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Joubert's syndrome and Role Of Physiotherapy Rehabilitation: An Interesting 4 years follow up case study

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Abstract

Background: *Among children, Joubert's syndrome (JS) is a genetic disorder of cerebellar development featured by developmental delay, ataxia, decreased muscle tone and abnormal eye movements.*

Methods:*To date there are limited case studies available reporting role of Physiotherapy rehabilitation along with 4 years follow-up with structural (French angles), motor (GMFM) and functional outcome measure (weeFIM) documentation in JS. Hence, reporting a rare case experience with long term effect of Physiotherapy treatment in rehabilitation in JS.*

Results:*There was an improvement in structural joint angles of upper and lower limbs in each follow up measured by universak goniometer. There was an improved gross motor function and functional independence level of child with Joubert's syndrome in each successive years with Physiotherapy rehabilitation program.*

Conclusion:*The institutional multiple-neurophysiological-approach-based treatment (including NDT/Roods/sensory stimulation/ sensory integration/ strength training/, balance training, functional training/Task oriented-goal directed treatment approaches) is effective in case of JS.*

Keywords*—Joubert Syndrome, Genetic Disorder, French Angles, Gross Motor Function, Functional Independence, Physiotherapy*

I. INTRODUCTION

Joubert's syndrome(JS) is a genetic disorder with defective cerebellar function with heterogenus presentation which occurs mostly in males and 35

genes or more responsible for cause of JS[1-6]. JS is part of ciliopathies (dysfunction of primary cilium)leading to multi system disorders[6]. Child with JS shows developmental delay[5], hypotonia [2,4,6,7], abnormal eye movement[1,2,5], neonatal respiratory / breathing abnormalities [2,5,7,8] , dietary problems[7], ataxia[2,4,5] , retinal atrophy[4], nystagmus [5,9] ,mouth , tongue, facial dyskinesis/ feature of prominent lower jaw can be supportive for diagnosis[6], ptosis, polydyctaly (15 % cases) [6], , scoliosis (5% cases) [6], congenital heart disease, polycystic kidneys[4], hepatic fibrosis[4] and seizures[2,10]difficulty in upright posture and /or pain [6],borderline mental level[2,4] (apparently normal), progressive evaluation & psychic and motor improvement present[8]. Few children with JS are able to read, write, use math application and can work with computer[8]. Can play football, ride bicycle and motor cycle, normal gait with difficulty in running, language normal but show, independent in bath, shave, dress and toilet, socially good and manage money[8].

Major clinical diagnosis for JS is decreased muscle tone, mental function disturbance, occulomotor apraxia, movement ataxia, in magnetic resonance imaging(MRI) molar tooth sign[4,5]. Supporting signs are altered respiratory function, pigmentation in retina, facial dysmorphism and urinary abnormality[3,4,7,8,11]. The recurrence rate of JS is 25%[5]. At 20-22 weeks of gestation, ultrasound can be used for prenatal diagnosis combined with fetal MRI[5]. For diagnosis of JS clinical multidisciplinary evaluation and periodic follow up along with neuroimaging (MRI) is very important to confirm clinical diagnosis.[1,9] MRI findings i.e. dilatation of fourth ventricle appears bat wing shaped[3,4], superior cerebellar peduncle appears elongated and thickened[11],agenesis/dysphagia/hypoplasia of vermis[3,4,10],incomplete fusion of halves of vermis (MTS- Molar tooth sign)[4,7,10], widened foramen of magendie and posterior cistern present, encephalomeningocele[9]. Elongation with thinning of ponto-mesencephalic junction and deepening of interpeduncular fossae also present in MRI[2], congenital hydrocephalus[3],abnormal cerebellar brainstem and cerebello-cortical connections due to lack of posterior vermis is also observed[11]. Neuroimaging (MRI) should be used to distinguish similar conditions like Dandy walker syndrome and rhombencephalon synapsis from JS[5]. Outcome measures such as gross motor function measure (GMFM) and Functional independence measure in children (weeFIM) are used for tracking improvement in JS[7]. Generalized ability index (GAI) depends less on speed of motor tasks, it is more reliable measure of cognitive abilities traditional measure of Full scale intelligent quotient (FSIQ) [6].

Standard therapies such as Physiotherapy/Occupational therapy/Speech Therapy and educational intervention allow to set aim in pediatric rehabilitation[6]. As per previous study, the standard therapies and orthotic treatments found effective in JS after 4 months duration which showed fair improvement in functions[10]. An another study, Physiotherapy treatment with NDT- neurodevelopmental therapy principles and patient tailored program was used (1 hour per day for 5 days a week for 13 months) and showed improved motor and functional level in female child of JS where rehabilitation facilities were based on cognitive-behavioral difficulties as well as visual dysfunctions[7]. It was observed that motor issues like ataxia and occular apraxia improve as children matures[4]. It was also found that children with JS eventually walk independently[6]. Other therapies like parent and child interaction, cognitive-behavioral treatment also found to be effective for neuro- behavioral and psychiatric issues in JS[6].

As per recommendation, ideal management of JS need early diagnosis and treatment to avoid complications[6]. Scoliosis requires regular monitoring at every 1to 2 years duration till complete growing stage[6]. No specific therapy or treatment approach have been proven more or less effective in this population[6]. To date limited evidences present on effectiveness of Physiotherapy treatment in case of JS and hence present study proposed a case report with 4 years follow up of Physiotherapy treatment. To date no published data available evaluating long term effect of Physiotherapy treatment in case of JS. Hence this study proposed to see the effect of Physiotherapy exercises (Neuro-developmental therapy-NDT along with multiple neuro-physiological approaches) on functional activity in case with JS.

II. Related Work

In 2017 İpek O and collegues presented a 19-month-old female single case study of joubert syndrome with Physiotherapy rehabilitation. A child with mild clinical signs of JS was evaluated through the Gross Motor Function Measure (GMFM), and the independence level was evaluated through the Pediatric Functional Independence Measure (WeeFIM). The case was included in the rehabilitation program by the physiotherapist for 60 min for five days a week throughout for 13 months following with the neuro-developmental treatment (NDT) principles. Study concluded that physiotherapy rehabilitation found to be an effective treatment strategy to overcome developmental delay.[7]

In 2014, Dekair LH, Kamel H, El-Bashir HO. JS labeled as hypotonic cerebral palsy. Joubert's syndrome(JS) is a genetic disorder with defective cerebellar function. A 18-month female child with JS who diagnosed as hypotonic cerebral palsy with abnormal eye movements. The brain MRI showed brain affection. Joubert syndrome is recommended as differential diagnosis of hypotonic CP along with brain MRI findings. Delayed diagnosis of JS can be associated with complications as renal anomalies and breathing difficulties. The genetic counseling is important in diagnosis of JS.[10]

III. METHODOLOGY

A 5 years and 4 month old male child visited Physiotherapy department of pediatric Neurosciences in a month of August 2017. Child was born with normal delivery of birth weight of 2700gm, having grade II consanguineous marriage, was admitted to hospital for 8 days for respiratory complications. Child was presented with gross motor delay and language developmental delay with complains of difficulty in rolling, sitting and inability to perform sit to stand, standing and walking. On examination, child was cognitively fair, following few verbal and motor commands. Mother complaint about respiratory complications immediately after birth and presently complain about having delayed motor development since birth with inability to sit, stand and walk independently. Mother reported inability to sit and stand due to sluggish continuous movements of upper limbs, lower limbs as well as in trunk. He had inability to hold supported sitting posture due to trunk ataxia. Child showed generalized hypotonia and joint hypermobility in both upper, lower limb as well as in spine. Speech was explosive but slow. Child was monosyllabic (Amma, dada, mama etc). Facial dysmorphic features were present with continuous protruded tongue, frontal bone bossing, epicathial line was not aligned along with eyes and eyes were not stable. His MRI of brain showed mild thickening superior cerebellar peduncle with mild elongation of inter-peduncular fossa with subtle thinning distal body of corpus callosum along with bat wing appearance of ventricular system. His genetic analysis was performed, craniosynostosis-6 is caused by heterozygous mutations in ZIC 1 gene, which indicates the primary abnormality.

Procedure

Institutional head and ethical committee approval was obtained. Consent was taken from parents. Child was evaluated in detailed on day one for muscle tone which was showing reduced tone (hypotonia) in both upper and lower limbs, deep tendon reflexes were diminished (hyporeflexia), sitting and standing balance was poor(sitting was possible with both hands support). French angles (joint angles) were evaluated with the help of universal goniometer[12] (table 2) and the oro-motor functions were evaluated by using direct close ended questions like whether child is able to chew, drink water and whether drooling was present etc and mother reported that, oro-motor functions were difficult for child since birth and scoring was done accordingly. Pull to sit test result was poor to fair, as able to flex neck partially along with mild elbows flexion. Gross motor function evaluation was done by using GMFM scoring system and functional evaluation was performed by using weeFIM scale.

Multiple neurophysiological approaches had been used in rehabilitation at different stages of recovery in present case of JS. The initial treatment planning was made by using Neuro-developmental therapy (NDT) principles clinically in child according to developmental status. As the child grows the sensory integration, sensory stimulation as well as multiple neurophysiological approaches were used for treatment purpose. Child was trained for trunk stability on bolster then on physio vestibular ball, initially in one direction and later multi-directional weight shifts were implemented, abdominal and back extensor muscle facilitation and strengthening was performed with multiple-angle holds on bolster, initially for sit to stand facilitation small height stool was used and later large height stool was used. Heavy joint compression techniques performed for both upper and lower limb joints, even for cervical spine in sitting and taught to mother for upper and lower limbs. Initially prone on hands, quadruped on ground mat and then tripod facilitation with weight shifts of bolster was started.

Later stages of rehabilitation includes stepping up, step-standing on single leg facilitation, stairs climbing up-down facilitation, obstacle training and bi-manual activities of object transfers and ball throw activities were also planned. Follow up was performed at 12 months duration of interval for successive 4 years. Child received Physiotherapy treatment at OPD peadiatric neuroscience for 4 days per week.

DATA ANALYSIS

The identity of child and data collected and recorded. The data collected was entered into data sheet. EPI info version 07, software was used for further data analysis. Difference between French angles measured was compared as well as the total score of GMFM scale, wee FIM scale and sub-components of weeFIM were analysis each year.

IV. RESULTS AND DISCUSSION

RESULTS

The demographic data of height, weight and head circumference at birth, on day one, after 12th , 24th, 36th and 48th month of Physiotherapy treatment mentioned in table 1. It was observed that the height, weight and head circumference was within 10th and 90th percentile for his age throughout 4 years of Physiotherapy treatment. (Table 1)Table 2 showed that the French joint angle test measurements in degrees using universal goniometer on day one, after 12th , 24th, 36th and 48th month of Physiotherapy treatment which reaches to functional level as age as well as treatment duration advances. It can be stated that the hypermobility of joints reduced as the age advances in child from age 5.4 years to 9.4 years of age in 4 years Physiotherapy treatment follow up.

From table 3, it was observed that the comparative scores of GMFM and weeFIM outcome measures on day 1, after 12 months, after 24 months, after 36 months and after 48 months of Physiotherapy treatment improved in each follow up. It was observed that child showed improvement in both gross motor function and functional independence. as the age advances. the This is suggestive of gross motor function and independence improves in parallel to each other.

It was observed that from age 5.4 years to 9.4 years both GMFM score as well as weeFIM score improves. It was also observed that, the gross motor function reaches to maximum from score 27 to 660 and functional score reaches from 32 to 66, with effect of institutional Physiotherapy treatment protocol. (Table 4)

It was also observed that as the gross motor function improves the child also showed improvement in functional independence of daily activities like self care , mobility- transfer and locomotion. It was also observed that the motor function improves along with cognitive function in child.(Table 5) Child showed improved performance in all the daily activities as well as showed significant improvement in all exercises, and functional independence levels in all domains of GMFM and weeFIM.

DISCUSSION

The present study evaluate institutional multiple-neurophysiological-approach-based treatment in rare condition of JS with 4 years follow up of gross motor functions and independence measure using GMFM score and weeFIM score system.

The French joint angle measurement at first day of assessment was suggestive of excessive generalized joint hypermobility in bilateral upper and lower limbs, but as the treatment protocol advances for stability and muscle strengthening, the joint hypermobility reduced in sequential follow up of 4 years (Table 2). According to few studies, it was observed that the knee joint hypermobility reduces from age 4 to 12 years children[13,14]. Similarly in present study, the joint hypermobility reduces and hence the French joint angles also reduces with age in present case study in 4 years of follow up in both upper and lower limb joints.

It was observed that the institutional multiple neurophysiological approach-based treatment with progressive increase in functional training showed improvement in GMFM score of child in sequential 4 year follow up when compared to first day of evaluation. It can be stated that child had reached to functional independence level (weeFIM) at the age of 9.4 year after four years regular Physiotherapy treatment. Functional level improved significantly in child (weeFIM score), it can be stated that as the GMFM score improves, the independence level of child also improves in present case, which might helped child to develop self care, mobility and locomotion functions in these 4 years of follow up. Similar results were found in single case study in 2017 which showed improved gross motor as well as functional independence in daily activities.[7]

In current study, in each year follow up, it was observed that the child developed in all domains of gross motor functions as well as levels of functional independence with regular Physiotherapy rehabilitation. The institutional multiple-neurophysiological-approach-based treatment principle of development was effective in present case of JS for achieving both gross motor and functional independence (Table 3 and 4). The gross motor functions of child had developed from supine activities to stairs and running whereas functional independence was improved significantly more in three domains of self care, mobility-transfer and locomotion but other three domains of spincter control, communication and cognitive function showed only slight improvement in function.

The multiple system problems in JS require different approaches and treatment strategies for each one at different stage of rehabilitation. From present case condition, it can be stated that during rehabilitation following any one approach for JS will not be suitable for achieving functional goals, hence multiple treatment like strategies of stability in sitting and standing, balance training using different equipment's (bolsters/ physio balls/ tilt boards) in different functional positions, strengthening with resistance bands, weight cuffs for upper and lower limb in functional positions,

joint proprioception training using heavy joint passive compression (Rood's approach) and using weights/sand bags/ weighted jackets was used, various visual and auditory stimulating toys were used to perform various functional training in sitting and reaching with objects, sit to standing facilitation using toys transfer, standing and ball throwing-ball kicking activities, stairs case stepping up and down activities, obstacle training etc. Presently child is able to play out-door games with stability like recreational foot ball, indoor cricket, mix with peers for play as well as for group game activities which is an indication of inclusiveness and involvement in society.

The present institutional multiple-neurophysiological-approach-based treatment is found to be an effective in condition of JS, which can be recommended in future for such a rare condition in rehabilitation. The results of present study cannot be generalized for all children with JS but there is need to plan individualized treatment plan for rehabilitation depending on problem list and associated complications. There is dearth of literature about documentation of outcome measures in long term follow up in JS, hence the outcomes used in present study can be a guided for following treatment plan for condition like JS or similar conditions like Dandy-walker syndrome, and JS related disorders etc.

The institutional multiple-neurophysiological-approach-based treatment (including NDT/Roods/sensory stimulation/ sensory integration/ strength training/, balance training, functional training/Task oriented-goal directed treatment approaches) is effective in case of JS.

A. Table (1,2,3,4 and 5)

Table 1: Demographic data of height, weight and head circumference at birth, on day one, after 12th , 24th, 36th and 48th month of Physiotherapy treatment

Year of assessment	2012	2017	2018	2019	2020	2021
Parameters	At Birth	Day One assessment (Degrees)	After 12 Months (Degrees)	After 24 Month (Degrees)	After 36 Month (Degrees)	After 48 Month (Degrees)
Height (cm)	NA	121	126	132	138	141
Weight (Kg)	2700	14.3	16.3	18.5	23	25
Head circumference(cm)	36	46	48	49	49.5	50

NA- not available.

Table 2:French angles test measurements in degrees on day one, after 12th, 24th, 36th and 48th month of Physiotherapy treatment on bilateral upper and lower limbs.

Year of assessment	2017	2018	2019	2020	2021
French Joint angles test	Day One assessment (Degrees)	After 12 Month (Degrees)	After 24 Month (Degrees)	After 36 Month (Degrees)	After 48 Month (Degrees)
Dorsum to shin angle (ankle)	5	5	10	25	30
Heel to ear test angle (hip)	170	150	140	120	100
Adductor angle (hip)	185	180	170	170	160
Popliteal angle (Knee)	185	180	170	165	160
Scarf's angle (shoulder)	85	65	60	45	45

Table 3.Comparative scores of GMFM and weeFIM outcome measures on day 1, after 12th, 24th, 36th and 48th month of Physiotherapy treatment

Outcome measures	Day 1 (2017)	After 12 Months (2018)	After 24 Months (2019)	After 36 Months (2020)	After 48 Months(2021)
GMFM Score	27	181	357	513	660
weeFIM Score	32	44	50	58	66

GMFM: Gross Motor Function Measure, FIM: Functional Independence Measure

Table 4:Comparative sub-component wise scores of GMFM scale on day 1, after 12th , 24th, 36th and 48th month of Physiotherapy treatment

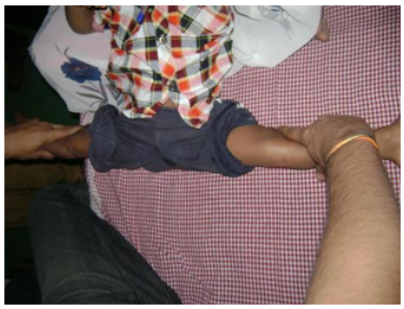
GMFM sub-components	Day 1 (2017)	After 12 Months (2018)	After 24 Months (2019)	After 36 Months (2020)	After 48 Months(2021)
Lying And Rolling	25	52	89	93	100
Sitting	2	62	84	100	100
Crawling	0	34	78	94	100
Kneeling	0	23	52	88	100
Standing	0	10	38	74	100
Walking Ability	0	0	6	30	100
Running Ability	0	0	0	14	20
Jumping Ability	0	0	0	12	18
Stairs	0	0	0	8	22
Total	27	181	357	513	660

Table 5: Comparative sub-component wise scores

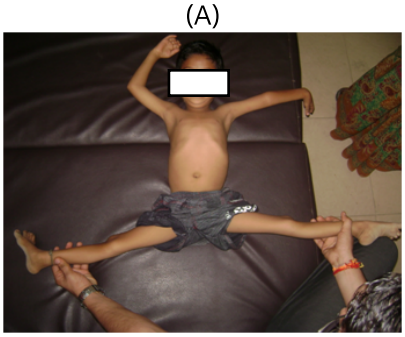
of weeFIM scale on day 1, after 12th, 24th, 36th and 48th month of Physiotherapy treatment

weeFIM Sub-components	Day 1 (2017)	After 12 Months (2018)	After 24 Months (2019)	After 36 Months (2020)	After 48 Months(2021)
Self Care	5	8	8	10	12
Spincter Control	2	2	2	2	2
Mobility-Transfer	2	6	8	11	12
Locomotion	3	5	7	8	11
Communication	11	12	12	13	13
Cognitive Function	9	11	13	14	16
Total score	32	44	50	58	66

B. Figures (1,2,3,4,5 and 6)

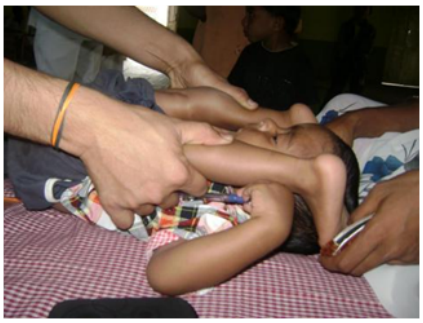


(A)

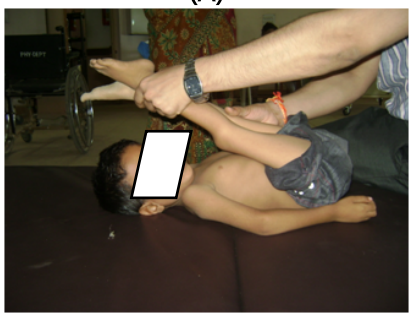


(B)

Fig 1: Hip Joint Hyper-mobility Test: Hip Adductor Extensibility By Performance Of Passive Hip Abduction Movement- (A) At 5 yrs age (B) At 6 yrs age.



(A)



(B)

Fig 2: Hip Joint Hyper-mobility Test: Side View: Hip Extensor Extensibility By Performance Of Passive Hip Flexion Movement (Heel To Ear Test)- (A) At 5 years age (B) At 6 years age.

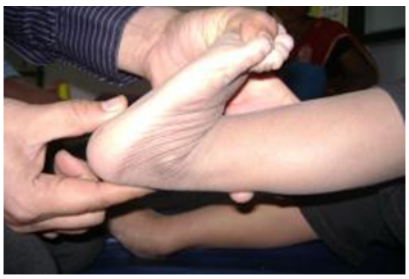


Fig 3: Ankle Joint Hyper-mobility Test: Without Forefoot Break: Plantar Flexor Extensibility By Performance Of Passive Ankle Dorsiflexion Movement

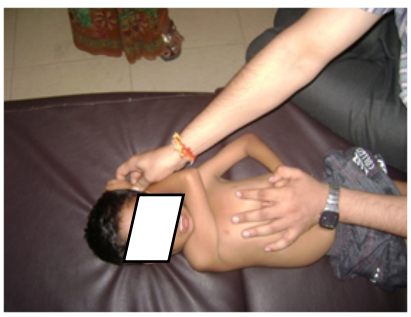


Fig 4: Scarf Sign Test For Shoulder Joint Hyper-mobility

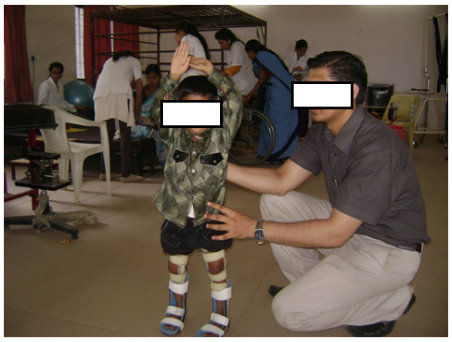


Fig 5: Standing Facilitation With Ankle Foot Orthosis (AFO) Support at 7 years of age

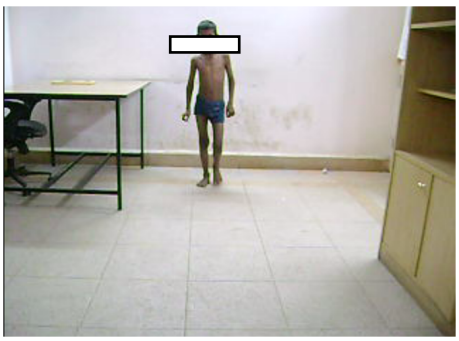


Fig 6: Independent Walking Ability At 8 Years Of Age.

C. Abbreviations and Acronyms

GMFM: Gross Motor Function Measure, FIM: Functional Independence Measure, Neuro-Developmental Therapy (NDT)

D. Units

Angle in Degrees

Conclusion and Future Scope

In case report, the institutional multiple-neurophysiological-approach-based treatment (including NDT/Roods/sensory stimulation/ sensory integration/ strength training/, balance training, functional training/Task oriented-goal directed treatment approaches) found effective in case of Joubert Syndrome. Pediatric Rehabilitation requires multiple approaches for treatment at different stages of recovery in other similar conditions like Dandy-walker syndromes, JS related disorders etc hence this approach can be used for similar conditions in future studies.

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