Research Article

Image Guided Ventriculoperitoneal Shunt Vs. Standard Revision of Lumboperitoneal Shunt For Management of Failed Lumboperitoneal Shunt in Idiopathic Intracranial Hypertension Patients

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Abstract

Background: Idiopathic intracranial hypertension may require surgical cerebrospinal fluid diversion, with image-guided ventriculoperitoneal shunting offering a potentially more reliable option. **Objective:** To prospectively compare the clinical and surgical outcomes of image-guided ventriculoperitoneal shunt insertion versus standard lumboperitoneal shunt revision in patients with failed lumboperitoneal shunts due to idiopathic intracranial hypertension. The study sought to evaluate differences in symptom improvement, visual outcomes, shunt-related complications, and mechanical failure rates between both surgical strategies. Ultimately, this work aimed to determine the more reliable and durable cerebrospinal fluid diversion procedure in this patient population. **Methods:** This prospective randomized controlled study was conducted at the Department of Neurosurgery, Kasr Al-Ainy School of Medicine, Cairo University, over 2 years starting in February 2024. It included 42 patients with idiopathic intracranial hypertension and failed previous lumboperitoneal shunts, confirmed clinically and/or radiologically. Patients were randomized equally into two groups: 21 underwent image-guided ventriculoperitoneal shunt insertion and 21 underwent standard lumboperitoneal shunt revision. **Results:** Image-guided ventriculoperitoneal shunting showed better numerical outcomes than lumboperitoneal shunt revision, with higher symptom improvement (85.71% vs. 66.67%) and lower shunt obstruction (4.76% vs. 28.57%) and visual deterioration (4.76% vs. 33.33%); however, these differences were not statistically significant. **Conclusion:** Image-guided ventriculoperitoneal shunting may provide more reliable clinical improvement and lower mechanical failure than standard lumboperitoneal shunt revision in patients with failed lumboperitoneal shunts due to idiopathic intracranial hypertension.

Keywords: Idiopathic intracranial hypertension, Ventriculoperitoneal shunt, Lumboperitoneal shunt, Shunt failure, Image-guided surgery, Neuronavigation, Shunt revision, Cerebrospinal fluid diversion.

Introduction

Idiopathic intracranial hypertension (IIH), formerly known as pseudotumor cerebri, is a disorder characterized by elevated intracranial pressure without an identifiable underlying cause. It commonly presents with headache, papilledema, transient visual disturbances, pulsatile tinnitus, and, in severe cases, progressive visual loss. Elevated cerebrospinal fluid opening pressure is a key diagnostic finding [1]. The primary goals of IIH management are preservation of vision and relief of symptoms. Initial treatment generally includes weight reduction, medical therapy with carbonic anhydrase inhibitors, and close ophthalmological monitoring [2]. In patients with refractory disease or progressive visual deterioration, surgical cerebrospinal fluid diversion may be required. Ventriculoperitoneal (VP) and lumboperitoneal (LP) shunts are among the most commonly used surgical options [3]. Although LP shunts have historically been favored because of their relative technical simplicity, they are associated with relatively high rates of failure, complications, and subsequent revision. VP shunts may provide more durable cerebrospinal fluid diversion; however, their placement in patients with IIH can be technically challenging because these patients frequently have small or slit-like ventricles [4]. Management of failed LP shunts remains an important surgical challenge. Revision options include standard revision or replacement of the LP shunt and conversion to a VP shunt. The use of image-guided techniques may facilitate accurate ventricular catheter placement in patients with small ventricles and may improve the safety and reliability of VP shunt insertion [5-6]. The aim of this study was to prospectively compare the clinical and surgical outcomes of image-guided ventriculoperitoneal shunt insertion versus standard lumboperitoneal shunt revision in patients with failed lumboperitoneal shunts due to idiopathic intracranial hypertension. The study sought to evaluate differences in symptom improvement, visual outcomes, shunt-related complications, and mechanical failure rates between both surgical strategies. Ultimately, this work aimed to determine the more reliable and durable cerebrospinal fluid diversion procedure in this patient population.

Patients And Methods

This prospective randomized controlled comparative study was conducted at the Department of Neurosurgery, Kasr Al-Ainy School of Medicine, Cairo University, over a period of 2 years starting in February 2024. The study included 42 patients with an established diagnosis of idiopathic intracranial hypertension (IIH) who had previously undergone lumboperitoneal (LP) shunt insertion and subsequently developed clinical and/or radiological evidence of shunt failure. Patients were randomly allocated into two equal groups: Group A included 21 patients who underwent image-guided ventriculoperitoneal (VP) shunt insertion, while Group B included 21 patients who underwent standard LP shunt revision.

Inclusion Criteria

Patients were included if they had an established diagnosis of IIH based on the Modified Dandy Criteria, previous LP shunt insertion, clinical and/or radiological evidence of LP shunt failure, persistent or recurrent symptoms of raised intracranial pressure, and willingness to provide informed consent. Patients of all ages were eligible for inclusion.

Exclusion Criteria

Patients were excluded if they had secondary causes of intracranial hypertension, active systemic or central nervous system infection, coagulopathy, previous VP shunt insertion, IIH without previous surgical intervention, or failed LP shunts without an established diagnosis of IIH.

Ethical Considerations

The study was approved by the Research and Ethical Committees of the Faculty of Medicine, Cairo University. All participants were informed about the purpose of the study, and written informed consent was obtained before enrollment.

Criteria For Assessment Of LP Shunt Malfunction

LP shunt malfunction was diagnosed based on clinical, radiological, or mechanical evidence of shunt failure. Findings suggestive of malfunction included progressive visual deterioration, recurrence of symptoms of raised intracranial pressure, radiological evidence of shunt dysfunction, cerebrospinal fluid leakage or wound collection, catheter obstruction or migration, and complications related to overdrainage.

Preoperative Evaluation

All patients underwent standardized preoperative clinical, neurological, ophthalmological, laboratory, and radiological assessment. Headache severity was assessed using the Numerical Rating Scale (NRS), and a complete neurological examination was performed. Ophthalmological assessment included best-corrected visual acuity using the Snellen chart, automated perimetry, optical coherence tomography, and fundoscopic examination with Frisén grading of papilledema. Radiological evaluation included brain MRI with MR venography and assessment of ventricular size. In Group A, thin-slice brain CT was additionally performed for Neuronavigation planning, while abdominal and lumbosacral imaging was obtained when required to assess the existing LP shunt.

Surgical Technique

All procedures were performed under standardized perioperative conditions with appropriate pre-anesthetic evaluation, prophylactic antibiotics, and sterile preparation of the operative field. The surgical procedure was performed according to group allocation, with image-guided VP shunt insertion in Group A and standard revision of the existing LP shunt in Group B.

Group A: Image-Guided Ventriculo-Peritoneal (Vp) Shunt Insertion

Patients in Group A underwent VP shunt insertion using a frameless stereotactic Neuronavigation system. The patient was positioned supine, and Neuronavigation registration was performed using preoperative thin-slice CT images. Kocher's point was used as the ventricular entry site, and the ventricular catheter was advanced along the planned Neuronavigation-guided trajectory. Free cerebrospinal fluid flow was confirmed, and the catheter was connected to the valve and distal peritoneal catheter. The number of ventricular catheter passes was documented. Postoperative brain CT was performed within 24 hours to assess the final position of the ventricular catheter.

Group B: Standard Lp Shunt Revision

Patients in Group B underwent standard surgical revision of the existing LP shunt. The patient was placed in the lateral decubitus position, and the previous lumbar incision was reopened to expose the shunt components. The cause of malfunction, including obstruction, migration, disconnection, or kinking, was identified intraoperative. The

malfunctioning proximal and/or distal catheter was revised, repositioned, or replaced as required. Free cerebrospinal fluid flow and appropriate distal peritoneal placement were confirmed before wound closure.

Postoperative Management

All patients received routine postoperative monitoring and antibiotic prophylaxis and underwent clinical evaluation before discharge. Follow-up was scheduled at 1, 3, and 6 months after surgery. During follow-up, patients were assessed for improvement of symptoms, visual status, shunt function, mechanical failure, and postoperative complications.

Outcome Measures

The main outcomes were clinical improvement, visual outcome, shunt-related complications, mechanical failure, and revision-free shunt survival. Headache severity was assessed using the NRS, while visual outcome was evaluated by visual acuity, automated perimetry, and Frisén grading of papilledema. Shunt failure was defined by recurrent symptoms of raised intracranial pressure with confirmed shunt dysfunction, obstruction, infection, overdrainage, or mechanical failure. Operative duration and postoperative complications were also compared between both groups during the 6-month follow-up period.

Statistical Analysis

Statistical analysis was performed using SPSS version 27 (IBM Inc., Chicago, IL, USA). Normality of quantitative data was assessed using the Shapiro-Wilk test and histograms. Quantitative parametric variables were expressed as mean ± standard deviation and compared between the two groups using the unpaired Student's t-test. Categorical variables were expressed as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test, as appropriate. A two-tailed P value <0.05 was considered statistically significant.

Results

In this study, 49 patients were assessed for eligibility; four patients did not meet the criteria, and three patients refused to participate in the study. The remaining 42 patients were randomly allocated into two equal groups (21 patients in each). All allocated patients were followed up and analyzed statistically, figure (1).

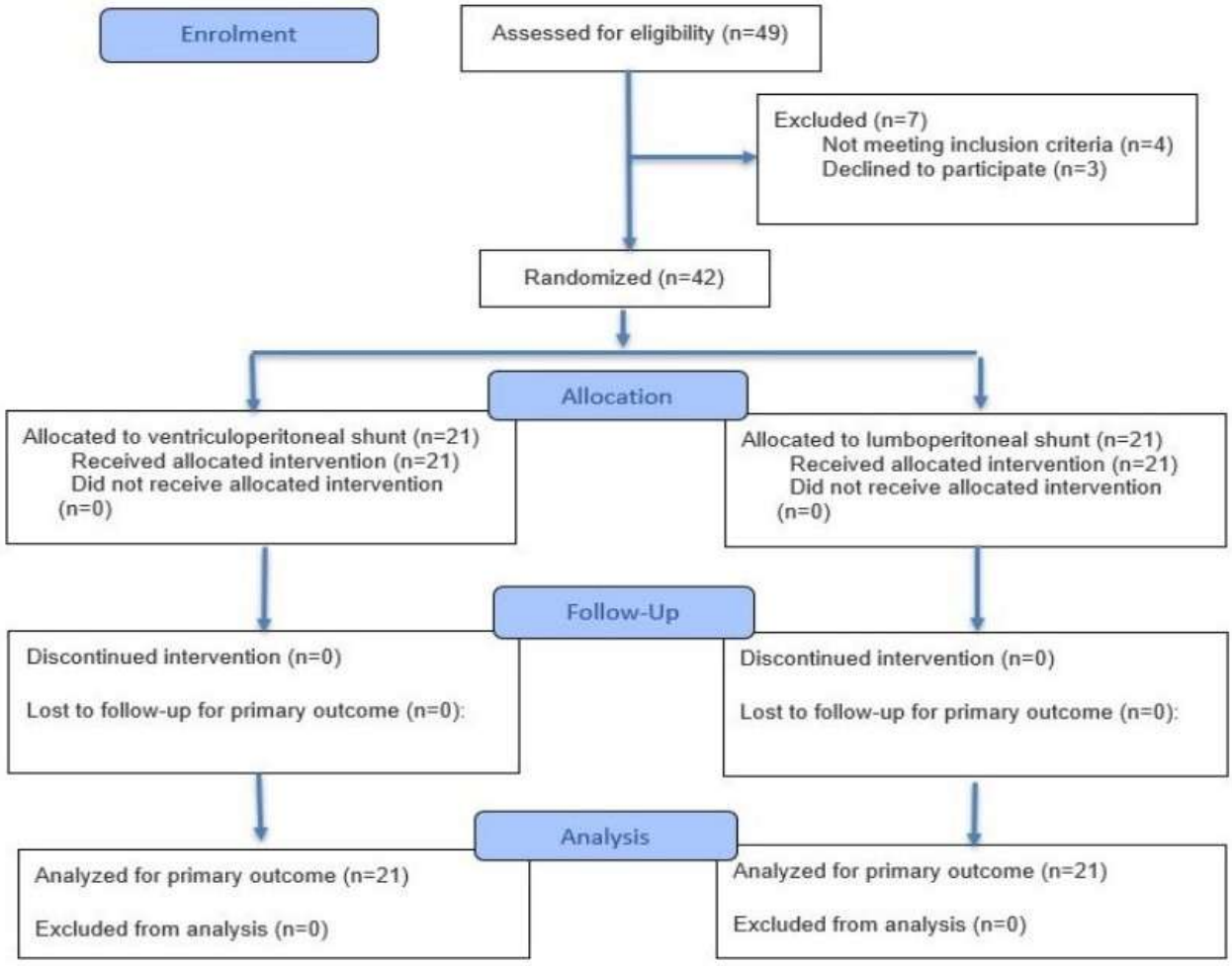

Figure 1: CONSORT flowchart of the enrolled patients

In the VP group, age ranged from 7 to 60 years, with a mean of 30.86 ± 13.34 years, compared with 23 to 53 years and a mean of 35.05 ± 7.75 years in LP group. The VP group included 4 males' 19.05% and 17 females 80.95%, whereas LP group included 2 males' 9.52% and 19 females 90.48%. There were no statistically significant differences between the two groups regarding age or sex. Regarding clinical condition, 18 patients 85.71% in VP group showed symptom improvement, while 1 patient 4.76% had visual deterioration, 1(4.76%) developed infection, and 1(4.76%) developed an abdominal collection. In LP group, 14 patients 66.67% showed symptom improvement and 7(33.33%) had visual deterioration, with no cases of infection or abdominal collection. Regarding fundus follow-up, 17 patients 80.95% in VP group showed improvement, 3(14.29%) remained stationary, and 1(4.76%) deteriorated, compared with 14 patients 66.67% showing improvement and 7(33.33%) showing deterioration in LP group, with no stationary cases. Clinical condition and fundus improvement were not statistically significantly different between the two groups. Regarding technical difficulty, 17 patients 80.95% in VP group had no technical difficulties, while difficult proximal catheter insertion occurred in 1 patient 4.76% and navigation inaccuracy greater than 2 mm occurred in 3 patients 14.28%. In LP group, 16 patients 76.19% had no technical difficulties, while difficult distal catheter insertion occurred in 3 patients 14.29% and difficult proximal catheter insertion occurred in 2 patients 9.52%, there was no statistically significant difference in technical difficulty between the two groups. In VP group, 18 patients 85.71% had no complications. One patient 4.76% developed an infection that was successfully managed with intravenous antibiotics, 1 patient 4.76% developed distal shunt obstruction after 1 month and underwent distal shunt revision, and 1 patient 4.76% developed visual loss. No cases of distal shunt slippage were reported. In LP group, 14 patients 66.67% had no complications, while 6 patients 28.57% developed shunt obstruction and 1 patient 4.76% developed distal shunt slippage; these 7 patients 33.33% also showed visual deterioration and were managed by distal shunt revision. No cases of shunt infection or visual loss were reported in the LP group. The overall complication rate was not statistically significantly different between the two groups.

Case presentation

Case 1 (VPS group)

- Age: 50 years
- Sex: Female
- Diagnosis: Idiopathic intracranial hypertension
- Past surgical history: Lumboperitoneal (LP) shunt insertion 1 year prior
- Medical history: Hypertension (controlled on ACE inhibitor), Chronic depression (On fluoxetine)

Clinical Presentation (Preoperative)

- History of IIH diagnosed 5 years earlier
- Initial symptomatic improvement after LP shunt insertion in 2024
- Recurrence of symptoms 3 months prior to admission in 2025

Symptoms

- Progressive diffuse headache
- blurring of vision

Ophthalmological Findings

Bilateral papilledema GII-GIII

- Bilateral visual field defects
- Clinical impression: Recurrence of raised intracranial pressure secondary to suspected LP shunt malfunction

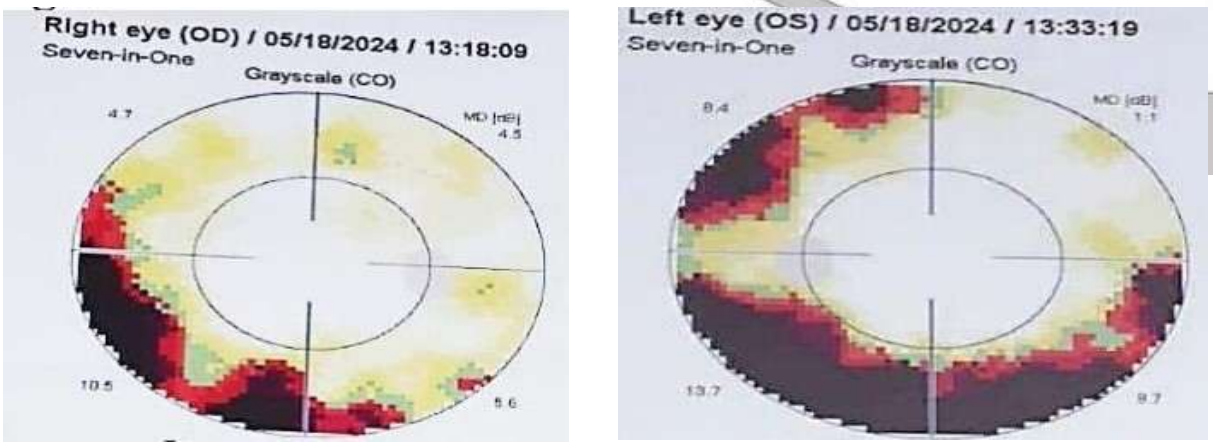

Figure 2: Right and left eye visual field report showing visual field defects corresponding to optic nerve affection before first surgery of lumboperitoneal shunt (2024)

Figure 3: Right and left eye color fundus photograph showing early papilledema before ventriculoperitoneal shunt (2025)

Radiological Findings (Preoperative)

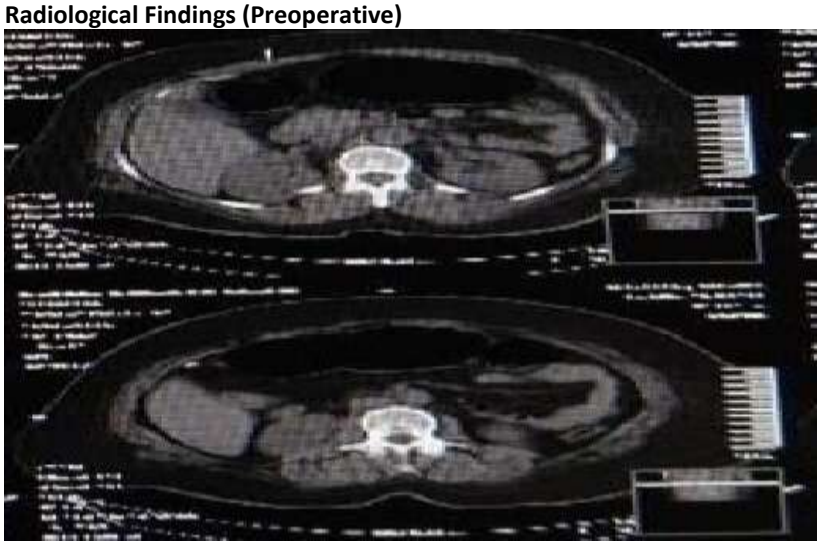

Figure 4: CT abdomen and pelvis

Distal catheter visualized within the peritoneal cavity o No evidence of distal migration Lumbosacral spine imaging (Figure 5)

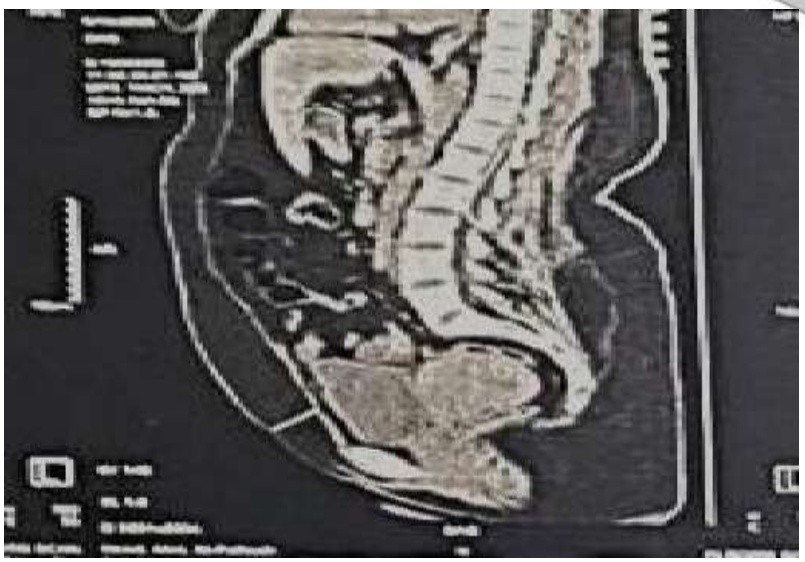

Figure 5: Preoperative CT lumbosacral spine showing intrathecal proximal shunt position (sagittal)

Proximal catheter visualized within the lumbar intrathecal space
No disconnection detected despite radiologically intact shunt system:

Clinical Suspicion Of Functional Obstruction

Surgical Intervention
Conversion to image-guided ventriculoperitoneal (VP) shunt
Neuronavigation used for accurate ventricular catheter placement
Successful insertion with confirmed cerebrospinal fluid flow
No intraoperative complications
Postoperative Outcome
Imaging (post-operative):
Ct brain

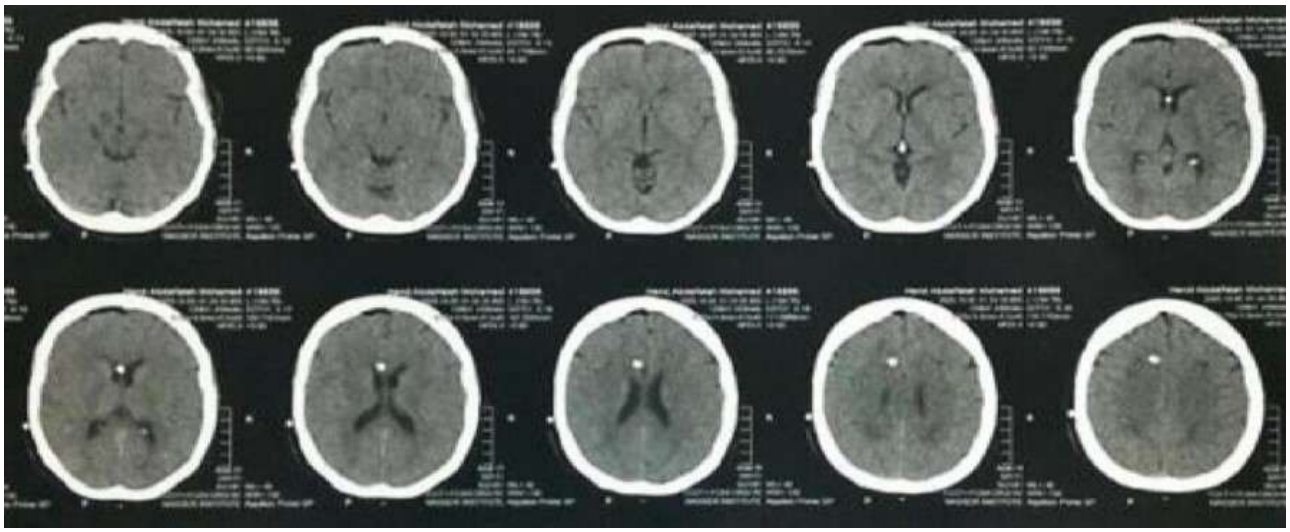

Figure 6: Post-operative CT brain showing intraventricular proximal shunt (axial)

Clinical Improvement
Marked reduction in headache intensity
Significant improvement in visual parameters
Stable neurological examination
Fundoscopic and visual field Improvement

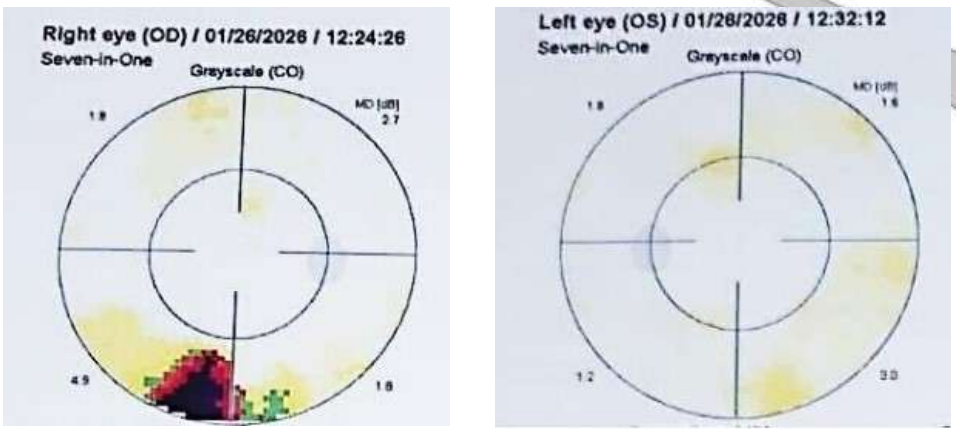

Figure 7: Post-operative visual field report of right and left eye showing improvement of visual field affection
Regression of papilledema
Improved visual field deficit

Overall Outcome:
Uneventful postoperative course
Discharged in improved clinical condition
Scheduled for follow-up
Case Significance
This case illustrates:
Functional failure of LP shunt despite radiologically intact catheter positioning
Recurrence of papilledema and symptomatic intracranial hypertension
Successful symptomatic and ophthalmological improvement following conversion to image-guided VP shunting
The clinical advantage of ventricular diversion in patients with failed LP shunts

Case 2 (VPS group)
Patient Profile
Age: 28 years
Sex: Male
Medical history: Medically free
Diagnosis: Idiopathic (benign) intracranial hypertension for 12 years

Surgical History
2012: Primary thecoperitoneal (lumboperitoneal) shunt insertion
December 2023: Distal shunt migration within the abdomen followed by shunt revision
Persistent malfunction necessitating another revision in July 2024
Continued shunt failure despite multiple revisions

Clinical Presentation (Current Admission)
Complaints:
Persistent headache
Dizziness
Lumbar wound collection (figure 8)

Figure 8: Lumbar wound subcutaneous collection

Clinical Examination
General Neurological Examination
Conscious and oriented
No focal motor or sensory deficits
Ophthalmological Findings
Bilateral no perception of light
Bilateral optic atrophy
No active papilledema
Additional Findings
Right-sided sensorineural hearing loss
The presence of bilateral optic atrophy reflects long-standing intracranial hypertension with irreversible optic nerve damage.
Radiological Findings
Xray abdomen, pelvis and LSS (figures 9-10)

Figure 9: Preoperative Xray lumbosacral spine (lateral) showing slipped proximal end of LP shunt, coiled subcutaneously

Figure 10: Preoperative CT abdomen and pelvis showing intraperitoneal distal shunt position (axial)
Imaging demonstrated slipped thecoperitoneal shunt

Evidence of Proximal catheter migration
Findings consistent with recurrent mechanical shunt malfunction

Surgical Management
Removal of the malfunctioning thecoperitoneal shunt
Insertion of navigator-guided ventriculoperitoneal shunt
Neuronavigation utilized for accurate ventricular catheter placement
Distal catheter positioned intraperitoneally
No intraoperative complications reported
Postoperative Outcome
Imaging
CT Brain (Figures 11-12)

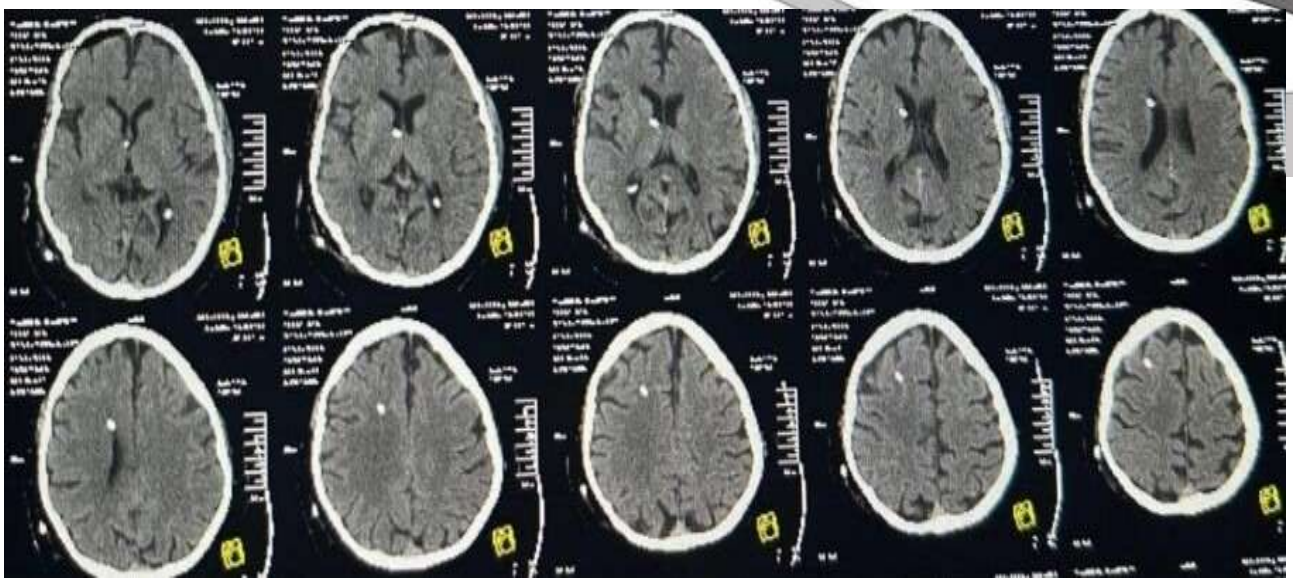

Figure 11: Post-operative CT brain showing intraventricular proximal shunt position (axial)

Figure 12: Post-operative Xray abdomen and pelvis (AP) showing intraperitoneal distal shunt position
Complete resolution of lumbar wound collection

Significant improvement in headache
Stable postoperative neurological examination
No new deficits observed
Visual function remained unchanged due to established bilateral optic atrophy.

Discussion

The two study groups were comparable regarding baseline demographic characteristics. The mean age was 30.86 ± 13.34 years in the VP group and 35.05 ± 7.75 years in the LP group, with no statistically significant difference between the groups (P = 0.220). Female predominance was observed in both groups, accounting for 80.95% of the VP group and 90.48% of the LP group, with no significant difference in sex distribution (P = 0.663). This baseline comparability reduces the potential effect of age and sex on subsequent clinical and surgical outcome comparisons. The marked female predominance is consistent with Durcan et al. [7], who described IIH as predominantly affecting women, particularly those of childbearing age. Clinical improvement was more frequent following image-guided VP shunting, with symptom improvement observed in 85.71% of patients compared with 66.67% following LP shunt revision. Visual deterioration was also less frequent in the VP group (4.76% versus 33.33%). Similarly, fundus improvement was observed in 80.95% of VP patients compared with 66.67% of LP patients, while fundus deterioration occurred in only 4.76% versus 33.33%, respectively. Although these differences did not reach statistical significance, the findings showed a consistent clinical trend in favor of image-guided VP shunting. These findings are consistent with Abubaker et al. [3], who reported symptomatic improvement in approximately 80–90% of VP-shunted patients with IIH. Elshitany and Abd ELHaleem Ali [8] also reported favorable symptomatic and visual outcomes following conversion to ventriculoperitoneal shunting in patients with repeated lumboperitoneal shunt malfunction. Similarly, Satti et al. [9] reported pooled symptomatic improvement of approximately 70–80% following CSF diversion, while emphasizing the greater mechanical failure burden associated with LP shunts. Regarding visual outcome, Banta and Farri**s** [12] demonstrated effective visual stabilization following CSF diversion, while Salih et al. [13] reported visual stabilization rates of approximately 70–85%

with both shunt types. In contrast, Andreão et al. [10] found no statistically significant difference in visual outcomes between LP and VP systems in their meta-analysis. Therefore, although the present study demonstrated a clear numerical advantage for VP shunting, the absence of statistical significance is consistent with the variability reported in previous studies. Technical difficulties were relatively infrequent in both groups. No technical difficulty was encountered in 80.95% of VP procedures and 76.19% of LP revisions. In the VP group, difficult proximal catheter insertion occurred in 4.76% of cases, while Neuronavigation deviation greater than 2 mm was recorded in 14.28%. In the LP group, difficult distal and proximal catheter insertion occurred in 14.29% and 9.52% of patients, respectively. No statistically significant difference was found between the groups. The high technical accuracy observed with image-guided VP placement agrees with Spennato et al. [5] and Wilson et al. [14], who reported high accuracy with navigation-assisted ventricular catheter insertion and reduced rates of proximal catheter malposition or failure. Azad et al. [11] also emphasized the importance of technical precision in ventricular catheter placement, particularly in patients with the small ventricles commonly encountered in IIH. These findings support the use of Neuronavigation as a means of overcoming the technical difficulty associated with ventricular cannulation in this patient population. The pattern of postoperative complications differed between the two surgical strategies. In the VP group, 85.71% of patients remained complication-free compared with 66.67% in the LP group. Shunt obstruction occurred in only 4.76% of VP patients compared with 28.57% of LP patients, while distal catheter slippage occurred exclusively in the LP group (4.76%). Visual deterioration was also markedly less frequent following VP shunting (4.76% versus 33.33%). The overall difference in complication rates, however, did not reach statistical significance. The higher mechanical failure observed following LP revision is consistent with Menger et al. [4], who identified obstruction and catheter migration as important causes of LP shunt failure. Elshitany and Abd ELHaleem Ali [8] also reported recurrent LP shunt malfunction requiring further surgical management in patients with idiopathic intracranial hypertension. Satti et al. [9] similarly reported high revision rates for LP shunts, supporting the greater mechanical vulnerability of this diversion pathway. The findings also agree with Andreão et al. [10], whose meta-analysis found broadly comparable overall complication rates between LP and VP shunts but highlighted a greater tendency toward mechanical complications, particularly obstruction and catheter migration, with LP systems. Azad et al. [11] likewise reported relatively similar overall failure rates between the two procedures, suggesting that the principal difference may lie in the type rather than simply the frequency of complications.

Conclusion

Both surgical approaches improved clinical outcomes in patients with failed lumboperitoneal shunts due to idiopathic intracranial hypertension. Image-guided ventriculoperitoneal shunting showed numerically better symptomatic and visual outcomes and fewer mechanical complications; however, these differences did not reach statistical significance.

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