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The Incidence Rate of Complications among Patients of Benign Intracranial Hypertension after Lumbo-Peritoneal Shunt Procedure Operation

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Abstract

Background: Lumboperitoneal (LP) shunts have been used to manage benign intracranial hypertension (BIH) for an extended period. While they may swiftly and effectively alleviate symptoms, their application is accompanied by potential complications. **Objectives:** This research aimed to retrospectively analyze the difficulties and complications related to LP shunt implantation. **Methods:** We conducted a retrospective analysis of the records of 47 patients who had LP shunt placement for the treatment of BIH at our hospital throughout the research period. A thorough history and physical examination were conducted in every case. All patients were asked about age, gender, body mass index, neurological history, and oral contraceptive usage. Post-operative complications, clinical and ophthalmological follow-up occurred at 1, 3, and 6 months post-op. **Results:** Patients were mostly women (93.6%). The mean age of the patients was 35, and 80.9 percent had BMIs exceeding 25. Many female patients (40.9%) used oral contraceptives. Nearly all patients (93.6%) reported decreased vision, and 87.2% suffered headaches. The most common issue was shunt obstruction (51%), followed by low tension headaches (63.8%). The peritoneal side (10.6%) had higher shunt slippage than the thecal (2.1%). Superficial infections and radiculopathy affected 10.6% of patients, whereas CNS infections, arachnoiditis, and shunt failure affected just 2.1%. Five patients (10.6%) had Chiari malformation, and 60% had syringomyelia. **Conclusion:** Using LP shunts to treat BIH seems to be a method devoid of major risks despite the high revision rates. At the same time, more severe complications such as CNS infections, arachnoiditis, and shunt failure were less common.

Keywords

Benign Intracranial Hypertension, Lumbo-Peritoneal Shunt, Headache,

Shunt Obstruction

1. Introduction

Elevated intracranial pressure (ICP) without visible structural abnormalities or signs of aberrant cerebrospinal fluid (CSF) flow is the hallmark of benign intracranial hypertension (BIH). Headache, blurred vision, tinnitus, diplopia, papilledema, and sometimes, sixth cranial nerve palsy are symptoms and indications essential for diagnosing ICP [1] [2].

Patients who do not respond to the best medical treatment or experience disease progression are eligible for surgical procedures; otherwise, medical treatment remains the mainstay of BIH care [3].

Lumbar peritoneal shunt (LPS) is the surgical procedure often used to divert CSF. LP shunts offer several advantages. Primarily, the use of LP shunts enables the surgeon to circumvent the need to access ventricular cavities inside the brain parenchyma, hence possibly diminishing the danger of brain harm, including cortical venous injury or hemorrhage, associated with catheter implantation. LP shunts are further shown to correlate with a reduced infection incidence [4]. This is particularly pertinent in BIH: several patients have tiny ventricles, complicating the implantation of a VP shunt [5].

LP shunts have several drawbacks [6], so this retrospective study examined patients who have undergone surgery to divert CSF by LP shunts to assess management, outcomes, and complications.

2. Patient and Methods

2.1. Study Design and Participants

In this retrospective study, 47 patients with BIH underwent LP shunt insertion. All patients were treated at the Neurosurgery department, Faculty of Medicine, Beni-Suef University Hospital, in Beni-Suef University, for 3 years from January 2021 to January 2024. Patients were allocated in the current research according to the following criteria:

Inclusion criteria:

- All patients with benign Intracranial Hypertension: the Modified Dandy criteria were used to diagnose BIH. The following criteria must be met: 1) papilledema or the presence of abducens palsy; 2) a neurological examination free of abnormalities affecting the cranial nerves; 3) the absence of hydrocephalus, masses, structural lesions, or abnormal meningeal enhancement on MRI or CT with contrast; 4) the composition of cerebrospinal fluid is normal; and 5) the adult patient must have an elevated lumbar puncture opening pressure (≥ 250 mmH20) [7].
- Age above 18 y

Exclusion criteria:

- Patients complaining of secondary Intracranial Hypertension due to sinus thrombosis.
- Conditions other than BIH are managed with LP shunts.
- Non-primary positioned LP shunts.
- Pediatric patients.
- Pregnancy.

2.2. Ethical Considerations

The study was approved by the ethical committee of the Faculty of Medicine at Beni-Suef University. The participant's data were recorded and analyzed without any personal identifiers, using coded information. The source documents and identification lists were archived in a secured facility per center. Permission to access data will be documented per the investigator.

2.3. Methods

A comprehensive history was obtained, and an exhaustive physical examination was conducted. All patients were asked about their age, gender, body mass index, neurological history, and use of oral contraception. The pre-operative investigation was done according to the complication. Based on clinical data, visual tests, and neuroimaging, post-operative follow-ups occurred at 1, 3, and 6 months.

2.3.1. Pre-Operative Assessment Included

A comprehensive clinical evaluation, including thorough medical, neurological, and ophthalmological examinations, was performed on all patients upon admission. At the first appointment, every patient was asked to fill out a standard questionnaire about symptoms, including headache, vomiting, blurred vision, and tinnitus, all of which might be signs of excessive intracranial pressure. Headaches were examined in terms of when they started, where they stayed, what made them worse or better, how often they occurred, what factors made them worse or better, and any other symptoms that may have been present. The visual analog scale was used to measure the intensity of the headaches in frequency and severity. The scale is 10 units long and has descriptions at each end to indicate the two extremes of pain (0 = no pain and 10 = greatest agony) [8]. The eye exam included Snellen charts, fundus examinations, and Goldmann kinetic computed perimetry for visual fields [9]. Documentation of clinical symptoms was done.

2.3.2. Lumbo-Peritoneal Shunt Insertion

In BIH, surgical intervention was considered for patients who had severe and acute visual impairment at first presentation, persistent, intractable headaches, long-term visual impairments that did not improve with medication and multiple lumbar cerebrospinal fluid drainages. We used Meditronic, USA lumbo-peritoneal shunt without reservoir in all cases; the thecal end of the shunt has multiple small openings with markings at every 5 cm length, and the inner and outer diameters of the tube are 0.7 mm and 1.4 mm respectively. The peritoneal end has the same diameter. Both thecal and peritoneal catheters are radio-opaque (bar-

ium-impregnated), and a metal-connector is used to connect them. The total length of the shunt is 84 cm.

Under general anesthesia, the surgeon slightly angled the surgical positioned the patient in a lateral decubitus posture, elevating their right side. The lumbar spine's spinous processes on lumbar vertebrae 4 and 5 were the sites of a 3-centimeter midline incision. We inserted a 14-gauge Tuohy needle into the subarachnoid area, with the angle facing the patient's head. A depth of 8 cm was reached by inserting the proximal end into the thecal sac. The Tuohy needle was withdrawn when cerebrospinal fluid was seen to be leaking from the end. 3 sutures are taken around the shunt, fixing it into the lumbar fascia, preventing the shunt from moving out of the spinal column. We positioned the distal end of the shunt using a flexible passer after making a 1-cm incision on the right flank. We made a 3-centimeter incision in the lower right quadrant of the abdomen and inserted the tube through the same opening. We fastened the tube with a second suture-made collar. After separating the rectus abdominis fibers, we implanted the distal end into the peritoneal cavity under vision. We applied sutures in layers to all the incisions [10].

2.3.3. Post-Operative Protocol Included

- Scheduled follow-ups at 1, 3, and 6 months.
- Clinical data: a post-treatment headache assessment was performed for all patients using the visual analog scale.
- Fundus examination and visual field: both the visual and fundus examinations were examined to see if the papilledema had resolved.
- Radiological imaging: X-ray lumbar region.
- Fundus examination, visual perimetry, and lumbar puncture are considered the main tools for the detection of shunt obstruction.
- We consider further investigations for new onset symptoms, e.g., persistent neck pain or and radiculopathy.
- For shunt obstruction, laparoscopic revision was done, and changing the site of the peritoneal catheter (usually, we prefer supra-hepatic space).

2.4. Statistical Analysis

The research was carried out using SPSS 27 for Windows. Mean ± standard deviation (SD) was used to depict continuous data, while frequencies and percentages were used to indicate categorical variables. We used Fisher's Exact Test to look at categorical variables like sex and body mass index and the independent t-test to compare continuous characteristics like age between groups. Binary logistic regression analysis was used to determine the risk factors associated with the occurrence of complications. Statistical significance was determined by a p-value lower than 0.05.

3. Results

In **Table 1**: The majority of patients were female (93.6%). The average age of the

patients was 35 years, and the distribution of BMI shows that most patients (80.9%) had a BMI greater than 25. Notably, a significant proportion of female patients (40.9%) reported a history of pill intake. Regarding symptoms, nearly all patients presented with blurred vision (93.6%), and a large majority also reported headaches (87.2%).

Table 1. Baseline characteristics of patients with lumbo-peritoneal shunt.

Items	Values (no = 47) No (%)
Age (mean ± SD)	35 ± 8
Sex	
Males	3 (6.4%)
Females	44 (93.4%)
BMI	
≤25	9 (%)
>25	38 (%)
History of pill intake among females	18/44 (%)
Symptoms	
Headache	41 (87.2%)
Blurring of vision	44 (93.6%)

Table 2 highlights several complications associated with lumbo-peritoneal shunt procedures in this patient cohort. Shunt obstruction was the most common complication, affecting 51% of patients, followed by low tension headaches, which were reported in 63.8% of cases. Shunt slippage occurred more frequently on the peritoneal side (10.6%) than on thecal side (2.1%). Notably, superficial infections and radiculopathy affected 10.6% of patients. In contrast, more severe complications such as CNS infections, arachnoiditis, and shunt failure were less common, occurring in only 2.1% of the cohort. Five patients (10.6%) developed acquired Chiari malformation, with 60% of these patients also developing syringomyelia.

The analysis presented in Table 3 and Table 4 indicates no statistically significant relationship between baseline characteristics (age, sex, and BMI) and the incidence of complications. The mean age was slightly higher in the group with complications (36.5 ± 6.2 years) compared to the no-complications group (33.5 ± 5.7 years). Yet, this difference did not reach statistical significance ($p = 0.108$). Regarding sex, the distribution was nearly identical between groups, with 5.9% males and 94.1% females in the no-complications group versus 6.7% males and 93.3% females in the complications group, yielding a p-value of 0.999 from the Fisher Exact Test, showing no significant association. BMI also appeared balanced between groups, as 82.4% of individuals with BMI > 25 were in the no-complications group and 80% in the complications group, with another non-significant p-value of 0.999. The logistic regression analysis supported these findings, with age

Table 2. LP shunt complication.

Items	Values (no = 47) No (%)
No complications	17 (36.2%)
Shunt obstruction	24 (51%)
Shunt slippage	
Thecal	1 (2.1%)
Peritoneal	5 (10.6%)
Difficulty insertion of the catheter in the thecal sac	5 (10.6%)
Superficial infection	5 (10.6%)
CNS infection	1 (2.1%)
Acquired Chiari malformation	5 (10.6%)
Syringomyelia among Chiari patients	3/5 (60%)
Arachnoiditis	1 (2.1%)
Failure	1 (2.1%)
Low tension headache	30 (63.8%)
Radiculopathy	5 (10.6%)

Table 3. Relation between the presence of complications and baseline characteristics.

Items	No complications (no = 17)	Complications (no = 30)	P-value
Age (mean ± SD)	33.5 ± 5.7	36.5 ± 6.2	0.108 (T-test)
Sex			
Males	1 (5.9%)	2 (6.7%)	0.999 (FET)
Females	16 (94.1)	28 (93.3%)	
BMI			
≤25	3 (17.6%)	6 (20%)	0.999 (FET)
>25	14 (82.4%)	24 (80%)	

FET = Fisher exact test.

Table 4. Multivariable binary logistic regression analysis for factors associated with complications.

Items	P-value	OR	95% CI for OR
Age/years	0.642	1.542	0.681 - 3.762
Sex			
Males	0.986	Reference category	Reference category
Females		0.964	0.431 - 2.615
BMI	0.972		
≤25		Reference category	Reference category
>25		0.824	0.531 - 4.785

OR = Odds Ratio; CI = Confidence Interval.

having an odds ratio (OR) of 1.542 (95% CI: 0.681 - 3.762, p = 0.642), sex showing an OR of 0.964 for males versus females (95% CI: 0.431 - 2.615, p = 0.986), and BMI yielding an OR of 0.824 for > 25 versus ≤ 25 (95% CI: 0.531 - 4.785, p = 0.972). Consequently, these results indicate that age, sex, and BMI are not significant predictors of complications within this cohort.

4. Discussion

BIH, a complex multifactorial neuro-ophthalmic illness, is characterized by increased intracranial pressure without a clear cause, such as a brain tumor or another disease of the central nervous system [11]. The disease may manifest in a wide variety of ways clinically. Still, common symptoms include nausea, headache, back and neck pain, pulsatile tinnitus, blurred vision, and diplopia. For most people with BIH, weight loss and/or acetazolamide medication improve symptoms. For patients who do not respond to medication, surgical procedures, including shunt operations, are an option [12].

Forty percent of all CSF shunt procedures are LP shunts [13]. The fact that the LP shunt does not involve the brain at all is one advantage that made it favored by several neurosurgeons [14] [15]. Few studies have examined the effectiveness of this method [4] [16]. For 3 years, we followed 47 people in a retrospective study to learn about the complications of LP shunt.

BIH mostly affects females of reproductive age and is strongly correlated with obesity. Recent years have shown a recognized increase in the incidence of BIH, along with the global rise in obesity rates [12].

In the present research, the predominant demographic was female patients (93.6%). The mean age of the patients was 35 years, and the BMI distribution indicated that a majority (80.9%) had a BMI above 25. A considerable percentage of female patients (40.9%) showed a history of contraceptive pill use. In the same context, previous studies noticed that obese women in their twenties to forties make up the bulk of those affected by BIH [16] [17]. Another compilation of prior research included a cohort of 142 patients, 80.3% female (106/132), with a mean age of 32.4 years and an average follow-up duration of 32.7 months [10] [18]-[21]. Contreras-Martin and Bueno-Perdomo [19] also reported that ten out of the forty-two women, or 23.81 percent, were found to be using hormonal contraception. Weight gain and obesity increase the risk of BIH. However, moderate weight reduction may result in illness resolution, as current research underscores the pathogenic influence of metabolic and hormonal variables [12]. BIH treatment strategies focus on decreasing intracranial pressure, alleviating headaches, and safeguarding eyesight. Weight reduction is a nonsurgical method for treating BIH [20]. A possible pathophysiological role of obesity in BIH is metabolically active adipose tissue, which may generate various adipokines and inflammatory cytokines. This inflammatory environment may lead to cognitive impairment by disrupting neural network function. Systemic inflammation associated with obesity and heightened mechanical stress on frontostriatal networks due to elevated in-

tracranial pressure may have a role in BIH [22]. Obesity also correlates with increased intrabdominal and intrapleural pressure, which may impede CSF outflow by raising venous pressure, thus leading to raised ICT [23].

Almost all patients in the current research had impaired vision (93.6%), and a significant majority also experienced headaches (87.2%) as presenting symptoms of BIH.

The most often reported symptoms of BIH, as noted by González-Hernández *et al.* [24] and Rodríguez de Rivera *et al.* [25], are headache (lacking pathognomonic features), nausea, vomiting, visual field abnormalities, diplopia, photophobia, and pulsatile tinnitus. Also, headaches accompanied by bilateral papilloedema and diminished visual acuity are the primary symptoms concluded by Contreras-Martin and Bueno-Perdomo [19]. According to our findings, the proportion of patients who presented with headache symptoms was comparable to the one reported before (82.25%) in previous studies [26]-[28]. Prominent theories suggest that factors, including sex hormones and adipokines, namely 11β-hydroxysteroid dehydrogenase type 1 and leptin, contribute to the widespread instability of CSF fluid. Still, the exact process by which BIH develops is yet unknown. Disruptions to the dynamics of CSF fluid and venous sinus pressure are involved in the pathophysiology of BIH, causing its symptoms [12].

Kalyvas *et al.* [23] determined in their systematic review of surgical treatments for BIH that only 1.4% of patients required additional surgical intervention after LPS. The rate of severe complications was 9.4%, with shunt infection being the most prevalent severe complication. The majority of revisions were performed due to shunt obstruction.

Shunt obstruction was the most common complication, affecting 51% of patients, and Shunt slippage occurred more frequently on the peritoneal side (10.6%) than on the thecal side (2.1%). This percentage is higher than the Sinha *et al.* series (8.6%). Ewaiss *et al.* reported 40% of cases of shunt obstruction in their series [29]. Kalyvas *et al.* reported shunt obstruction in 51.6% of operated patients [30]. We may consider that the short length of the shunt tube, especially in females with abdominal obesity, increases the risk of shut slippage and obstruction.

Research shows that 40% of LP shunt problems are mechanical failure. This generally causes clinical symptoms to recur. Shunting obstruction, catheter migration, disconnection, fracture, or malposition are reasons. Intracranial hypertension persists when LP shunt blockage fails to divert cerebrospinal fluid. Shunt obstruction is commonly suspected but confirmed only after surgery. Lumbar catheter, valve, and distal catheter obstructions may occur anywhere in the shunt system. Each shunt system component must be examined for malfunction during surgery [31].

The diagnosis of blockage was established by the recurrence of symptoms (headache and visual symptom) and signs (papilledema and visual field defect) and confirmatory lumbar puncture (manometry).

Laparoscopy is beneficial for diagnosing and managing shunt blockage. It is

helpful for placement of the tube under vision and confirming shunt function by visualization of CSF drainage from the shunt tubing [32].

Laparoscopic revision was considered in most cases of shunt obstruction, removal of any fat debris, and ensuring shunt functioning, and we prefer to place the shunt tube in supra hepatic space, as in **Figure 1**.

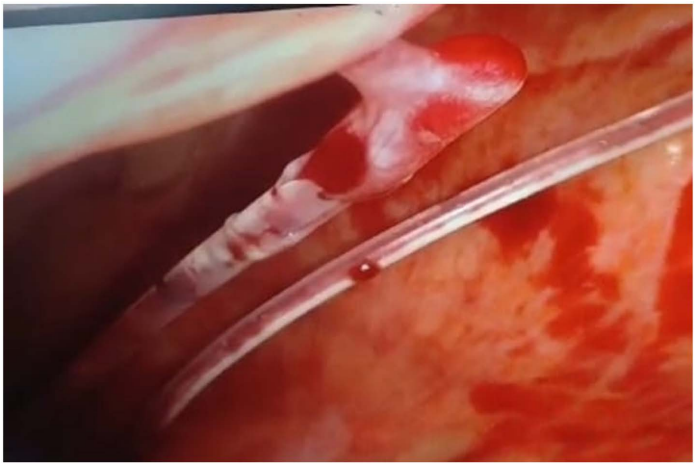


Figure 1. A female patient 35 years old presented with shunt obstruction after 1 year of insertion. Laparoscopic revision of shunt showing peritoneal fat obstructing peritoneal end.

Symptoms of intracranial hypotension include headache in the upright position and improvement in lying flat due to the siphoning effect [33]. Sinha *et al.* suggest the longer the length of the lumbar catheter, the more resistance to CSF flow [34].

These symptoms were reported in 63.8% of cases. Five patients (10.6%) developed myelopathy and brachilagia within 2 years after shunt insertion. Usually, we don't perform routine MRIs of cervical spine for our patients unless indicated. Acquired Chiari malformation (ACM) was reported in these five patients, with 60% of these patients also developing syringomyelia.

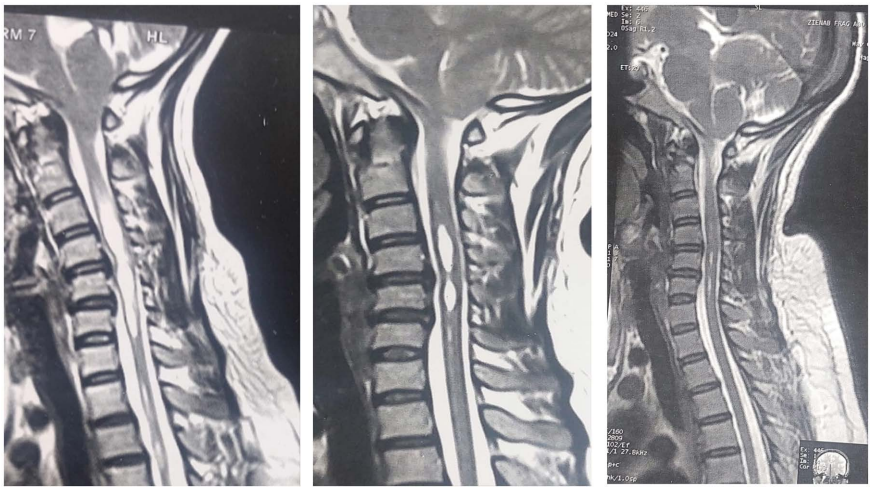
The incidence of ACM was relatively high in Chumas *et al.* and Payner *et al.* series, whereas it was very low (0.5%) in Yadav *et al.* and Aoki *et al.* (1%) series [35].

Rekate *et al.* found no incidence of ACM in youngsters; the valve system was used in most (84%) cases [36].

ACM was not discovered with the utilization of valves [35].

We used a valve-less shunt in our series, which may explain the higher incidence of Chiari malformation as programmable shunts and reservoirs were not available in our institute. We consider shunt removal to limit progression and follow up with the patients clinically and radiologically.

Shunt removal and medical treatment were enough to control the condition in 3 cases, one patient needed posterior fossa decompression plus shunt removal, and other cases with a large cervical syrinx needed insertion of ventriculoperitoneal (VP) shunt, and the syrinx disappeared within one year as in **Figure 2**.



(a) (b) (c)

Figure 2. Showing the disappearance of syringomyelia after ventriculoperitoneal shunt insertion. (a) Female patient developed chiari malformation and cervical syrinx 2 years after LP shunt insertion; (b) 6 months after LP shunt removal and VP shunt insertion; (c) 1 year after LP shunt removal and VP shunt insertion.

Shunt infections have been reported in 1% - 9% of LP Shunts [34].

The alteration of position for abdominal-end insertion, which may lead to a risk of sterility compromise, is a potential source of infection [36]. Proper catheter care during positional changes may prevent this issue.

After repositioning to the supine posture, we stabilise the catheter with a mop and repaint the abdomen. A transportation board may be used to reposition patients without altering the surgical drapes; extended surgical durations have been proposed as a potential source of infection. Certain centers use the dual-surgeon approach by concurrently inserting lumbar and peritoneal ends in the left lateral position to minimize duration and infections [34].

Shunt infection is among the most dangerous consequences, whereas meningitis is a potentially life-threatening consequence of the LP shunt. In our study, one patient had a shunt infection (2.1%) and was treated with shunt removal and intravenous antibiotics.

Lumbo-peritoneal shunt (LPS) operation may cause radiculopathy owing to mechanical irritation of the cauda equina nerve roots [37].

In a previous study, 3 patients (4.4%) suffered radiculopathy among 67 receiving LPS; two patients needed LPS removal, and one required a spinal catheter revision [38].

In our study, radiculopathy affected 10.6% of patients; radiculopathy usually improved with medical treatment. One case of radiculopathy was severe, not responding to medical therapy and thecal end was mal-directed. Shunt revision was done, and shunt redirection and radiculopathy improved, as shown in **Figure 3**.

Singh *et al.* do not encounter any unusual complications (excessive drainage, scoliosis, arachnoiditis, cysts, abscess, etc. [39]. Vural reports a late and extreme

Figure 3. A female 41 years developed sciatica one day after surgery. CT lumbosacral spine shows a mal-directed thecal end.

complication of lumbo-peritoneal shunt resulting in granulation tissue formation [40].

In our study, arachnoiditis complication occurred only in one patient (2.1%), as shown in **Figure 4**, after one year of shunt insertion, and the patient developed motor affection, shunt removal, and surgical decompression, and duroplasty was needed.

Figure 4. MRI lumbosacral spine showing arachnoiditis after 1 year of LP shunt.

Instances of unsuccessful needle insertion have been documented in previous series [10].

Patients exhibiting pronounced kyphoscoliotic deformity, significant lumbar canal stenosis, and calcified ligamentum flavum should be excluded from consideration for the lumbar-peritoneal shunt operation [38].

Sufficient lumbar flexion, achievable under general anesthesia, diminishes unsuccessful efforts. In challenging circumstances, C-arm fluoroscopy may assist in visualizing the interspinous interval [34].

Difficulty insertion of the catheter in the thecal sac is reported in five cases (10.6%), getting of CSF flow occurred after the repeated time of tapping. In two instances, we had to do muscle separation to access the subarachnoid space.

Also, in the study of Fang *et al.* [41], two cases of shunt infection, two cases of subdural hematoma requiring surgical intervention, and two cases of shunt dysfunction were among the six patients (7.1%) who had severe complications as a result of LPS. Seventeen people (31.8%) had minor side effects as a result of LPS. Mild side effects, such as orthostatic vertigo, orthostatic headache, and subdural effusions, are often seen within one month after LPS. A prevalent reason for revision in LPS shunts is shunt obstruction, recognized in the literature as a significant issue that must be resolved, subsequently leading to secondary intracranial hypotension due to excessive cerebrospinal fluid outflow via the LPS, resulting in low tension headaches [42]-[46].

In the current investigation, the comparison between patients with and without complications in the context of LPS reveals no statistically significant differences in the baseline characteristics studied. The age difference between the two groups (mean ± SD) shows a slight increase in the complications group. Still, the p-value (0.108) suggests that this difference is not significant. Additionally, sex distribution and BMI categories exhibit no significant differences, as indicated by the p-values (all 0.999, using Fisher's Exact Test).

In the group studied by Grech *et al.* [47], weight and waist circumference did not serve as predictors of cognitive performance issues associated with BIH. Yri *et al.* [48] similarly discovered that the BMI of BIH patients did not serve as a predictor for cognitive function, indicating that cognition seems to be affected by the existence of weight excess in BIH rather than its extent. Obesity, whether occurring alone or with other neurological disorders, has been linked to many negative consequences, necessitating bigger cohorts to clarify this relationship [49] [50].

Several restrictions are placed on this study. Even though this study collected case data prospectively from 2021 through 2024, it is still considered a retrospective case analysis since no clinical trial registration was made. A single institution's limited case series was a part of the study. The lack of a blind technique by the observer introduces the possibility of bias. Because there was no control group in the study, comparing the results to those of other operational techniques is not feasible.

5. Conclusion

We can conclude that the incidence of BIH is elevated in young women with greater body weight and is correlated with the use of hormonal contraception. The primary symptoms of BIH are headache and visual impairments. Our research reveals that shunt obstruction was the most common complication, followed by low-tension headaches. In contrast, more severe complications such as CNS infections, arachnoiditis, and shunt failure were less common. For better treatment results, we recommend: 1) usage of LP shunts with valves. 2) Always stressing the importance of aseptic technique management; 3) Quickly identifying and treating serious complications; 4) being sure of the adequate length of shunt tube in both thecal sac and abdomen.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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