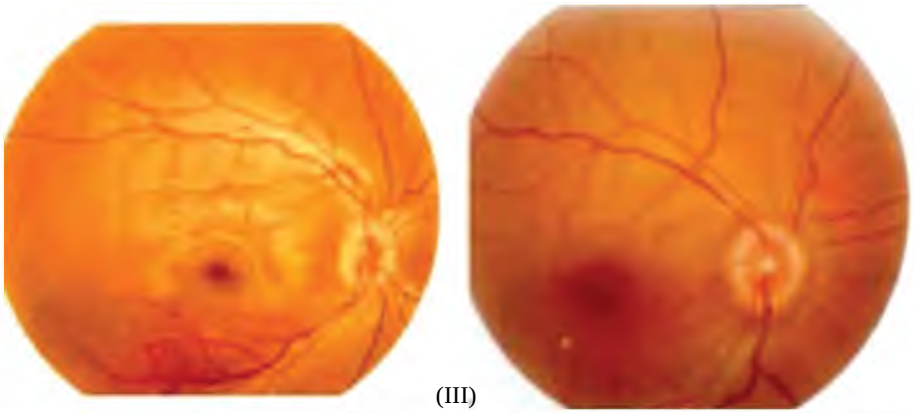


Fig. (2-II)



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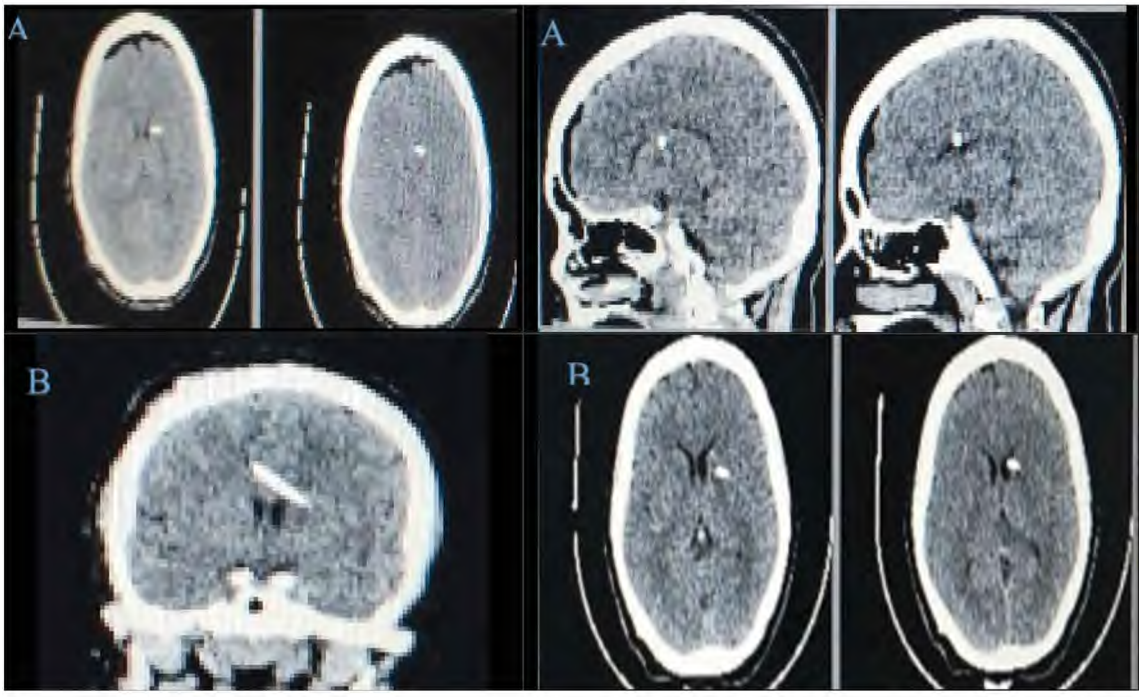
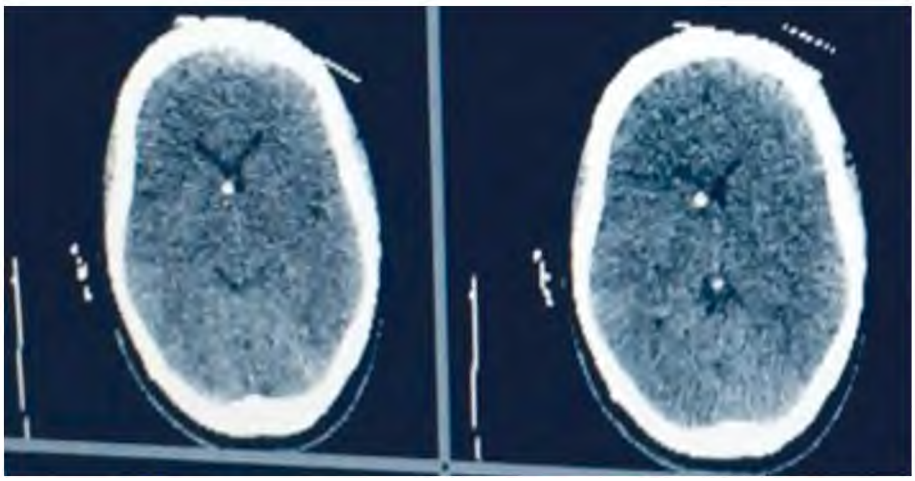


(V)



(XII)

Fig. (2): I: (A, B) Post-operative CT brain scans & (C, D, E, F) X-ray showing shunts in place. II: CT brain scan of a patient 3 months postoperative, showing that the ventricles have been successfully drained. III: Preoperative fundus (Left) showing mild venous engorgement of the optic disc, blurred margins, and obliteration of the cup. Late postoperative fundus (Right) showing resolution of papilledema. V: CT brain scans of a patient who required revision of the ventricular catheter. (A) Immediate postoperative (B) 3 months postoperative. VI: CT brain after revision of grade 3 ventricular catheter.

Three-month postoperative follow-up:

Eighteen patients (90%) had sustained symptomatic relief, and fundus improvement was seen in 17 (85%) (Figs. 1, II, III). Two patients (10%) required revision: One (5%) due to non-functioning ventricular catheter with persistent headache and papilledema (Figs. 1, V, VI). One (5%) due to distal catheter displacement causing abdominal symptoms. Radiological assessments showed stable shunt components in 18 patients (90%). Revisions were limited to ventricular and peritoneal components in one patient each.

Discussion

In the present prospective study, 20 consecutive patients with IIH underwent ultrasound-guided ventricular shunting procedures. The patients' ages ranged from 24 to 45 years (average 34.8±6.48 years). All 20 (100%) patients were females. The BMI ranged from 25.3 to 35.4 kg/m^2 (average 30.1 ±2.7 kg/m2). These findings are consistent with the known epidemiological profile of IIH, which predominantly affects obese women of reproductive age *[6]*. Momin et al. *[9]* carried out a single-centre retrospective study on 6 adult patients with IIH. They reported that the mean age at insertion was 34±10 years. All patients identified were female. Also, Esam et al. *[10]* conducted a study on 16 patients with IIH who were managed by stereotactic guided ventricular catheter placement; their sample included 14 women and 2 men, with an age range of 20 to 45 years and a mean age of 29.7 years.

Regarding MRI findings of the present study, partial empty Sella was found in 80% of patients, flattening of the posterior aspect of the globe in 25% of patients, attenuated transverse sinus in 20% of patients and optic hydrops in 10% of patients. These findings were supported with reports from other researchers. Barkatullah et al. *[11]* reported that several MRI-based findings, including empty sella, optic hydrops, flattening of the posterior aspect of the globe, and transverse sinus stenosis, have been found to be associated with IIH.

The results of the current study show that the majority of surgeries were conducted as standard procedures with minimal delays, highlighting the efficiency of the ultrasound-guided VPS placement method. The surgical time for most cases (80%) fell within the range of 75 to 90 minutes, indicating that the use of ultrasound guidance did not significantly increase the procedure time compared to traditional methods. This aligns with previous studies, which have suggested that while advanced imaging techniques, such as stereotactic navigation may add a small amount of time due to preparation and navigation, they ultimately lead to more precise catheter placement, potentially reducing the need for revisions or complications *[12]*. In the study by Yim et al. *[13]*, the mean operative time for neuronavigation-assisted ventriculoperitoneal shunt placement was 117.4±38.6 minutes, while the time for procedures without neuronavigation was 103.4± 43.0 minutes. Additionally, the mean operative time for VP shunt placement with intraoperative CT was 112.0±45.6 minutes.

Moreover, in terms of ventricular catheter placement, 90% of patients in this present study had successful catheter placement on the first attempt. This high success rate emphasizes the value of real-time ultrasound guidance in ensuring accurate shunt placement from the outset, reducing the need for multiple attempts or adjustments with minimal procedural delays. This finding is in line with the literature, which has shown that image-guided techniques like ultrasound can improve the precision of catheter insertion, which is crucial for the long-term success of the VP shunt. Accurate placement is particularly important in IIH cases, where improper placement can lead to complications such as obstruction or shunt failure *[14]*.

Regarding the accuracy of ventricular catheter placement in the present research on initial postoperative cranial CT, 75% of the cases had grade I, 20% had grade II and 5% had grade III catheter placement. These findings are consistent with those of Leu et al. *[14]*, who demonstrated the effectiveness of ultrasound-guided ventriculoperitoneal shunt placement, achieving a high rate of optimal catheter placement (93% grade 1 and 7% grade 2). This highlights the precision and dependability of ultrasound in guiding shunt placement, particularly in conditions like IIH, where accurate catheter positioning is critical. The ability to make real-time adjustments during the procedure further enhances this precision, potentially reducing complications and the need for revision surgeries. This makes ultrasound-guided VPS a safer and more effective option for IIH patients. In the study by Esam et al. *[10]*, which utilized stereotactic guidance for VPS placement in IIH patients, all patients underwent successful ventricular catheter insertion on the first attempt. This was confirmed through postoperative CT scans. Yim et al. *[13]* found that a grade 1 or 2 catheter placement was found in 96% of cases when intraoperative CT has been utilized. It is important to consider the accessibility and costs associated with intraoperative CT, which may not be applicable in all settings. Intraoperative CT is a high-cost imaging technique that requires specialized equipment and infrastructure, which can be a significant barrier to widespread use, especially in resource-limited settings. Wilson et al. *[15]* found that 89% of catheters placed using ultrasound guidance were positioned with high accuracy, emphasizing the effectiveness of this technique in achieving precise catheter placement.

Conclusion:

Ultrasound-guided ventriculoperitoneal shunt placement is an efficient and safe treatment for idiopathic intracranial hypertension. It allows real-time, accurate ventricular visualization, aiding optimal catheter placement, as confirmed in most postoperative imaging. Most patients showed significant symptom relief post-surgery, with sustained improvement, though a few required revisions due to catheter malposition or displacement.

Recommendations:

Based on this study's findings, ultrasound-guided ventriculoperitoneal shunt placement is a safe and effective option for idiopathic intracranial hypertension. Larger studies with extended follow-up are recommended to confirm long-term outcomes and detect late complications.

References

1- BIDOT S., SAINDANE A.M., PERAGALLO J.H., BRUCE B.B., NEWMAN N.J. and BIOUSSE V.: Brain Imaging in Idiopathic Intracranial Hypertension. J. Neuroophthalmol., Dec. 35 (4): 400-11, 2015. doi: 10.1097/WNO.0000000000000303. PMID: 26457687.

2- WALL M.: Idiopathic intracranial hypertension. Neurol. Clin., Aug. 28 (3): 593-617, 2010. doi: 10.1016/j.ncl.2010.03.003. PMID: 20637991; PMCID: PMC2908600.

3- THAMBISETTY M., LAVIN P.J., NEWMAN NJ. and BIOUSSE V.: Fulminant idiopathic intracranial hypertension. Neurology, Jan 16; 68 (3): 229-32, 2007. doi: 10.1212/01.wnl.0000251312.19452.ec. PMID: 17224579.

4- FRIEDMAN D.I. and JACOBSON D.M.: Diagnostic criteria for idiopathic intracranial hypertension. Neurology, Nov. 26; 59 (10): 1492-5, 2002. doi: 10.1212/01.wnl.0000029570.69134.1b. PMID: 12455560.

5- ELSHITANY, HESHAM ATEF, ABD ELHALEEM ALI and EHAB: Management of idiopathic intracranial hypertension with repeated lumboperitoneal shunt malfunction. Egyptian Journal of Neurosurgery, 34: 1-6, 2019.

6- FLANNERY A.M., DUHAIME A.C., TAMBER M.S. and KEMP J.: Pediatric Hydrocephalus Systematic Review and Evidence-Based Guidelines Task Force. Pediatric hydrocephalus: Systematic literature review and evidence-based guidelines. Part 3: Endoscopic computer-assisted electromagnetic navigation and ultrasonography as technical adjuvants for shunt placement. J. Neurosurg Pediatr., Nov. 14 (Suppl 1): 24-9, 2014. doi: 10.3171/2014.7.PEDS14323. PMID: 25988779.

7- TOSCANO S., LO FERMO S., REGGIO E., CHISARI C.G., PATTI F. and ZAPPIA M.: An update on idiopathic intracranial hypertension in adults: A look at pathophysiology, diagnostic approach and management. J. Neurol., Sep. 268 (9): 3249-3268, 2021. doi: 10.1007/s00415-020-09943-9. Epub 2020 May 27. PMID: 32462350.

8- MOMIN S.M.B., MULLINS S.R., CRAVEN C.L., WATKINS L. and TOMA A.K.: Ventriculo-atrial shunt in idiopathic intracranial hypertension. Acta Neurochir (Wien), Feb. 22; 166 (1): 98, 2024. doi: 10.1007/s00701-024-05985-4. PMID: 38386079; PMCID: PMC10884045.

9- MOMIN S.M.B., MULLINS S.R., CRAVEN C.L., WATKINS L. and TOMA A.K.: Ventriculo-atrial shunt in idiopathic intracranial hypertension. Acta Neurochir (Wien), Feb. 22; 166 (1): 98, 2024. doi: 10.1007/s00701-024-05985-4. PMID: 38386079; PMCID: PMC10884045.

10- ESAM A., MOKBEL M.D. and ESAM MOUNIR M.D.: Image-guided stereotactic ventricular catheter placement for refractory idiopathic intracranial hypertension: Accuracy and effectiveness. Med. J. Cairo Univ., 87 (September): 2775-82, 2019.

11- BARKATULLAH ARHEM F., LEISHANGTHEM LAKSHMI and MOSS HEATHER E.: MRI findings as markers of idiopathic intracranial hypertension. Current opinion in neurology, 34.1: 75-83, 2021.

12- SAMPATH R., WADHWA R., TAWFIK T., NANDA A. and GUTHIKONDA B.: Stereotactic placement of ventricular catheters: Does it affect proximal malfunction rates? Stereotact Funct Neurosurg., 90 (2): 97-103, 2012. doi: 10.1159/000333831. Epub 2012 Mar 2. PMID: 22398576.

13- YIM B., REID GOOCH M., DALFINO J.C., ADAMO M.A. and KENNING T.J.: Optimizing ventriculoperitoneal shunt placement in the treatment of idiopathic intracranial hypertension: An analysis of neuroendoscopy, frameless stereotaxy, and intraoperative CT. Neurosurg Focus, Mar. 40 (3): E12, 2016. doi: 10.3171/2015.12.FOCUS15583. PMID: 26926052.

14- LEU S., KAMENOVA M., MARIANI L. and SOLEMAN J.: Ultrasound-Guided Insertion of the Ventricular Catheter in Ventriculoperitoneal Shunt Surgery: Evaluation of Accuracy and Feasibility in a Prospective Cohort. J. Neurol Surg A Cent Eur. Neurosurg., Jan. 82 (1): 9-17, 2021. doi: 10.1055/s-0040-1714388. Epub 2020 Sep 23. PMID: 32968996.

15- WILSON T.J., STETLER W.R. Jr., AL-HOLOU W.N. and SULLIVAN S.E.: Comparison of the accuracy of ventricular catheter placement using freehand placement, ultrasonic guidance, and stereotactic neuronavigation. J. Neurosurg., Jul. 119 (1): 66-70, 2013. doi: 10.3171/2012.11.JNS111384. Epub 2013 Jan 18. PMID: 23330995.

صلاحية استخدام التوجيه بالموجات فوق الصوتية في زرع التحويلة البطينية الصفاقية لمرضى ارتفاع الضغط داخل الجمجمة مجهول السبب

في هذه الدراسة تم تقييم فاعلية ودقة استخدام التوجيه بالموجات فوق الصوتية أثناء زرع التحويلة البطينية الصفاقية في مرضى ارتفاع الضغط داخل الجمجمة مجهول السبب. شملت الدراسة ٢٠ مريضًا، جميعهم من الإناث، يعانون من أعراض الضغط المرتفع داخل الجمجمة، وتم توجيه إدخال القسطرة البطينية باستخدام جهاز موجات فوق صوتية أثناء الجراحة. أظهرت النتائج تحسنًا سريريًا ملحوظًا في أغلب الحالات، مع وضع مثالي للقسطرة في غالبية المرضى حسب تقييم الأشعة المقطعية بعد العملية. أوضحت الدراسة أن هذه الطريقة آمنة، دقيقة، وقابلة للتكرار، وتوفر بديلاً فعّالًا للوسائل الملاحية المكلفة، مع نسبة مراجعة جراحية منخفضة.