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Thecoperitoneal Shunt: Indications and Complications

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Abstract

Background: Thecoperitoneal shunt (TPS) is a method of diverting cerebrospinal fluid (CSF), similar to the ventriculoperitoneal shunt (VPS). While VPS is a common and widely used procedure for hydrocephalus, TPS is less frequently practiced due to limited data on its indications and complications.

Patients and Methods: In this study, we retrospectively reviewed our experience with TPS and its indications and complications, in 17 patients operated on from January 2021 to December 2023, with at least six months of follow-up. We analyzed the patients' clinical data, indications, imaging studies, and complications.

Results: Seventeen patients underwent TPS in our institute. The common indications were idiopathic intracranial hypertension (IIH), normal pressure hydrocephalus (NPH), cerebral venous thrombosis (CVT) with vision loss, pseudomeningocele, and CSF leak from the surgical site. The mean follow-up period was 1.2 years. Common complications included shunt overdrainage with subdural collection, shunt infection, shunt blockage, and shunt disconnection. A literature review revealed various other indications and complications.

Conclusion: TPS is an effective and favorable treatment modality for various conditions and demonstrates good clinical outcomes. The encountered complications can be managed effectively and may be reduced with additional precautions and strategies.

Keywords: Thecoperitoneal shunt, Lumboperitoneal shunt, Ventriculoperitoneal shunt, idiopathic intracranial hypertension, normal pressure hydrocephalus, cerebral venous thrombosis, pseudomeningocele, CSF leak

INTRODUCTION

Thecoperitoneal shunt (TPS) is an alternative method of Cerebrospinal Fluid (CSF) diversion, akin to the ventriculoperitoneal shunt (VPS). It is also known as lumboperitoneal shunt. Although not commonly practiced due to limited indications, it has numerous advantages compared to VPS, including no risk of intracerebral hemorrhage (ICH), seizures, or proximal obstruction by the choroid plexus. TPS is possible in conditions with narrow ventricles. Complications differ from those associated with VPS and include root pain,

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irregular CSF flow, and local infections followed by central nervous system infections. A review of the literature offers insights into indications, techniques, complications, and management options for this procedure.

METHODOLOGY

This retrospective study was conducted at the Institute of Neurosurgery, Madras Medical College, and Rajiv Gandhi Government General Hospital, Chennai, from January 2021 to December 2023. We reviewed details such as patient history, clinical neurological findings, imaging studies, procedural indications, follow-up, and complications. The Chhabra thecoperitoneal shunt system, without a pressure system or valve, was used in all cases.

Patients with IIH were selected for surgery when their lumbar puncture (LP) opening pressure exceeded 25 cm H2O and fulfilled the Modified Dandy criteria. NPH patients were considered for surgery when a CSF tap of 30 ml showed clinical improvement in gait. CVT patients underwent TPS when their LP opening pressure was greater than 25 cm H_2O and presented with vision loss and papilledema. Pseudomeningocele and CSF leak patients were selected for surgery if they improved with a lumbar drain but experienced after its removal or when it became non-functional. Patients unfit for definitive procedures such as duroplasty underwent TPS within four days following. Patients who had undergone previous VPS before TPS for other indications were excluded from the study.

RESULTS

A total of 17 patients underwent TPS at our institute over a three-year period. The mean age of the patients was 39.2 years, with a mean follow-up period of 1.2 years (*Fig. 1*).

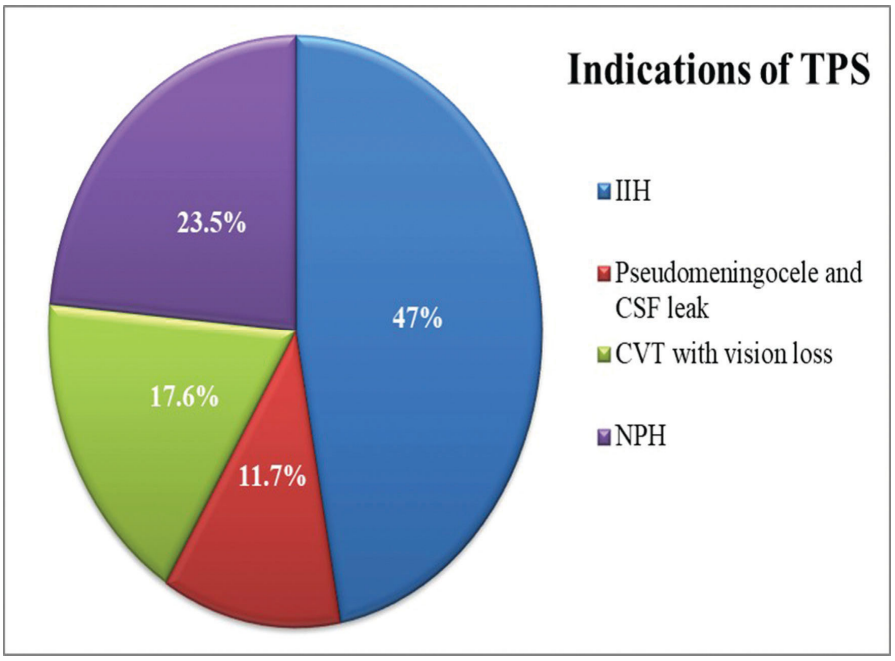


Fig. 1: Pie chart represents the indications of TPS in our study

Idiopathic Intracranial Hypertension (IIH)

Eight patientswith IIH underwent TPS. Their LP opening pressure averaged 34.5 cm H2O. Among them, 2 presented with headache alone, 2 with visual disturbances, and 4 with both. Complications included hypotensive headache due to CSF over drainagein one patient (12.5%), evidenced by collapsed ventricles and bilateral subdural hygroma on CT imaging. This patient was treated with shunt ligation, which was removed after clinical improvement. Another patient experienced local redness without discharge at the lumbar surgical site (12.5%) which subsided with antibiotic treatment.

Normal Pressure Hydrocephalus (NPH)

Four patients diagnosed with NPH after CSF tap tests underwent TPS. All patients showed

improvement in gait and cognition during follow-up. One patient (25%) experienced shunt blockage at the abdominal end, requiring shunt revision. At one-year follow-up, three out of four patients' families reported satisfaction with improvement in gait, and two reported improvement in urinary incontinence and cognition.

Cerebral Venous Thrombosis with Vision Loss

Three patients presented with acute vision loss, with MRI showing thrombosis of dural venous sinuses (*Fig.* 2). TPS was performed when LP opening pressure exceeded 25 cm H_2O, and patients were simultaneously treated for CVT. Visual acuity improved symptomatically and according to the Snellen chart. One patient (33%) developed a hypotensive headache with subdural hemorrhage five weeks post-procedure, which was treated by burr hole and evacuation followed by shunt removal. Another patient (33.3%) experienced a local infection, which was conservatively managed with antibiotics.

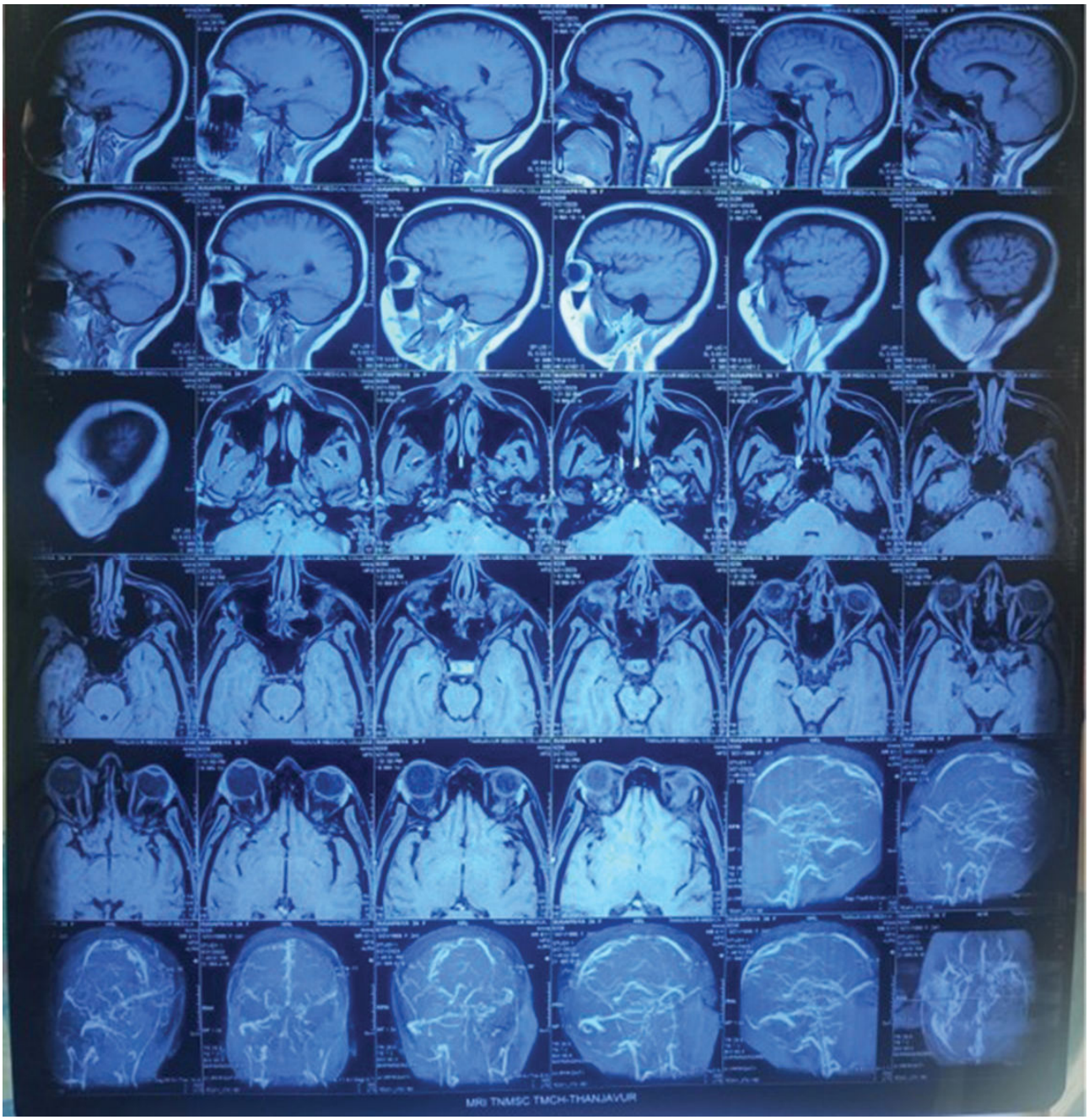


Fig. 2: MRI/MRV of a patient showing CVT involving superior sagittal sinus, bilateral transverse sinus, sigmoid sinus and cortical veins.

Pseudomeningocele and CSF Leak

Two patients (11.7%) in this group underwent TPS. One patient, post-excision of a cerebellopontine angle tumor, developed a pseudomeningocele. Another patient, post-excision of a parietal region glioblastoma, experienced a CSF leak from the suture site. Both cases showed improvement (100%), and there was no pseudomeningocele or CSF leak recurrance. However, one patient developed local discomfort at the lumbar site due to shunt disconnection, necessitating removal of the TPS.

DISCUSSION WITH REVIEW OF LITERATURE

Indications

The coperitoneal shunt has been used as a method of extracranial shunting of CSF since 1975 by Selman. In our study, IIH, NPH, CVT with vision loss, pseudomeningocele, and CSF leak are common indications for TPS.

Ning Ping Poo *et al.*, did 172 TPS for communicating hydrocephalus with significant improvement in functional score and brain imaging[1]. Aoki *et al.*, with 200 patients with communicating hydrocephalus, did TPS and found that infection and shunt malfunction was lower when compared to VPS[2].

Manoj Phalak, has done 22 TPS in patients with posttraumatic hydrocephalus and found that TPS is safe, minimally morbid, and a good alternative procedure for VP shunt[3].

HO Angle, has done 7 TPS for patients with Slit ventricle syndrome (SVS)[4]. SVS is described in hydrocephalus patients who continue to have shunt malfunction-like symptoms, in the presence of functioning shunt and small ventricles on imaging. TPS has been done for a patient with post-traumatic syringomyelia and showed the complete collapse of syringomyelia[5]. Multiple case series have shown good recovery for CSF rhinorrhoea with TPS for both post-traumatic and spontaneous cases.

Yadav *et al.*, have mentioned good outcomes with TPS for growing skull fractures[6]. TPS can be used if the dural defect is deep in the cranial base or across the cerebral venous sinuses. Robertson has treated a case of external hydrocephalus with thecoperitoneal shunt[7].

In our study,the shunt was placed in a single-stage procedure with lateral decubitus position (*Fig. 1.3*). Yang *et al.*, have modified the single-stage procedure to a two-stage procedure with prone position, first and then a supine position[8]. According to their study, lumbar tapping was better and the kinking of the catheter was lower when compared to a single-stage procedure. In our study, with a single-stage procedure, tapping was done at 1st attempt or to a maximum of 2nd attempt with no complication like kinking of the catheter. The use of C-arm guidance can help in the correct placement of the adequate length of the catheter and the position can be confirmed.



Fig. 3: Post-operative X-ray of a patient with TPS

Studies have been done to suggest laparoscopic assisted placement of shunts for direct visualization of the tip of the shunt inside the peritoneal cavity and avoid extraperitoneal placement.[9]

In our study, as with most other studies, there was a female preponderance of patients with IIH with a mean age of 27.5 years +/- 3.5 years. In our study, headache resolved in 100% of cases, and visual acuity and papilledema improved in 83.3%. Arumulla *et al.*, did TPS for 23 patients with IIH and found visual acuity improvement in 64% and 97% improvement in papilledema[10].

In our study, 3 patients with CVT with vision loss, underwent TPS. There was clinical improvement and resolution of papilledema in all the three patients (100%). Reddy *et al.*, in their study of CVT with vision loss in 13 patients, found that TPS or optic nerve sheath fenestration is an option and advised the use of a programmable valve[11]. Upto 15% of patients present with visual disturbances in CVT[12]. Vision loss in CVT can be due to optic nerve dysfunction due to increasing intracranial hypertension, occipital region infarcts, AVM following chronic CVT, uncal herniation with PCA infarcts.

4 of our patients who presented and were diagnosed to have NPH,underwent TPS. 75% showed improvement in gait and 50% in urinary symptomsand cognition. Yerneni *et al.*, with 25 patients of NPH with TPS showed 92% improvement in gait and 68% improvement in incontinence and 62% improvement in cognitive function at 6month follow-up and demonstrated that TPS is an effective alternative for VP shunting in patients with NPH[13].

SINPHONI-2 an open-label randomized trial has suggested that TPS may be beneficial with iNPH[14]. Immediate treatment rather than delayed treatment is preferred. When compared with VP shunt, adverse events were slightly higher in TPS (49% vs 35%).

In our study, 2 patients were taken up for TPS for pseudomeningocele and CSF leak. The first line of management in our institute is lumbar drainage, and if it is unsuccessful, definitive procedures like Duroplasty is done. The 2 patients taken up for TPS in our study were not fit for definitive procedure, so TPS was done. Both the patients had good recovery in terms of wound healing. Several studies have shown the role and benefits of TPS in the management of pseudomeningocele and CSF leaks.

Aokiin their series published in 1989, with 10 patients undergoing TPS for pseudomeningocele had no and good recovery[15]. He also suggests that early removal of TPS can be done if the subdural collection is evolving.

An occult spinal pseudomeningocele following trivial injury was treated successfully with TPS by Kitchen in his case report in 1992[16].

For recurrent iatrogenic cranial pseudomeningoceles, Subgaleo peritoneal shunt (SPS) has been tried as an alternative for TPS with no complications and good positive results[17]. Failed TPS was also corrected using SPS.

COMPLICATIONS

Over drainage leading to shunt removal was done in 2 patients (11.7%) (*Fig. 1.4*). One developed subdural hygroma, which resolved after removal of the TPS. The other patient developed subdural hemorrhage for which burr-hole evacuation followed by shunt removal was done. None of our patients were treated with programmable valves. Nadkarni *et al.*, in their study with 40 cases, used TPS with a programmable valve, which allows a controlled outflow of lumbar CSF[18]. Matsubara has reported a case of shunt pullout with a CSF leak from the shunt site causing over-drainage and bilateral subdural hematoma[19].

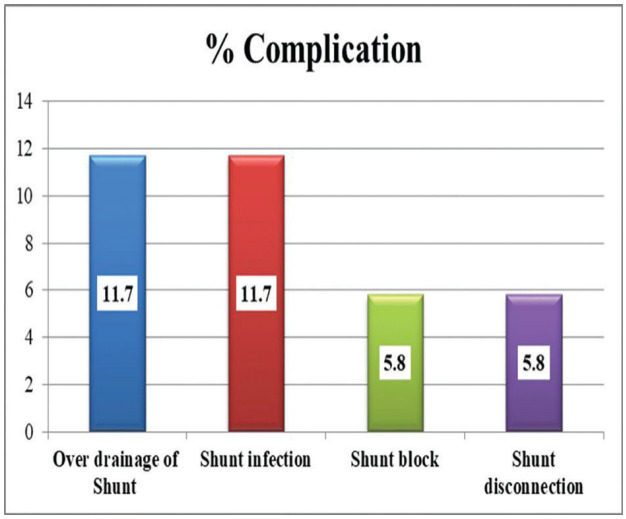


Fig. 4: Chart representing percentage of complications

Yang *et al.*, also suggested that the incorporation of a programmable valve reduces the chances of over-drainage[8]. A case report of bilateral 6th nerve palsy following over drainage was reported in 2022, the symptom improved only after removal of TPS[20].

Over drainage can be identified clinically by hypotensive headaches, radiologically by slit ventricles, subdural hygroma/ hematoma, and relief of symptoms on ligation of the shunt.

One patient in our study had a shunt block (5.8%), due to obstruction at the abdominal end. The patient developed features of NPH slowly over time underwent shunt revision at the abdominal end and improved symptomatically. A recent study by Arumalla *et al.*, showed 7.3% had shunt block as a complication[10]. A total of 212 patients were taken up in that study.

In our study, one patient who underwent TPS for pseudomeningocele, had a shunt disconnected

at the lumbar end (5.8%). The shunt was removed and the patient didn't develop pseudomeningocele later. Algroom R presented a case of migrated TPS, the proximal end towards third ventricle and the distal end towards the pelvis[21]. He suggested migration can be prevented by the usage of locks and anti slip clips. Additional sutures to secure the shunt can also be done.

Mohammed Fekry, in his study with 67 patients of TPS, reported shunt migration in (17.9%) 12 patients[22]. He suggested good fixation techniques to reduce the chances of migration. A rare case of shunt migration into the bladder and calculus formation has been reported[23].

Two of our patients (11.7%) had shunt infection in the form of localized redness and pyrexia. Both the patients were treated conservatively. Whether it was a case of shunt infection or a superficial infection was not confirmed. To confirm a shunt infection, culture, and sensitivity testing must be performed, which requires the removal of the shunt. Arumalla *et al.*, had an infection rate of 2.5%, Yadav *et al.*, had an infection rate of 3.4%, and most of their cases were treated by shunt removal with or without placement of a new shunt[10,24].

Some complications as described below were not encountered in our study. Aoki *et al.*, and Arumalla *et al.*, described the chances of postoperative radiculopathy as 5% and 0.3% respectively[2,10]. In most cases, radiculopathy settled within 1 month. Tanaka *et al.*, in their study, showed a 15% chance of radiculopathy if the shunt is placed without using fluoroscopic guidance[25]. In our study, fluoroscopic guidance was not used in any patient, and radiculopathy was never a complaint. The same team also suggests the creation of a fascial sheath around subcutaneous TPS to prevent postop shunt migration[26].

Progressive lumbar hyperlordosiscould occur in pediatric children treated with TPS for communicating hydrocephalus, with most patients needingorthopedic surgical correction[27].

The formation of granulation tissue around the catheter at the interspinous ligament has been documented in literature as a late and extreme complication of TPS[28].

Acquired Chiari malformation (ACM), is described as pre-operative imaging with no cerebellar tonsil herniation or CVJ abnormalities, presenting with cerebellar tonsil herniation, postoperatively in procedures like TPS. Johnson *et al.*, in his study in 1998 has described 12 patients with ACM following TPS[29]. Aslam Hentati has given three options for ACM management: to put a valve to a valveless shunt, to resite the shunt or to decompress the CVJ[30]. The author uses a valve for his valveless shunts and symptoms improve in all his patients. Chumas *et al.*, and Payner *et al.*, have reported higher incidences of ACM in children[31,32]. Recent studies show that ACM is a rare complication and can be easily avoided by shunt with a valve[33].

CONCLUSION

TPS is a valuable treatment option for a variety of conditions characterized by low, normal, and high intracranial / CSF pressure. Compared to VPS, TPS offers advantages such as reduced risk of neural injury, intracerebral hemorrhage, and seizures. Employing shunts with valves (either fixed pressure or programmable), and utilizing proper surgical techniques can further reduce complications associated with this procedure.

REFERENCES

1. Foo NP, Tun YC, Chang CC, Lin HL, Cheng CH, Chuang HY. Clinical Outcome and Safety of Lumboperitoneal Shunt in the Treatment of Non-Obstructive Hydrocephalus. Clin Interv Aging. 2023;18:477-483 https://doi.org/10.2147/CIA.S401116
2. Aoki N. Lumboperitoneal shunt: clinical applications, complications, and comparison with ventriculoperitoneal shunt. Neurosurgery. 1990 Jun;26(6):998-1003; discussion 1003-4. PMID: 2362678.
3. Phalak, Manoj & Agrawal, Deepak &Dawar, Pankaj &Kothiwala, Anil & Singh, Pankaj & Sharma, Bhawani. (2013). Theco-peritoneal shunt for post-traumatic hydrocephalus – A valuable adjunct?. The Indian Journal of Neurotrauma. 10. 10.1016/j.ijnt.2013.10.005.
4. Le H, Yamini B, Frim DM. Lumboperitoneal shunting as a treatment for slit ventricle syndrome. PediatrNeurosurg. 2002 Apr;36(4):178-82. doi: 10.1159/000056054. PMID: 12006752.
5. Vassilouthis J, Papandreou A, Anagnostaras S Thecoperitoneal shunt for post-traumatic syringomyelia. Journal of Neurology, Neurosurgery & Psychiatry 1994;57:755-756.
6. Yadav YR. Cranio-cerebral erosion (growing skull fracture): Management by lumber-peritoneal shunt: Case report Clin Pract Rev. 2005;6:224–9
7. Robertson WC Jr, Gomez MR. External hydrocephalus. Early finding in congenital communicating hydrocephalus. Arch

Neurol. 1978 Aug;35(8):541-4. doi: 10.1001/archneur.1978.00500320061014. PMID: 666616.

8. Yang TH, Chang CS, Sung WW, Liu JT. Lumboperitoneal Shunt: A New Modified Surgical Technique and a Comparison of the Complications with Ventriculoperitoneal Shunt in a Single Center. Medicina (Kaunas). 2019 Sep 26;55(10):643. doi: 10.3390/medicina55100643. PMID: 31561485; PMCID: PMC6843463.
9. Alawamry, A., Youssef, E.M., Morsy, A.A. *et al.* Laparoscopic-assisted intraperitoneal placement of lumboperitoneal shunt in patients with idiopathic intracranial hypertension. Egypt J Neurosurg 38, 4 (2023). https://doi.org/10.1186/s41984-022-00184-8
10. Arumalla, Kirit& Mohammed, Naseer & Bhat, Dhananjaya & Shukla, Dhaval & Bhagavatula, Indira. (2023). Thecoperitoneal Shunts—Our 20 Years Experience. Indian Journal of Neurosurgery. 12. 10.1055/s-0042-1758777.
11. Reddy TA, Seshagiri DV, Reddy HK, Patwardhan AA, Joshi TH, Shukla D, *et al.* Surgical Management of Vision Loss in Cerebral Venous Thrombosis: Case Series from a Tertiary Care Stroke Center. Ann Indian AcadNeurol 2023;26:733–41
12. Aaron, Sanjith; Arthur, Anupriya1. Visual Impairment in Cerebral Venous Thrombosis: The Various Shades of Gray. Annals of Indian Academy of Neurology 26(5):p 629-630, Sep–Oct 2023. | DOI: 10.4103/aian.aian_449_23
13. Ketan Yerneni, Constantine L. Karras, Collin J. Larkin, Hannah Weiss, Benjamin Hopkins, Kartik Kesavabhotla, Matthew B. Potts, Matthew C. Tate, Orin Bloch, Lumboperitoneal shunts for the treatment of idiopathic normal pressure hydrocephalus,Journal of Clinical Neuroscience,Volume 86,2021,Pages 1-5,ISSN 0967-5868, https://doi.org/10.1016/j.jocn.2020.12.031.
14. Lumboperitoneal shunt surgery for idiopathic normal pressure hydrocephalus (SINPHONI-2): an open-label randomised trial. Kazui, Hiroaki *et al.* The Lancet Neurology, Volume 14, Issue 6, 585 – 594
15. Aoki N. Lumboperitoneal shunt for the treatment of postoperative persistent collection of subcutaneous cerebrospinal fluid (pseudomeningocoele). Acta Neurochir (Wien). 1989;98(1-2):32-4. doi: 10.1007/BF01407173. PMID: 2741733.
16. Kitchen N, Bradford R, Platts A. Occult spinal pseudomeningocele following a trivial injury successfully treated with a lumboperitoneal shunt: a case report. Surg Neurol. 1992 Jul;38(1):46-9. doi: 10.1016/0090-3019(92)90211-5. PMID: 1615374.
17. Kiran NA, Thakar S, Mohan D, Aryan S, Rao AS, Hegde AS. Subgaleo-peritoneal shunt: An effective and safer alternative to lumboperitoneal shunt in the management of persistent or recurrent iatrogenic cranial pseudomeningoceles. Neurol India. 2013 Jan-Feb;61(1):65-8. doi: 10.4103/0028-3886.108014. PMID: 23466843.
18. Nadkarni, T. D., Rekate, H. L., & Wallace, D. (2008). Concurrent use of a lumboperitoneal shunt with programmable valve and ventricular access device in the treatment of pseudotumor cerebri: review of 40 cases. Journal of Neurosurgery: Pediatrics PED, 2(1), 19-24. https://doi.org/10.3171/PED/2008/2/7/019
19. Matsubara T, Ishikawa E, Hirata K, Matsuda M, Akutsu H, Masumoto T, Zaboronok A, Matsumura A. A new mechanism of cerebrospinal fluid leakage after lumboperitoneal shunt: a theory of shunt side hole--case report. Neurol Med Chir (Tokyo). 2014;54(7):572-7. doi: 10.2176/nmc.cr2013-0067. Epub 2013 Dec 5. PMID: 24305015; PMCID: PMC4533463.
20. Ibrahim A. Alhalal, Hashem T. Al-Salman, Abdulrahman H. Al Anazi. Bilateral sixth cranial nerve palsy following lumboperitoneal shunt. Neurosciences Journal Jul 2022, 27 (3) 187-190; DOI: 10.17712/nsj.2022.3.20210140
21. Alqroom R, Abu Nowar H, Firas S, Amer AS, Wesam K (2016) Thecoperitoneal Shunt 'Cast Away'. J Neurol Stroke 5(2): 00172. DOI: DOI: 10.15406/jnsk.2016.05.00172
22. Elshirbiny, M.F., Badr, H., ahmed, A. *et al.* Migration complications of lumboperitoneal shunts. Egypt J Neurosurg 37, 36 (2022). https://doi.org/10.1186/s41984-022-00178-6
23. Dembla, Saurabh R.. Migration of a Thecoperitoneal Shunt into the Bladder with Calculus Formation. Neurology India 70(5):p 2281-2282, Sep–Oct 2022. | DOI: 10.4103/0028-3886.359221
24. Yadav YR, Pande S, Raina VK, Singh M. Lumboperitoneal shunts: review of 409 cases. Neurol India 2004;52(02):188–190
25. Tanaka T, Goto H, Momozaki N, Honda E. Incidence of radiculopathy following lumboperitoneal shunt placement without fluoroscopy for normal pressure hydrocephalus. SurgNeurol Int. 2022 Sep 23;13:437. doi: 10.25259/SNI_791_2022. PMID: 36324979; PMCID: PMC9610451.
26. Tanaka T, Goto H, Momozaki N, Honda E. Creating of "fascial sheath" around subcutaneous lumboperitoneal shunt catheters largely prevents postoperative subcutaneous shunt catheter migration. SurgNeurol Int. 2022 Nov 11;13:528. doi: 10.25259/SNI_978_2022. PMID: 36447847; PMCID: PMC9699832.
27. McMaster M, Carey R. The lumbar theco-peritoneal shunt syndrome and its surgical management. J Bone Joint Surg Br. 1985;67-B(2):198-203. doi:10.1302/0301-620X.67B2.3980525
28. A late and extreme complication of lumboperitoneal shunt. Vural, Murat *et al.* The Spine Journal, Volume 15, Issue 5, e7 - e12

29. Johnston I, Jacobson E, Besser M. The acquired chiari malformation and syringomyelia following spinal CSF drainage: A study of incidence and management. Acta Neurochir (Wien) 1998;140:417–27

30. Hentati A, Badri M, Bahri K, Zammel I. Acquired Chiari I malformation due to lumboperitoneal shunt: A case report and review of literature. SurgNeurol Int. 2019 May 10;10:78. doi: 10.25259/SNI-234-2019. PMID: 31528416; PMCID: PMC6744799.

31. Chumas PD, Armstrong DC, Drake JM, *et al.* Tonsillar herniation: the rule rather than the exception after lumboperitoneal shunting in the pediatric population. J Neurosurg 1993;78(04):568–573

32. Payner TD, Prenger E, Berger TS, Crone KR. Acquired Chiari malformations: incidence, diagnosis, and management. Neurosurgery 1994;34(03):429–434, discussion 434

33. Duthel R, Nuti C, Motuo-Fotso MJ, Beauchesne P, Brunon J. Complications des dérivationslombo-péritonéales. Etude rétrospectived'unesérie de 195 patients (214 interventions) [Complications of lumboperitoneal shunts. A retrospective study of a series of 195 patients (214 procedures)]. Neurochirurgie. 1996;42(2):83-9; discussion 89-90. French. PMID: 8952901.