Impact of Bobath Based Rehabilitation Program and Conventional Physiotherapy: Children with Hydrocephalus

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Abstract

Introduction. *Hydrocephalus is an abnormal enlargement of the brain ventricles caused by increased amounts of cerebrospinal fluid. The aim of the study was to determine the efficacy of Bobath Based Rehabilitation Program and conventional physiotherapy for improving motor function in children with hydrocephalus and reducing levels of anxiety in parents of children with hydrocephalus.*

Materials and methods. *The study design was quasi experimental in nature. Twenty patients with hydrocephalus, aged below 10 years, both males and females were included as per the eligibility criteria. All parents provided their written informed consent for participations in the study. These subjects were randomly divided into two equal groups using computer generated table: group A (n = 10) and group B (n = 10). All patients were assessed for motor function using GMFM-88 scale, whereas their parents were evaluated for anxiety levels using STAI tool. Group A received Bobath Based Rehabilitation Program whereas group B received conventional physiotherapy. Both groups received interventions for a total of 8 weeks, with 1 60-minute session per week and their parents were taught an individualized program of home exercises and encouraged to practice daily. Then the subjects were re-assessed after completing 8 weeks of interventions. Statistical analysis was performed using paired t-test and unpaired t-test.*

Results. *Our study revealed statistically significant difference in the GMFM-88, STAI-S and STAI-T scores in group A (p = 0.032, 0.0001, 0.0001) and group B (p = 0.0001, 0.001, 0.003), respectively.*

Discussion. *These two interventions have their benefits in improving gross motor function in children with hydrocephalus. These interventions can indeed be customized to address specific needs of children with hydrocephalus, such as muscle weakness, impaired coordination, and balance issues. This personalized approach optimizes the intervention effectiveness directly targeting the areas of difficulty experienced by each child. Moreover, these therapeutic approaches engage mechanisms of neuroplasticity through repetitive and task-specific exercises. Training general physiotherapists to deliver both therapies efficiently could maximize access to rehabilitation services in areas with inadequate healthcare infrastructure.*

Conclusion. *Bobath Based Rehabilitation Program and conventional physiotherapy are effective interventions for improving motor function in children with hydrocephalus and in reducing levels of anxiety in their parents.*

Keywords: *hydrocephalus; motor function; anxiety; Bobath based rehabilitation program*

Ethics approval. The study was conducted with the informed consent of the patients.

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Сравнение эффективности программы реабилитации на основе концепции Бобат и стандартной физической реабилитации у детей с гидроцефалией

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Аннотация

Введение. *Гидроцефалия – это состояние, при котором развивается патологическое увеличение желудочков головного мозга, вызванное избытком спинномозговой жидкости.* **Цель** *исследования – оценить, насколько эффективна реабилитационная программа на основе концепции Бобат и стандартные методы физической реабилитации с точки зрения улучшения двигательной функции у детей с гидроцефалией и снижения уровня тревожности у их родителей.*

Материалы и методы. *Исследование имело квазиэкспериментальный дизайн. В соответствии с критериями включения в исследование были включены 20 пациентов с гидроцефалией, среди которых были представители обоих полов в возрасте до 10 лет. Все родители предоставили письменное добровольное информированное согласие на участие их детей в исследовании. Пациентов рандомизировали в две равные по численности группы с использованием сгенерированной на компьютере таблицы: группу A (n = 10) и группу B (n = 10). У всех пациентов оценили двигательную функцию с помощью шкалы GMFM-88. У их родителей оценивали уровень тревожности с помощью опросника STAI. В группе A пациенты проходили реабилитацию на основе концепции Бобат, а в группе B – стандартную программу физической реабилитации. В обеих группах общая длительность лечения составила 8 нед. Пациентам проводили по одному сеансу длительностью 60 мин 1 раз в неделю, при этом родителей обучали индивидуальному комплексу упражнений и рекомендовали ежедневно выполнять его дома. Через 8 нед пациентов оценивали повторно. Статистический анализ выполнили с использованием t-критерия Стьюдента для зависимых и независимых выборок.*

Результаты. *В рамках настоящего исследования были выявлены статистически значимые различия в оценках GMFM-88, STAI-S и STAI-T между группой A (p = 0,032, 0,0001, 0,0001) и группой B (p = 0,0001, 0,001, 0,003).*

Обсуждение. *Обе программы реабилитации имеют свои преимущества с точки зрения улучшения крупной моторики у детей с гидроцефалией. Рассматриваемые методы можно адаптировать под потребности конкретного пациента с гидроцефалией с учётом степени слабости мышц, нарушения равновесия и координации. Такой индивидуальный подход позволяет максимально повысить эффективность реабилитации и скорректировать нарушения у ребёнка. Кроме того, рассматриваемые методы активируют механизмы нейропластичности благодаря повторению упражнений, направленных на решение конкретных задач. Обучение специалистов обеим программам реабилитации может повысить доступность такой помощи в регионах с недостаточно развитой инфраструктурой здравоохранения.*

Заключение. *Программа реабилитации на основе концепции Бобат и стандартная физическая реабилитация существенно улучшают двигательную функцию у детей с гидроцефалией и снижают уровень тревожности у их родителей.*

Ключевые слова: *гидроцефалия; двигательная функция; тревожность; программа реабилитации на основе концепции Бобат*

Этическое утверждение. Исследование проводилось при условии получения письменного добровольного информированного согласия пациентов.

Источник финансирования. Авторы заявляют об отсутствии внешних источников финансирования при проведении исследования.

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Introduction

Hydrocephalus is a common central nervous system disorder in children and is unique in being caused by widely differing prenatal, perinatal, or postnatal events [1]. It affects patients of any age, with thousands of new cases each year in the United States and many more globally [2]. Hydrocephalus is an abnormal enlargement of the brain ventricles due to increased amounts of cerebrospinal fluid (CSF). Excessive pressure in the ventricles exerted by CSF compresses the nervous tissue, which causes brain damage and may result in disproportionally large head size in new-borns or infants [3].

Paediatric hydrocephalus (namely, congenital, prematurity germinal matrix bleed, postinfectious, and neoplastic) when compared to adult patients of hydrocephalus is more complicated and has significantly more developmental and cognitive morbidities [4]. The incidence of congenital hydrocephalus has been estimated to be about 0.5 cases per 1000 live births and the overall incidence of neonatal hydrocephalus is estimated to be about 3 to 5 cases per 1000 live births [5, 6]. The overall global hydrocephalus prevalence is 85/100,000. When stratified by age groups, the global prevalence of hydrocephalus is 88/100,000 in the paediatric population. The prevalence of hydrocephalus is significantly higher in Africa and South America when compared to other continents [7]. The pooled estimated incidence of congenital hydrocephalus is highest in Africa and Latin America (145 and 316 per 100,000 births, respectively) and lowest in the United States/Canada (68 per 100,000 births) [8]. As far as India (Chhattisgarh) is concerned, male to female ratio for congenital hydrocephalus is 3 : 2. Infective hydrocephalus occurs maximally in children aged 2 to 5 years, while neoplastic hydrocephalus occurs in children aged 5 to 10 years, and congenital hydrocephalus is documented in children aged 1–6 months [9].

The most common cause of acquired hydrocephalus in infants is intraventricular haemorrhage, usually due to premature birth. Older children typically present with a combination of headache, vomiting, cranial nerve signs, loss of developmental milestones, changes in vision, or papilledema. Disabilities associated with hydrocephalus depend on the patient's age. Infants may present with irritability, vomiting, headache, an abnormally increasing head circumference, bulging of the anterior fontanelle, splaying of the cranial sutures, downward deviation of the eyes (sun setting appearance), behavioural changes or decreased interest in feeding [10, 11]. Congenital and early-onset hydrocephalus can be prevented by supplementation with folic acid during pregnancy [12].

Hydrocephalus is the leading indication for paediatric neurosurgical care worldwide [13]. The increased intracranial pressure interferes with the function of the adjacent structures and can cause a range of impairments in brain function. A ventriculoperitoneal shunt is a cerebral shunt that drains extra CSF in hydrocephalus patients [3]. Complications of ventriculoperitoneal shunts include block, infection, shunt chamber migration, shunt tip displacement, shunt tract collection, and seizures [14]. The complications resulting from shunts implanted during infancy can lead to general movement dysfunction and can cause a decreased ability to appropriately interact with peers and understand social cues [15].

Research has shown that complications from shunts for infantile hydrocephalus can lead to lifetime disorders with comorbidities that impair social functioning and mobility. Previous literature suggested application of strengthening exercises for core muscles, upper extremities and lower extremities in a six-year-old boy with lumbar spina bifida with meningocele post resection and hydrocephalus post ventriculoperitoneal shunt placement. A therapeutic program comprising range of motion exercises, trunk control exercises, pelvic stability exercise, and educating parents about positioning and handling and coordination exercises improved the independence of the child [3].

Having a child with hydrocephalus presents significant challenges across various domains, including financial, physical, social, and psychological aspects, profoundly impacting parents. The diagnosis of hydrocephalus elicits feelings of fear, confusion, and helplessness as parents grapple with understanding the condition and its implications for their child's health and future. Uncertainty about the long-term prognosis leads to persistent anxiety, disrupting routines and affecting work and social activities. Neurosurgical treatment adds another layer of stress for both paediatric patients and caregivers [16, 17].

It has been documented that low income, a lack of health insurance, and providing home care for more than one person all contribute significantly to parental worry [18]. Given that the parents of these children are more anxious, a study introducing physiotherapy programmes into the lives of children with hydrocephalus and assessing anxiety as a key variable is needed.

Physical disability is the most common cause of poor quality of life in children with hydrocephalus. There is minimal to scarce literature on physiotherapy interventions especially in such children. Thus, this study is an attempt to investigate the effectiveness of physiotherapeutic interventions on the motor function in children with hydrocephalus, as well as their impact on the levels of anxiety among parents of affected children.

Materials and methods

Twenty-six post operated children with hydrocephalus were screened at the Outpatient Department and Inpatient Department of Paediatric Surgery Division of Department of Surgery, Guru Gobind Singh Medical College and Hospital, Faridkot and Outpatient Department of Physiotherapy, University College of Physiotherapy, Faridkot, Punjab. Twenty-two patients met the eligibility criteria and were enrolled in the study. The selected patients had a diagnosis of hydrocephalus (congenital/acquired, obstructive/non-obstructive) according to CT scan, ultrasound and MRI, confirmed by a paediatric surgeon. The patients were both males and females, aged below 10 years, which had undergone right ventriculoperitoneal shunting. Patients were included minimum 7 days and maximum 3 months post-surgery. Uncooperative patients, patients enrolled in another clinical trial, patients required immediate intensive intervention for safety reasons, patients with other neurological disorders such as spina bifida, cerebral palsy, seizures in combination of hydrocephalus

and patients whose parents did not provide consent to participate were excluded from the study. The ethical approval was granted by the Institutional Ethical Committee, Baba Farid University of Health and Sciences, Faridkot prior to the beginning of the study. The demographic profile and detailed medical history of the patients were taken through their parents' interviews as well as medical records. Written informed consent was obtained from the parents of each enrolled patient, explaining the nature of study thoroughly.

All the patients in both groups were assessed for motor function using Gross Motor Function Measure (GMFM-88), and the parents of all the patients were evaluated for levels of anxiety using State Trait Anxiety Inventory (STAI). The selected patients were randomly divided into two groups using computer generated table: Group A (n = 11) and Group B (n = 11). Group A received Bobath based Rehabilitation Program (BBRP)whereas Group B received Conventional Physiotherapy (CP) for a total of eight weeks, with one supervised session per week lasting for 60 minutes. This study included a rural population and it was challenging for parents and children to come daily for physiotherapeutic program in any setting; therefore, the parents of the children in both groups were taught exercises to perform at home for the rest of the week for a total of eight weeks program. Between therapy sessions, the parents would video call the therapist, and the therapist would also conduct video calls to assess compliance. All the subjects and their parents were re-assessed for the above variables after eight weeks of intervention completion in both the groups.

The motor function was assessed using Gross Motor Function Measure, which consists of 88 items grouped into five dimensions: lying and rolling; sitting; crawling and kneeling; standing; walking, running, and jumping. Items are scored on a four-point ordinal scale. For K-GMFM-88, the intraclass correlation coefficient (ICC) ranged from 0.978 to 0.995, and Spearman's correlation coefficient ranged from 0.916 to 0.997. Parents' levels of anxiety were assessed using State-Trait Anxiety Inventory (STAI), which was developed by Charles Spielberger in 1970. The STAI consists of a 20-item State Anxiety Scale (STAI- S) and a 20-item Trait Anxiety Scale (STAI-T). The STAI-S assesses the temporary anxiety evoked by a situation while the STAI-T assesses general anxiety levels. The STAI was established with the reliability at 0.850. The State Cronbach's alpha was 0.797 and Trait Cronbach alpha was 0.781.

The duration between the surgical intervention and the initiation of rehabilitation ranged from 7 days (minimum) to 3 months (maximum).BBRP comprised exercises for head control, functional reaching exercises, weight shifting in various positions, trunk turning, balance exercises, weight bearing exercises, stepping exercises, quadruped imbalances, and imbalances from the "kneeling" position. The nature of the exercises and the number of repetitions were based on the patient's ability and level of performance. A complete description of BBRP is provided in the Appendix 1. CP comprised exercises for muscle strengthening, postural maintenance, postural changes, bridging, sit to stands, calf raises, standing marches, and step ups. The nature of the exercises and the number of repetitions were also based on the patient's ability and level of performance. A complete description of CP is provided in the Appendix 2.

Two patients voluntarily discontinued the interventional program due to compliance-related issues and were considered dropouts. Thus, a total of 20 patients completed the study: Group A (5 males, 5 females) and Group B (7 males, 3 females).

The data were analysed using SPSS v. 26. The patients were assessed for homogeneity of age, height, weight, and BMI as well as for baseline GMFM-88, STAI-S and STAI-T scores. The differences among all the variables were not significant as illustrated in Table 1.

Table 2 shows the comparison of the mean GMFM-88, STAI-S and STAI-T scores before and after the intervention in two groups. The analysis of the GMFM-88, STAI-S and STAI-T scores using Student's t-test indicated significant difference ($p < 0.05$) at pre- (week 0) and post-intervention (week 8) in both groups.

The analysis of difference between the mean pre- and post-GMFM-88, STAI-S and STAI-T scores in groups A and B is provided in Table 3. A comparison of the GMFM-88, STAI-S and STAI-T scores revealed a statistically non-significant difference ($p > 0.05$) between groups A and B.

Discussion

Our study comprised a rural Indian population of children with hydrocephalus. A total of twenty-two patients with hydrocephalus were initially included in the study. However, two patients were unable to complete the intervention due to compliance-related issues. Thus, a total of twenty patients successfully completed the interventional program. In developed nations, children with hydrocephalus benefit from advanced diagnostics, timely surgical interventions, and structured rehabilitation, ensuring they reach early developmental milestones. In contrast, developing countries like India, especially in rural areas, often lack basic healthcare facilities, leading to delayed diagnosis and surgery for many children.

While urban and affluent families may access comprehensive care, children in remote and lower-income regions face significant barriers to rehabilitation, including insufficient facilities, long travel distances, and unreliable transportation. These challenges limit effective postsurgical rehabilitation and delay developmental progress, despite efforts by programs, NGOs, and government initiatives to improve access. The scarcity of rehabilitation units, compounded by the lower socioeconomic status of these families, restricts the availability of therapy sessions, as travelling to distant centres becomes impractical. Hence, this might be the reason that rehabilitation specialists cannot provide frequent therapy sessions for these children. Thus, the study interventions, which were implemented once a week, included supervised training sessions among rural patients.

Hydrocephalus leads to motor impairments, resulting in delayed developmental milestones such as sitting up, crawling, and walking. The evaluation of motor function in hydroceph-

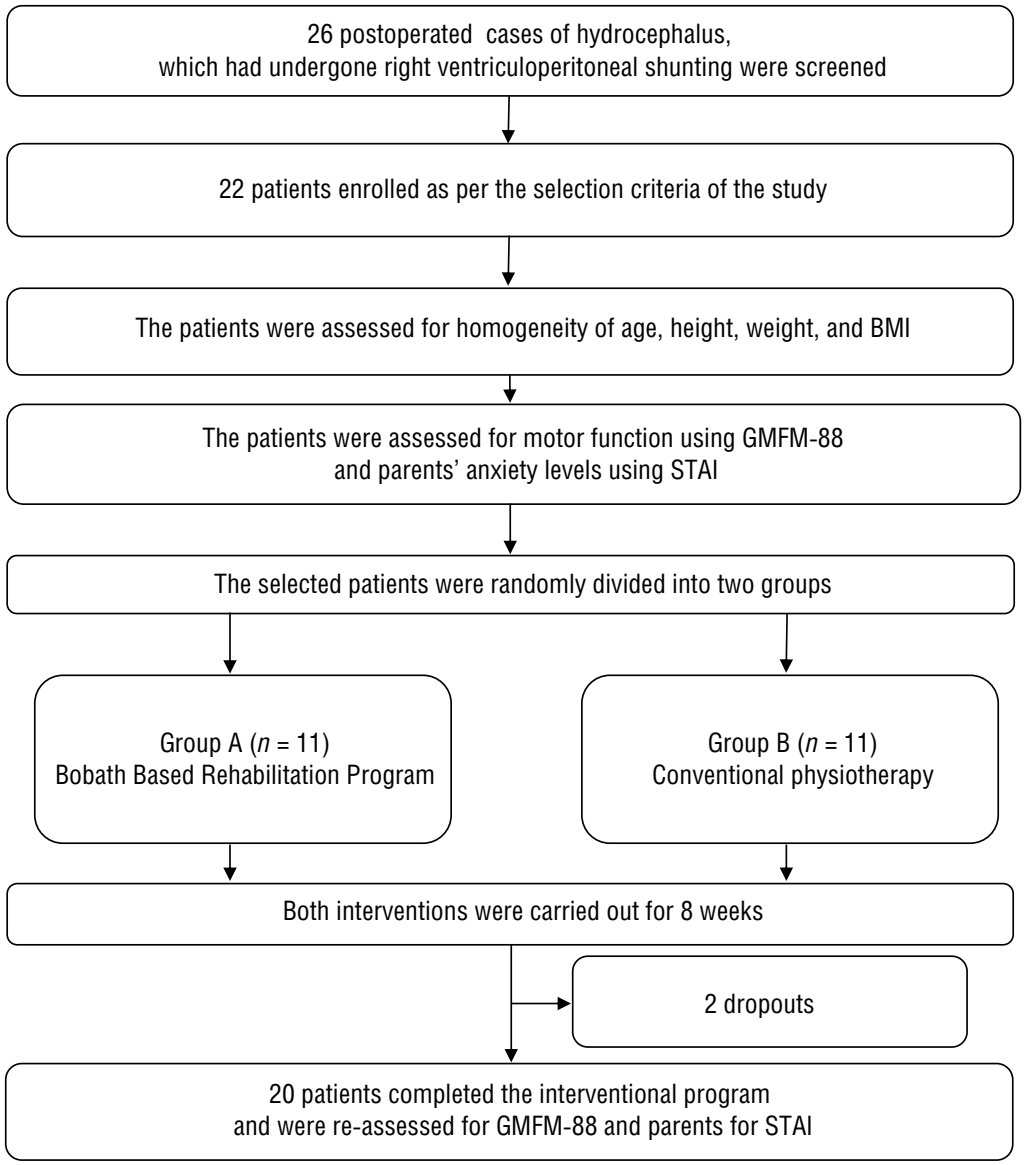

Fig. 1. Study flowchart.

Table 1. Comparison of the mean age, height, weight, and BMI, and baseline GMFM-88, STAI-S and STAI-T scores between groups A and B, *M* ± *SD*

Parameter	Group A (5 males, 5 females)	Group B (7 males, 3 females)	*t*	*p*
Age, months	30.90 ± 31.37	33.4 ± 30.5	–0.181	0.859
Height, cm	77.32 ± 22.9	78.78 ± 23.84	–0.140	0.890
Weight, kg	8.80 ± 2.83	10.00 ± 4.14	–0.757	0.459
BMI, kg/m^2	12.54 ± 2.62	14.07 ± 2.51	–0.985	0.350
GMFM-88, score	25.29 ± 26.70	33.23 ± 33.30	–0.588	0.564
STAI-S, score	57.2 ± 9.8	54.2 ± 10.2	0.67	0.511
STAI-T, score	56.4 ± 8.9	52.6 ± 11.0	0.85	0.406

Table 2. Comparison of the mean GMFM-88, STAI-S and STAI-T scores at pre- and post-intervention in groups A and B, *M* ± *SD*

Parameter	Group A		*t*	*p*	Group B		*t*	*p*
	week 0	week 8			week 0	week 8		
STAI-S, score	57.2 ± 9.84	37.1 ± 4.74	6.339	0.0001	54.2 ± 10.17	38.9 ± 3.63	5.093	0.001
STAI-T, score	56.4 ± 8.86	37.7 ± 3.94	6.121	0.0001	52.6 ± 11.02	38.4 ± 4.59	4.085	0.003
GMFM-88, score	25.3 ± 26.7	38.35 ± 31.07	–2.526	0.032	33.23 ± 33.3	45.18 ± 35.3	–7.827	0.0001

Table 3. Comparison of improvement in the mean GMFM-88, STAI-S and STAI-T scores at pre- and post-intervention in groups A and B, *M* ± *SD*

Parameter	Group A	Group B	*t*	*p*
GMFM-88, score	13.06 ± 16.35	11.95 ± 4.83	0.206	0.839
STAI-S, score	–20.10 ± 10.03	–15.30 ± 9.49	–1.099	0.286
STAI-T, score	–18.70 ± 9.66	–14.20 ± 10.99	–0.972	0.344

alus helps monitor the potential neurological damage caused by increased intracranial pressure. It aids in diagnosing and tracking the progression of the condition, guiding treatment decisions.

In this study, motor function was assessed in both groups using GMFM-88. Although GMFM-88 has not been validated in children with hydrocephalus, it is the most widely used scale in literature. It has been employed to measure motor function in children with cerebral palsy, Down syndrome, and spinal cord diseases [19–21]. D.J. Russell et al. reported that the GMFM-88 might be used to assess functional improvement in individuals other than those with CP [21]. A study performed by K.H. Lee et al. showed that intensive neurodevelopmental treatment was effective not only for managing developmental disabilities without CP but also for addressing them in CP [23].

The GMFM-88 scores improved in groups A and B who received BBRP and CP, respectively. The two interventions have their benefits in improving gross motor function in children with hydrocephalus. They can be customized to address the specific needs of children with hydrocephalus, such as muscle weakness, impaired coordination, and balance issues. This personalized approach optimizes the intervention effectiveness by directly targeting the areas of difficulty experienced by each child. Moreover, these therapeutic approaches engage mechanisms of neuroplasticity through repetitive and task-specific exercises. By consistently challenging the brain with these activities, therapies stimulate the formation of new neural connections, facilitating improvements in motor function over time [24–27].

Furthermore, involving parents or caregivers in the therapy process is crucial for maximizing its benefits. Educating parents about therapeutic techniques and providing them with a home program empowers them to reinforce therapy goals outside the clinical setting. This continuity of care promotes progress in motor function and ensures that the benefits of treatment extend beyond therapy sessions. Additionally, analysis revealed that there was no significant difference in improvement between the two groups, indicating that both interventions are equally effective and that none are superior to one another.

Parents of children with hydrocephalus experience profound anxiety due to uncertainties about the condition's progression, the effectiveness of treatments, and potential complications, as well as with the demanding daily care and lifestyle adjustments needed. Financial concerns about the high costs of treatment add to their stress. They often feel isolated socially and emotionally overwhelmed by their child's health challenges, including fears of developmental delays or disabilities, which can impact the entire family dynamic and further intensify their anxiety.

In a study performed by F.B. Mwiinga et al., parents reported having feelings of anxiety, sadness, stress, and depression as a result of caring for a child with hydrocephalus. In the present study, the level of anxiety in parents of children with hydrocephalus was evaluated using STAI-S and STAI-T, with improvement observed in the STAI-S and STAI-T scores in both groups [28]. A pivotal reason that parents find hope in their child's progress is witnessing them achieving milestones that were previously deemed unattainable, serving as poignant symbols of potential improvement and resilience.

Witnessing tangible growth in their child's motor abilities might help reduce parental worry by instilling hope and providing a sense of relaxation [29].The active involvement of parents in home-based therapy corresponds with recent studies indicating that educating parents about therapeutic strategies develops a sense of control and can lead to improved psychological outcomes [30].

As highlighted in the literature, parents' and therapists' supportive interaction also probably helped lower anxiety. It has been demonstrated that parents who receive effective communication and empathy from healthcare professionals feel less alone, more supported, and validated, all of which considerably reduce anxiety [31]. Engaging parents in a network of shared experiences and offering social support is consistent

with research showing that these components lessen feelings of loneliness and emotional stress [32].

One notable strength of this study is its focus on a rural population, which addresses a gap in the current literature, as no previous studies have specifically explored this demographic. The study was delimited geographically to rural areas around Faridkot. Furthermore, due to compliance and epidemiological issues, the sample size was small. Larger, randomized studies are needed to validate these findings and investigate the long-term effects of both interventions on motor function and level of anxiety in parents. Exploring barriers to rehabilitation access and developing community-based intervention approaches could also help decrease healthcare gaps in remote communities. Training general physiotherapists to deliver both therapies efficiently could maximize access to rehabilitation services in areas with inadequate healthcare infrastructure. Thus, tailored, locally achievable therapies can help children with hydrocephalus in underprivileged areas, reducing the gaps in rehabilitation services that are frequently seen between urban and rural populations [33].

Conclusion

Bobath Based Rehabilitation Program and Conventional Physiotherapy are effective interventions for improving motor function in children with hydrocephalus and in reducing levels of anxiety in their parents

References | Список источников

1. Bondurant CP, Jimenez DF. Epidemiology of cerebrospinal fluid shunting. *Pediatr Neurosurg.* 1995;23(5):254–259. doi: 10.1159/000120968
2. Hochstetler A, Raskin J, Blazer-Yost BL. Hydrocephalus: historical analysis and considerations for treatment. *Eur J Med Res.* 2022;27(1):168. doi: 10.1186/s40001-022-00798-6
3. Munawaroh N, Nurhasanah L, Isma R. Case report of speech and ambulation ability after five years therapy in a six-year-old boy with habilitation sixth lumbar spina bifida with meningocele post resection and hydrocephalus post VP shunt. Indonesian *Journal of Physical Medicine & Rehabilitation.* 2022;11(01):13–23. doi: 10.36803/ijpmr.v11i01.324
4. Singh R, Prasad RS, Singh RC. et al. Evaluation of pediatric hydrocephalus: clinical, surgical, and outcome perspective in a Tertiary Center. *Asian J Neurosurg.* 2021; 16(4):706–713. doi: 10.4103/ajns.AJNS_132_21
5. Chi JH, Fullerton HJ, Gupta N. Time trends and demographics of deaths from congenital hydrocephalus in children in the United States: National Center for Health Statistics data, 1979 to 1998. *J Neurosurg.* 2005;103 (2 Suppl):113–118. doi: 10.3171/ped.2005.103.2.0113
6. Wiswell TE, Tuttle DJ, Northam RS, Simonds GR. Major congenital neurologic malformations: a 17-year survey. *Am J Dis Child.* 1990;144(1):61–67. doi:10.1001/archpedi.1990.02150250071035
7. Isaacs AM, Riva-Cambrin J, Yavin D, et al. Age-specific global epidemiology of hydrocephalus: systematic review, metanalysis and global6 birth surveillance. *PloS One.* 2018;13(10):e0204926. doi: 10.1371/journal.pone.0204926
8. Dewan MC, Rattani A, Mekary R, et al. Global hydrocephalus epidemiology and incidence: systematic review and meta-analysis. *J Neurosurg.* 2018;130(4):1065–1079. doi: 10.3171/2017.10.JNS17439
9. Jaiswal A, Jaiswal J. Incidence of hydrocephalus in pediatric age in a tertiary care centre of Chhattisgarh. *Journal of Evolution of Medical and Dental Sciences.* 2015;4(83):14564–14572. doi: 10.14260/jemds/2015/2070
10. Khalatbari H, Parisi MT. Management of hydrocephalus in children: anatomic imaging appearances of CSF shunts and their complications. *AJR Am J Roentgenol.* 2021;216(1):187–199. doi: 10.2214/AJR.20.22888
11. Kirkpatrick M, Engleman H., Minns RA. Symptoms and signs of progressive hydrocephalus. *Arch Dis Child.* 1989;64(1):124–128. doi: 10.1136/adc.64.1.124
12. Wald NJ. Folic acid and the prevention of neural-tube defects. *New England Journal of Medicine.* 2004;350:101–103. doi: 10.1056/NEJMp038186
13. Yu M, Peterson MR., Cherukri V, et al. Infection diagnosis in hydrocephalus CT images: a domain enriched attention learning approach. *J Neural Eng.* 2023;20(3):10.1088/1741-2552/acd9ee. doi: 10.1088/1741-2552/acd9ee
14. Bawa M, Dash V, Mahalik S, Rao KL. Outcome analysis of patients of congenital hydrocephalus with ventriculoperitoneal shunt at a tertiary care hospital in North India. *Pediatr Neurosurg.* 2019;54(4):233–236. doi: 10.1159/000501018
15. Walters S. Benefits of a group exercise program on a student with congenital hydrocephalus and multiple co-diagnoses (2013). PTHMS Undergraduate Publications. 2. URL: https://digitalcommons.sacredheart.edu/pthms_honors/2
16. Kahle KT, Kulkarni AV, Limbrick DD, Warf BC. Hydrocephalus in children. *Lancet.* 2016;387(10020):788–799. doi: 10.1016/S0140-6736(15)60694-8
17. Barnes K, Zimmerman K, Herbey I, et al. Understanding and identifying the needs of parent caregivers of children with hydrocephalus: a qualitative study. *J Neurosurg Pediatr.* 2023;31(5):433–443. doi: 10.3171/2022.12.PEDS22425
18. Duzgun MV, Erdem Y. Factors affecting the anxiety level and quality of life of parents of children with hydrocephalus. *International Journal of Caring Sciences.* 2020;13(2):1382–1391.
19. Russell DJ, Palisano RJ, Walter S, et al. Evaluating motor function in children with Down syndrome: validity of the GMFM. *Dev Med Child Neurol.* 1998;40(10):693–701. doi: 10.1111/j.1469-8749.1998.tb12330.x
20. Adair B, Said CM, Rodda J, Morris ME. Psychometric properties of functional mobility tools in hereditary spastic paraplegia and other childhood neurological conditions. *Dev Med Child Neurol.* 2012;54(7):596–605. doi: 10.1111/j.1469-8749.2012.04284.x
21. Wang HY, Yang YH, Jong YJ. Correlations between change scores of measures for muscle strength and motor function in individuals with spinal muscular atrophy types 2 and 3. *Am J Phys Med Rehabil.* 2013;92(4):335–342. doi: 10.1097/phm.0b013e318269d66b
22. Russell DJ, Avery LM, Rosenbaum PL, et al. Improved scaling of the gross motor function measure for children with cerebral palsy: evidence of reliability and validity. *Phys Ther.* 2000;80(9):873–885.
23. Lee KH, Park JW, Lee HJ, et al. Efficacy of intensive neurodevelopmental treatment for children with developmental delay, with or without cerebral palsy. *Ann Rehabil Med.* 2017;41(1):90–96. doi: 10.5535/arm.2017.41.1.90
24. Veličković TD, Perat MV. Basic principles of the neurodevelopment treatment. *Medicina.* 2005; 41:112–120.
25. Bertenthal B, Von Hofsten C. Eye, head and trunk control: the foundation for manual development. *Neurosci Biobehav Rev.* 1998; 22(4):515–520. doi: 10.1016/s0149-7634(97)00038-9
26. Assaiante C, Mallau S, Viel S, et al. Development of postural control in healthy children: a functional approach. *Neural Plast.* 2005;12(2-3):109–118. doi: 10.1155/NP.2005.109
27. Sah AK, Balaji GK, Agrahara S. Effects of task-oriented activities based on neurodevelopmental therapy principles on trunk control, balance, and gross motor function in children with spastic diplegic cerebral palsy: a single-blinded randomized clinical trial. *J Pediatr Neurosci.* 2019;14(3):120–126. doi: 10.4103/jpn.JPN_35_19
28. Mwiinga FB, Malekani N, Mwape M. Caregivers' experiences in caring for children with hydrocephalus at the University Teaching Hospitals, Lusaka Zambia. *Medical Journal of Zambia.*2024;50(4):347–354. doi: 10.55320/mjz.50.4.436
29. El-Zraigat I, Al-Dhafairi F. Coping strategies with the psychological stress among parents of children with intellectual disabilities and slow learners in light of selected variables in the State of Kuwait. *British Journal of Education, Society & Behavioural Science.* 2017;19(3):1–13. doi:10.9734/BJESBS/2017/31637
30. King G, Law M, Hanna S, et al. Predictors of the leisure and recreation participation of children with physical disabilities: a structural equation modeling analysis. *Children's Health Care.* 2006;35(3):209–234. doi: 10.1207/s15326888chc3503_2
31. Plant KM, Sanders MR. Predictors of care-giver stress in families of preschool-aged children with developmental disabilities. *J Intellect Disabil Res.* 2007;51(Pt 2):109–124. doi: 10.1111/j.1365-2788.2006.00829.x

32. Raina P, O'Donnell M, Rosenbaum P, et al. The health and well-being of caregivers of children with cerebral palsy. *Pediatrics*. 2005;115(6):e626–636. doi: 10.1542/peds.2004-1689

33. Bright T, Wallace S, Kuper H. A systematic review of access to rehabilitation for people with disabilities in low- and middle-income countries. *Int J Environ Res Public Health*. 2018;15(10):2165. doi: 10.3390/ijerph15102165

Appendix 1. Bobath Based Rehabilitation Program

1. Head control by stroking at the middle of the posterior aspect of neck. The child can be seated on the therapist's lap, facing the therapist, and alternately lowered slowly backwards and side-to-side. This action helps stimulate head righting and strengthens the neck and abdominal muscles.
2. Active movements such as reaching to toys in different directions from different developmental positions help stimulate head and trunk control and facilitate trunk elongation.
3. Reaching activities involving sitting (supported or unsupported) to toys in different directions may assist in head control, trunk elongation and rotation, and development of sitting control.
4. Weight shifting in various positions and through therapeutic handling is important to enhance the development of early head and trunk control.
5. Grasping.
6. "Parachute reactions", that is the ability to protect oneself in case of fall.
7. Trunk turning.
8. Equilibrium reaction in case of fall.
9. Equilibrium control during movement.
10. Neck holding exercises on the foam roller.
11. Activities on the foam roller in neurodevelopmental treatment.
12. Vestibular and proprioceptive training on balance board and exercise balls of different sizes, dynamic balance training and proximal stabilization in sitting, kneeling, and standing positions (eyes open and closed).
13. Balance exercises in front of the mirror, standing on one foot to improve the proprioceptive input (eyes open and closed).
14. Weight bearing exercises in the sitting, crawling, kneeling, and standing positions for equal weight transfer on both lower extremities without interfering with postural control.
15. Functional reaching and ball throwing-keeping exercises in various directions.
16. Stepping exercises in different directions and on different grounds.
17. Quadruped imbalances. Execution: a patient is positioned on all fours, a therapist imbalances them by pushing them sideways and backwards from the shoulder and sideways and forwards from the pelvis.
18. Imbalances from the "kneeling". Execution: with the patient supported on their knees, the therapist imbalances them from all directions.
19. The servant knight position. Execution: a patient loads on one knee, the contralateral lower limb performs a triple flexion (flexion at hip level, flexion at knee level and flexion at ankle joint level), the servant knight position.

Appendix 2. Conventional physiotherapy

1. Muscle strengthening:
2. Isotonic contractions of shoulder flexors, extensors, abductors, internal and external rotators.
3. Isotonic contractions of elbow flexors and extensors (with a child in sitting position on a mat or chair).
4. Isotonic contractions of trunk flexors and extensors with a child in a supine or prone position.
5. Postural maintenance (e.g., sitting, crawling, kneeling, standing).
6. Postural changes (e.g., rolling, transition from supine to sitting, from prone to crawling, from crawling to kneeling).
7. Bridging. A patient in a supine position with knees bent to 90 degrees. A patient pushes through feet on flat surface to raise pelvis to neutral position and slowly returns pelvis to the mat.
8. Sit to stands. A patient in a seated position with both feet planted on the floor, hips, and knees in 90 degrees of flexion. A patient stands and slowly descends back to a seated position.
9. Calf raises. A patient standing in parallel bars both feet used to raise heels off floor and back to neutral position.
10. Standing marches. A patient standing in parallel bars, slowly alternates lifting knee to 90 degrees of hip flexion.
11. Step ups. A patient standing in parallel bars, steps up onto raised platform alternating leading leg.
12. Side step-up. A patient standing parallel to one side of parallel bars, steps sideways onto raised platform and off platform on opposite side. A patient sidesteps up and over raised platform, going back and forth.
13. One leg stand. A patient starts by standing facing the wall, with arms outstretched and fingertips touching the wall. A patient lifts one leg, keeping the hips at the level and keeps a slight bend in the opposite leg. Gently place foot back on the floor.

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