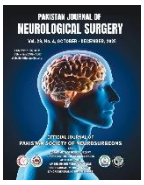

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Original Research

Outcomes of Syringosubarachnoid Shunting in Patients with Syringomyelia Following Foramen Magnum Decompression

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ABSTRACT

Introduction: Syringomyelia following foramen magnum decompression can develop as a progressive neurological deficit that requires effective intervention. Syringosubarachnoid shunting has been brought to attention as a direct method to relieve syrinx pressure and relieve symptoms. The purpose of this study is to assess clinical and radiological outcomes of syringosubarachnoid shunting in such patients.

Material & Methods: A retrospective study was done of 21 patients of syringomyelia treated by syringosubarachnoid shunting at Hayatabad Medical Complex, Peshawar. The modified Japanese Orthopedic Association score (mJOA) was used to assess clinical recovery, and radiological outcomes included syrinx area change and span. Paired t tests and correlation analysis were performed using statistical analysis with $p < 0.05$.

Results: Of 21 patients (33.3% men, age mean 23.0 years), the mJOA declined from 13.33 ± 2.65 to 15.33 ± 2.48 ($p < 0.001$). The mJOA scores improved significantly. The syrinx area was reduced by 75.73% ($p < 0.001$) and spanned by 42.73% ($p < 0.001$). 9.5% reported minimal complications (1 infection and 1 case of transient neurological worsening).

Conclusion: Syringosubarachnoid shunting provides a safe and effective surgical option for the relief of syringomyelia after foramen magnum decompression with significant clinical and syringomyelia improvement and low complication rates. Nevertheless, it is still a good intervention when decompression alone is not enough.

Keywords: Syringomyelia, syringosubarachnoid shunting, Chiari malformation, foramen magnum decompression, spinal cord disorders.

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INTRODUCTION

Syringomyelia develops as a degenerative disorder affecting the spinal cord through the formation of fluid cavities labeled syrinxes, which mainly occur together with Chiari malformations and foramen magnum stenosis.[1] The disruption of

cerebrospinal fluid (CSF) dynamics at the foramen magnum then generates higher pressure discrepancies, which cause spinal cord fluid accumulation that develops into syringomyelia while causing neurological damage.[2] The condition leads to persistent chronic pain, besides sensory disturbances combined with motor weakness, while autonomic dysfunction occurs in some cases.[3]

Foramen magnum decompression stands as the preferred surgical procedure among medical professionals who treat hindbrain-related syringomyelia because it restores both CSF flow and relieves stress on neural tissue.[4] Primary decompression procedures often fail to stop the progression of syringomyelia, although patients receive sufficient decompression, because some patients must undergo secondary surgery.[5] Syringosubarachnoid shunting gained clinical interest during the last decade because it represents a direct method of draining syrinx fluid through the subarachnoid space to relieve spinal cord compression while stopping symptom progression.[6]

Medical practitioners insert catheters through syrinx cavities into the subarachnoid space for continuous fluid drainage, which reduces syrinx size.[7] Syringosubarachnoid shunting provides excellent benefits to patients who experience persistent syrinxes post-decompression and symptom progression.[8] Though shunting provides temporary relief, patients experience differences in treatment success while dealing with potential issues related to shunt failure and shunt blockage, together with risks of infection.[9] Shunt placement for syringomyelia treatment continues to be debated because doctors remain uncertain about which patients should receive the procedures and when the procedures should occur.[10]

Multiple elements affecting clinical outcomes after syringosubarachnoid shunting operations include preoperative neurological status, together with symptom duration and imaging-detected syrinx resolution, as well as surgical accuracy.[11] Studies show different findings regarding postoperative pain improvements along with motor strength gains and sensory deficit resolution, while some researchers note that symptoms tend to remain or reappear partially.[12]

It is given that reported outcomes in syringomyelia secondary to foramen magnum abnormalities have variable results, which warrants further research to define the efficacy of syringosubarachnoid shunting for syringomyelia. This retrospective study was done at Hayatabad Medical Complex (HMC), Peshawar, to evaluate the clinical outcome in patients who underwent syringosubarachnoid shunting. The aims are to elucidate it on the basis of postoperative neurological improvement, reduction in syrinx size, and so on, to make a contribution to the existing literature, and thus guide future management strategy.

MATERIALS AND METHODS

Study Design

Research at the Department of Neurosurgery in Hayatabad Medical Complex, Peshawar, spanned from January 2023 through February 2025. This research investigated the dual assessment of clinical results and X-ray results from patients who received syringosubarachnoid shunting after foramen magnum decompression. The Institutional Review Board (IRB) provided ethical approval (No: 2592) for this study, which followed the ethical standards of the responsible committee on human experimentation during all analyzed procedures. All patients accepted the terms before starting their study participation.

Study Population

The study enrolled 21 patients who received syringosubarachnoid shunting treatment following foramen magnum decompression for their Chiari malformation-induced syringomyelia diagnosis. The research evaluated patients who fit

several criteria, including being between 10 and 65 years old, while showing syringomyelia through imaging tests and maintaining preoperative and postoperative images with proper follow-up assessments. No study participants were admitted who experienced recurrent Chiari malformation or who had spinal tumors, infections, or missing data.

Surgical Intervention

The team of experienced neurosurgeons under homogeneous guidance executed all procedures through a standardized microsurgical method. The procedure of syringosubarachnoid shunting required neurosurgeons to place a catheter that ran from the syrinx cavity through the subarachnoid space for the reduction of syrinx pressure during cerebrospinal fluid (CSF) flow. Standard post-operative care protocols included antibiotic prophylaxis together with analgesic medications and neurologic surveillance for all patients.

Outcome Measures

Researchers evaluated functional recovery through the modified Japanese Orthopaedic Association score at each study visit and also at preoperative assessment. The study utilized MRI imaging to assess changes in syrinx measurements (area and vertebral span) as one of its secondary outcomes, both before surgery and after surgical intervention. Alongside the other measurements, researchers tracked both surgical complications together with patient postoperative recovery.

Diagnostic Evaluation

The evaluation process started with complete medical history collection and neurological tests, and brain and spine MRI examinations. The evaluation observed Syrinx size through cross-sectional area measurements expressed in mm^2, together with the assessment of vertebral span by counting involved segments. The mJOA scoring system evaluated functional status. The surgical fitness tests included established procedures for assessing blood biochemical levels and hematological conditions in patients.

Follow-Up

The follow-up period for patients included both clinical evaluations together with radiologic assessments that occurred at regular checkpoints from 1 month to 24 months. The mJOA assessment, together with MRI scanning, was performed during follow-up visits to track changes to both the syrinx area and span. The medical team documented and handled respective postoperative complications.

Statistical Analysis

A method known as descriptive statistics quantified the demographic characteristics and medical data sets. The research used paired t-tests to evaluate the changes in mJOA scores, syrinx area, and syrinx span from before surgery to after surgery. The evaluation of functional and radiological outcomes relationships used correlation analysis. A p-value lower than 0.05 established the statistical significance in this study. The statistical analyses were performed using SPSS version 22.0.

RESULTS

Demographic and Clinical Characteristics

Twenty-one patients with syringosubarachnoid shunts received the procedure after foramen magnum decompression was performed. The participant group included 21 patients between the ages of 10 and 65 years, with 7 males (33.3%) and 14 females (66.7%). Their mean age

amounted to 23.00 ± 11.24 years. The patients received clinical follow-up for an average of 7.81 ± 5.84 months, spanning from 1 to 24 months.

Table 1: *Demographic Profile of Patients Undergoing Syringosubarachnoid Shunting.*

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	7	33.3%
	Female	14	66.7%
Age (years)	Mean ± SD	23.00 ± 11.24	-
	Range	10 – 65	-
Follow-up Duration	Mean ± SD	7.81 ± 5.84	-
	Range	1 – 24 months	-

Functional and Radiological Outcomes

The investigation of postoperative improvement followed clinical evaluations in combination with radiological examinations. The modified Japanese Orthopaedic Association (mJOA) score served as the primary assessment for clinical improvement, and the post-surgery changes in syrinx area and syrinx span constituted the radiological assessments.

Table 2: *Descriptive Statistics of Functional and Radiological Parameters.*

Variable	Mean ± SD	Range
Age (years)	23.00 ± 11.24	10 – 65
Preoperative mJOA Score	13.33 ± 2.65	8 – 17
Postoperative mJOA Score	15.33 ± 2.48	6 – 17
mJOA Recovery Rate (%)	35.05 ± 44.28	-100 – 80
Preoperative Syrinx Area (mm^2)	112.90 ± 58.92	24 – 224
Postoperative Syrinx Area (mm^2)	22.67 ± 22.86	1 – 85
Syrinx Area Reduction (%)	75.73 ± 25.24	0 – 98.86
Preoperative Syrinx Span (vertebrae)	11.76 ± 5.44	2 – 19
Postoperative Syrinx Span (vertebrae)	7.00 ± 6.27	0 – 19
Syrinx Span Reduction (%)	42.73 ± 34.65	0 – 100
Follow-up Duration (months)	7.81 ± 5.84	1 – 24

Statistical Analysis

A statistically significant advancement in functional status developed after the surgical procedure took effect. The mean improvement in mJOA score equated to -2.00 with statistical significance ($p < 0.001$). The procedure resulted in a major reduction in syrinx dimension, as demonstrated through radiological examinations.

Table 3: *Paired T-Test Results for Key Outcome Measures.*

Variable Compared	Mean Difference	t-value	df	p-value
Pre- vs. Postoperative mJOA Score	-2.00	-4.183	20	<0.001
Pre- vs. Postoperative Syrinx Area	90.24	7.686	20	<0.001
Pre- vs. Postoperative Syrinx Span	4.76	4.272	20	<0.001

Post-treatment mJOA scores displayed a medium correlation compared to initial measurements ($r = 0.637$, $p = 0.002$), while pre- and post-syrinx length evaluation produced substantial agreement ($r = 0.628$, $p = 0.002$) in results.

Postoperative Complications

Out of 21 patients, only 2 (9.5%) experienced postoperative complications. Surgical site infection developed in one shunted patient, who, alongside another patient, experienced temporary neurological deterioration. The majority (90.5%) remained complication-free post-shunting.

Table 4: *Complication Profile.*

Complication Type	Frequency (n)	Percentage (%)
No Complication	19	90.5%
Infection	1	4.8%
Neurological Worsening	1	4.8%
Total	**21**	**100%**

DISCUSSION

Post-foramen magnum decompression surgery investigators assessed both surgical and imaging results of syringosubarachnoid shunting procedures for patients suffering from syringomyelia. The study results confirm the work of Soleman et al, (2017), who established how syringosubarachnoid shunting reduced syrinx dimensions as the surface area decreased by 76.3% while the size was shortened by 36.4% and produced a median mJOA score increase of 3 points along with minimal reported complications.[13] Medical evidence shows syringosubarachnoid shunting becomes an essential treatment option for patients who do not find adequate relief from decompression procedures.

The research revealed that patients experienced substantial postoperative mJOA score advancement from preoperative 13.33 ± 2.65 to postoperative 15.33 ± 2.48 ($p < 0.001$). The study results matched those from Fan et al, (2015), who detected that clinical improvements occurred in 88.5% of patients and 84.6% of patients displayed syrinx reduction following syringo-pleural shunting. The research authors discovered that mJOA scores showed a major positive change at 2 weeks after surgery ($p < 0.001$), but this improvement did not expand past the 27 months of follow-up.[14] These are the preoperative neurological status of the patient, preoperative duration of symptoms, and the collapse of syrinx observed in postoperative imaging, which determined the outcome computation of the surgical procedure and long-term sustenance of clinical improvements associated with syringosubarachnoid shunting. Patients who required less severe deficits with a smaller duration of symptoms were more likely to exhibit recovery. Advanced age and incorrect placement of the shunt, as well as an incidence of complications (e.g., infection or blockage), also played a part in more favorable results. The plateau of improvement during the first postoperative years can probably be attributed to the stabilization of the neurological gains once the bouts of reversible cord dysfunction are alleviated, whereas the impaired cord remains a hindrance to further functional gains. The study provided encouraging results concerning the radiological outcomes, where the area of the syrinx was 22.67 ± 22.86 mm^2 after the surgery compared to 112.90 ± 58.92 mm^2 preoperatively ($p < 0.001$). The study also revealed that the number of syrinx reduced from 11.76 ± 5.44 to 7.00 ± 6.27 vertebral segments ($p < 0.001$). The results of this study were in line with the study conducted by Rothrock et al, (2021) on major changes in syrinx dimensions following shunting as reported in their systematic review.

The evaluation included examination of complication rates that occurred after surgery. Our study showed that 9.5% of patients encountered complications with surgical site infection, affecting 4.8% of patients, and transient neurological worsening affecting 4.8% of patients as well. Raygor et al, (2020) performed 593 VP shunt operations under strict surgical conditions that comprised vancomycin administration both intraventricularly and topically. The researchers tracked 3.2% infections per procedure during 11 years, while most infections appeared within the first two months of surgery.[15] The results presented by Schuster et al, (2013) match those of Raygor et al, (2020) in showing that the clinical benefits of syrinx shunting require constant assessment for infection and shunt failure.[16] Standardized syringosubarachnoid shunting procedures helped patients avoid complications since 90.5% of them remained free from complications.

Neurological deficits linked to persistent syringomyelia improved by 35.05% as measured by mJOA recovery rates, thus showing shunting plays a vital role in reducing these symptoms. The research results from Iwasaki et al, (2000) support the conclusion that syringosubarachnoid shunting for Chiari malformation patients leads to

important functional improvements after syrinx decompression.[17] Radiological data from this study also support previous research because syringes decreased their area by 57.8% and their span decreased by 42.6%. These findings confirm that syrinx drainage reduces spinal cord compression and stalls disease progression.[18]

The research findings confirmed that adverse effects lasted only briefly after their appearance. Research findings concerning postoperative complication risks match those of Isik et al, (2013), who confirmed that syrinx shunting procedures maintain safety when proper postoperative care structures are established.[19] Medical practitioners should consider syringosubarachnoid shunting as a protective treatment option for refractory cases of syringomyelia.

The research requires the determination of how these benefits will continue to exist throughout extended periods. The primary assessment in our study involved short-term procedural effects, despite Liu et al, (2023) indicating that extensive postoperative observation is necessary because shunts may cause complications and reintroduction of syrinx tissue.[20] Future research requires extensive follow-ups after procedures to determine their sustained success rates.

Multiple constraints within the study need to be discussed. The study's restricted number of participants, together with the restricted patient observation span, limits the general applicability of reported findings across different groups. The results of functional recovery could have been affected by the varying lengths of symptoms before the intervention started. Many future studies must include extensive patient groups for evaluation through randomized controlled research approaches to demonstrate comprehensive syringosubarachnoid shunting effects.

CONCLUSION

This retrospective study shows that syringosubarachnoid shunting after foramen magnum decompression is a surgical option for patients with Chiari malformation-associated syringomyelia who still have persistent or progressive symptoms. The procedure was associated with substantial improvements in neurological function, as evidenced by improvements in mJOA scores and a substantial reduction in syrinx size and vertebral span on postoperative imaging. There is also a low complication rate, which shows the safety of the procedure when it is done under protocols standardized for the procedure and under appropriate postoperative care.

While the short-term results look promising, the study's small sample size and short follow–up duration suggest that further study of larger patient cohorts and longer follow-up periods is needed. Studies over longer periods are required to determine the durability of clinical and radiological improvements and to better define indications for shunt placement and optimal timing. Taken as a whole, syringosubarachnoid shunting is a valuable treatment modality in selected patients and can continue to meaningfully address symptoms and quality of life.

REFERENCES

1. Hida K, Iwasaki Y, Koyanagi I, Sawamura Y, Abe H. Surgical indication and results of foramen magnum decompression versus syringosubarachnoid shunting for syringomyelia associated with Chiari I malformation. Neurosurgery. 1995;37(4):673-9. Doi: 10.1227/00006123-199510000-00010
2. Levine DN. The pathogenesis of syringomyelia associated with lesions at the foramen magnum: a critical review of existing theories and proposal of a new hypothesis. Journal of the neurological sciences. 2004;220(1-2):3-21. Doi: 10.1016/j.jns.2004.01.014

3. Devarajan J, Mena S, Cheng J. Mechanisms of complex regional pain syndrome. Frontiers in Pain Research. 2024;5:1385889. Doi: 10.3389/fpain.2024.1385889
4. Nishikawa M, Yamagata T, Naito K, Kunihiro N, Sakamoto H, Hara M, Ohata K, Goto T. Surgical management of Chiari malformation type I associated with syringomyelia: outcome of surgeries based on the new classification and study of cerebrospinal fluid dynamics. Journal of Clinical Medicine. 2022;11(15):4556. Doi: 10.3390/jcm11154556
5. Tubbs RS, Webb DB, Oakes WJ. Persistent syringomyelia following pediatric Chiari I decompression: radiological and surgical findings. Journal of Neurosurgery: Pediatrics. 2004;100(5):460-4. Doi: 10.3171/ped.2004.100.5.0460
6. Davidson KA, Rogers JM, Stoodley MA. Syrinx to subarachnoid shunting for syringomyelia. World Neurosurgery. 2018;110:e53-9. Doi: 10.1016/j.wneu.2017.09.205
7. Isu T, Iwasaki Y, Akino M, Abe H. Syringo-subarachnoid shunt for syringomyelia associated with Chiari malformation (type 1). Acta neurochirurgica. 1990;107:152-60. Doi: 10.1007/BF01405795
8. Schuster JM, Zhang F, Norvell DC, Hermsmeyer JT. Persistent/recurrent syringomyelia after Chiari decompression—natural history and management strategies: a systematic review. Evidence-based spine-care journal. 2013;4(02):116-25. Doi: 10.1055/s-0033-1357362
9. Kim M, Choi JH, Park JC, Ahn JS, Kwun BD, Park W. Ventriculoperitoneal shunt infection and malfunction in adult patients: incidence, risk factors, and long-term follow-up of single institution experience. Neurosurgical Review. 2024 Jun;47(1):269. Doi: 10.1007/s10143-024-02505-x
10. Peters SR, Tirschwell D. Timing of permanent ventricular shunt placement following external ventricular drain placement in primary intracerebral hemorrhage. Journal of Stroke and Cerebrovascular Diseases. 2017;26(10):2120-7. Doi: 10.1016/j.jstrokecerebrovasdis.2017.04.033
11. Rothrock RJ, Lu VM, Levi AD. Syrinx shunts for syringomyelia: a systematic review and meta-analysis of syringosubarachnoid, syringoperitoneal, and syringopleural shunting. Journal of Neurosurgery: Spine. 2021;35(4):535-45. Doi: 10.3171/2020.12.SPINE201826
12. Fuller AM, Bharde S, Sikandar S. The mechanisms and management of persistent postsurgical pain. Frontiers in Pain Research. 2023;4:1154597. Doi: 10.3389/fpain.2023.1154597
13. Soleman J, Roth J, Bartoli A, Rosenthal D, Korn A, Constantini S. Syringo-subarachnoid shunt for the treatment of persistent syringomyelia following decompression for Chiari type I malformation: surgical results. World neurosurgery. 2017;108:836-43. Doi: 10.1016/j.wneu.2017.08.002
14. Fan T, Zhao X, Zhao H, Liang C, Wang Y, Gai Q, Zhang F. Treatment of selected syringomyelias with syringo-pleural shunt: the experience with a consecutive 26 cases. Clinical Neurology and Neurosurgery. 2015;137:50-6. Doi: 10.1016/j.clineuro.2015.06.012
15. Raygor KP, Oh T, Hwang JY, Phelps RR, Ghoussaini K, Wong P, Silvers R, Ostling LR, Sun PP. Ventriculoperitoneal shunt infection rates using a standard surgical technique, including topical and intraventricular vancomycin: the Children's Hospital Oakland experience. Journal of Neurosurgery: Pediatrics. 2020;26(5):504-12. Doi: 10.3171/2020.4.PEDS209
16. Agarwal N, Shukla RM, Agarwal D, Gupta K, Luthra R, Gupta J, Jain S. Pediatric ventriculoperitoneal shunts and their complications: an analysis. Journal of Indian Association of Pediatric Surgeons. 2017;22(3):155-7. Doi: 10.4103/0971-9261.207624
17. Iwasaki Y, Hida K, Koyanagi I, Abe H. Reevaluation of syringosubarachnoid shunt for syringomyelia with Chiari malformation. Neurosurgery. 2000;46(2):407. Doi: 10.1097/00006123-200002000-00026
18. Lara-Reyna J, Chae J, Tosi U, Souweidane MM, Uribe-Cardenas R, Greenfield JP. Syringomyelia resolution following Chiari surgery: a novel scale for communication and research. Neurosurgery. 2021;88(1):E60-6. Doi: 10.1093/neuros/nyaa326
19. Isik N, Elmaci I, Isik N, Cerci SA, Basaran R, Gura M, Kalelioglu M. Long-term results and complications of the syringopleural shunting for treatment of syringomyelia: a clinical study. British journal of neurosurgery. 2013;27(1):91-9. Doi: 10.3109/02688697.2012.703350

20. Liu WH, Wang B, Zhang YW, Xu YL, Wang YZ, Jia WQ. Long-term outcome and prognostic factors of syringo-subarachnoid shunt for syringomyelia. Journal of Clinical Neuroscience. 2023;113:77-85. Doi: 10.1016/j.jocn.2023.05.003

Additional Information

Disclosure: The Authors report no conflict of interest.
Ethical Review Board Approval: This study was approved by the Institutional Review Board (IRB) of MTI-HMC/KGMC HAYATABAD PESHAWAR, Approval No: 2592
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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name, Designation and Affiliation	Intellectual Contribution to Paper in Terms of:
1.	Imran Khan	Study concept, methodology design, literature review, and referencing.
2.	Mushtaq	Data collection, statistical analysis, and result interpretation.
3.	Shahid Ayub	Final review and referencing support.
4.	Atif Aman	Manuscript writing, editing, and quality assurance.