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ORIGINAL ARTICLE

The Effect of Conjugate Reinforcement of Leg Movements in Infants with Spina Bifida

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ABSTRACT

Objective: To assess the effect of conjugate reinforcement of leg movements in infants with Spina Bifida.

Study Design: Cross-sectional study

Place and Duration of Study: University Teaching Hospital, University of Lahore from May 2019-Dec 2019.

Material and Methods: The voluntary leg movements of 10 infants with Spina Bifida were videotaped in supine: baseline (untethered), acquisition (tethered to a mobile), & extinction (untethered) with rest interval between each. The babies were active while taking the data.

Results: Infants produced more leg movements when tethered to a mobile than baseline (p= 0.042) & also performed more total kicks when tethered to a mobile than baseline (p=0.016). Single kicks were the most common type.

Conclusion: Most of the babies with Spina Bifida generated more movements and kicks when tethered to a mobile. In addition to number of leg movements and kicks, each infant gave a discrete reaction to mobile paradigm with complex and new kind of kicks in different conditions as compared to baseline. Clinically, the leg muscles strengthening, and neuromuscular association of Spina Bifida infants can be increased with mobile paradigm that led to more kicks.

Key Words: *Spina bifida, Infants, Lower extremity*

INTRODUCTION

Spina bifida (SB) is the most eminent birth inadequacy inducing the focal sensory system (CNS).[1] Spina bifida is an inborn distortion wherein the spinal segment is bifid because of bombed conclusion or development of the embryonic neural cylinder.[2] The overall occurrence changes in the range of 0.17 and 6.39 per 1000 live births.[3] Irrespective of being the most common neural tube defect worldwide, there is limited evidence available of how the SB infants develop motor skills and the effect of physical therapy on their motor learning.

Diagnosis of spina bifida can be made early in eighteen weeks of pregnancy through screening of mother's serum alpha-fetoprotein ultrasonography, or analysis of amniotic fluid. Genetic involvement, teratogens exposure, anti-convulsant drug use by mother of decreased folic acid intake.[4]

Spina bifida babies may also present with delays in motor development. They have delayed milestones of head control, sitting, crawling, standing, and walking and it depends on the level of spinal lesion. Infants with spinal lesion at higher level exhibit new motor skills in later ages as

compared to infants with lower spinal lesion.[5]

Currently, therapists and researchers have started to utilize the neuroplasticity where neurons have the ability to alter their structure and function and self-organization to assess and measure as how the SB babies gain new motor skills.[6] Self-organization refers to the learning of babies because of coordination of different systems such as neuromuscular system with the environment. This concept was supported by Thelen's work in which she eliminated the effect of gravity by keeping the infants under water and was able to generate stepping response from infants who were unable to produce when placed against firm table top.[7]

Another support to concept of self-organization is explained by Chapman's work. In his study, he explained that SB infants are responsive to different positions in space and will change their leg movements and kick between 4 and 13 months by keeping in specially designed seat for infants in comparison to when keeping them in supine or sitting in usual infant seat.[8] The advocacy of this concept suggests that with repeated movements and passage of time, infants keep on strengthening their leg muscles and connection of these kicks and movements with brain and CNS. These suggestions indicate that external factors can either expedite or restrain motor learning.[9]

Infants with SB exhibit low frequency of leg movements as compared to healthy babies. These leg movements and kicks can measure level of motor development and coordination. Previous studies focus on the spontaneous leg movements in lumbar and sacral SB infants but up to researcher's knowledge, studies of goal directed (intentional) leg movements in infants with SB are not available. Reinforcing event provided by conjugate reinforcement is a particular behavior where more frequent responses will generate more intense reward. For example, the infants can learn to move their legs more frequently by observing the movement of overhead mobile.[10]

The concept of neuroplasticity and self-organization can be utilized by using the mobile paradigm and train babies with SB to move their legs and kicks more frequently as they usually do. The mobile paradigm will change the infant's surrounding and provide with more chances to move legs and kicks using goal directed movements. The aim of this study was to assess the frequency and types of voluntary and goal directed leg movements and kicks with the help of conjugate reinforcement in SB infants.

MATERIAL AND METHODS

Before recruitment of babies, the Institutional Review Board approval was taken. Ten infants with age range (20 - 36 weeks) with lumbar and sacral SB were included. Characteristics of the infants are summarized in table 1. The data was taken from University of Teaching Hospital, UOL, Lahore General Hospital and Children's Hospital, Lahore & compiled at University Teaching Hospital, University, Lahore.

TABLE 1: Summary of characteristics of SB infants

Charac-teristics	Baby 1	Baby 2	Baby 3	Baby 4	Baby 5	Baby 6	Baby 7	Baby 8	Baby 9	Baby 10
Age at data collection	6 months 2 weeks	7 months	5 months 1 week	6 months 3 weeks	8 months 4 days	10 months 3 weeks	6 months 2 weeks	10 months	14 months	9 months 7 days
Full term	yes	no	yes	yes	Yes	no	yes	yes	yes	no
Delivery method	C-section	C-section breech	C-section	C-section	C-section	C-section breech	C-section	C-section	C-section	C-section breech
Level of lesion	L5-S1	L1	L5-S1	L2	L5-S4	L2	L5-S1	L5-S1	L3	L5-S4
Lesion repaired	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1

Data was collected at a time when baby was active. The leg movements and kicks of each participant were videotaped with a camera that was placed away from the reach of baby according to the area of room. Video recorded for frame study. By videotaped data, the total number of total leg movements, kicks, and the type of kick were analyzed.

The baby was placed supine on a towel and a ribbon attached with the infant's ankles.

Next, the mobile was placed 10-12 inches over the baby's head such that the mobile was out of the infant's reach. The mobile is black and white, with stuffed toys. Based on the previous research the movements of each infant were videotaped in three settings: baseline (BL), acquisition (ACQ), and extinction (EXT). The first setting was 2 mins long and the ribbon was not attached to the overhead mobile and the ACQ condition was three minutes long and that is goal-directed, the ankle of the infant was connected to the mobile over the head with ribbon. When the baby moved his or her leg(s), the mobile above the infant's head also moved and provide visual and auditory response to the baby. The last condition was again two minutes long, the ribbon was tied around the infant's ankle, just like in the BL condition. The leg was randomly selected that tied to the mobile for each baby. The EXT also generated goal-directed movements since the baby already had seen his or her moved legs in ACQ condition. There was a rest break between every condition. There are three types of kicks we seen during this study: single, parallel or alternating.

RESULT

Infants promote more leg movements when tethered to a mobile as compared to baseline (p=0.042). The babies also performed more kicks in the acquisition condition compared to baseline (p = 0.016). Each infant responded differently to the mobile paradigm with respect to the frequency and types of kicks generated.

TABLE 2: Paired t-test performed to find the comparison of BL with ACQ or EXT

Domains	Number	Mean ±SD	t	p-value
Leg movement - BL Leg movement - ACQ	10	-1.000 ± 1.333	-2.372	0.042
Leg movement - BL Leg movement - EXT	10	-0.400 ± 0.966	-1.309	0.223
No. of kicks - BL No.of kicks - ACQ	10	-1.400 ± 1.506	-2.941	0.016
No. of kicks - BL No. of kicks - EXT	10	-0.300 ± 1.567	-0.605	0.560

The average number of leg movements generated by each baby in each condition is shown in fig 2. Every baby responded differently to conjugate reinforcement by mobile paradigm. Baby 3 and 8 generated more leg movements in the EXT condition whereas baby 3moved legs more in the acquisition condition

This fig presents average number of each baby's leg movements in each condition.

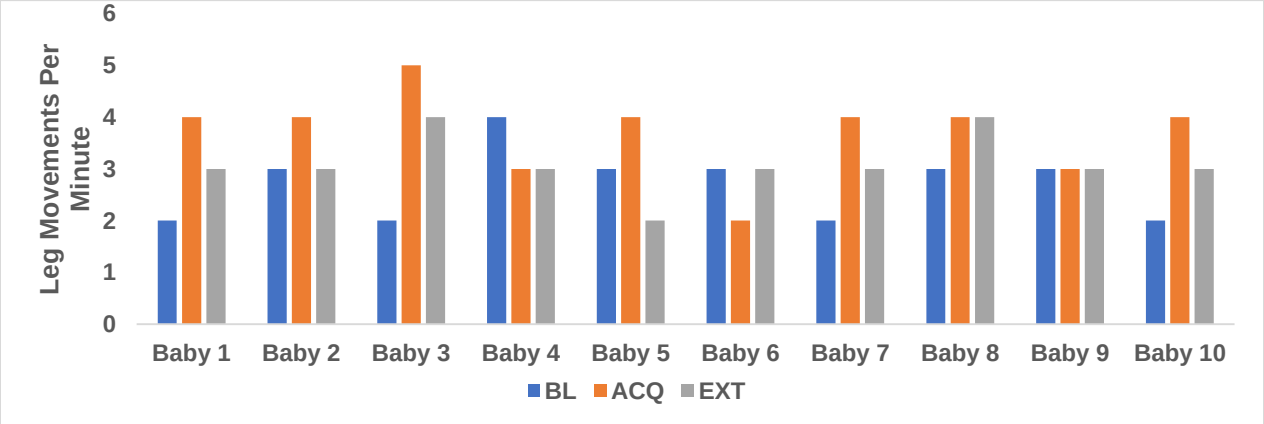

Fig 2: Individual baby average number of leg movements per condition

The individual baby's total kicks per condition are shown in fig 3. As subset of individual's total leg movements are kicks, so it was not unusual to observer fewer kicks than leg movements in each condition. Similarly, every baby's response to conjugate reinforcement by mobile paradigm was different. Fig 3 represents that babies 1,2,4 & 5 generated most kicks/min in the ACQ condition whereas babies 1,2,7 & 8 produced more kicks in the EXT condition.

This fig presents the total kicks per minute by each infant in every condition

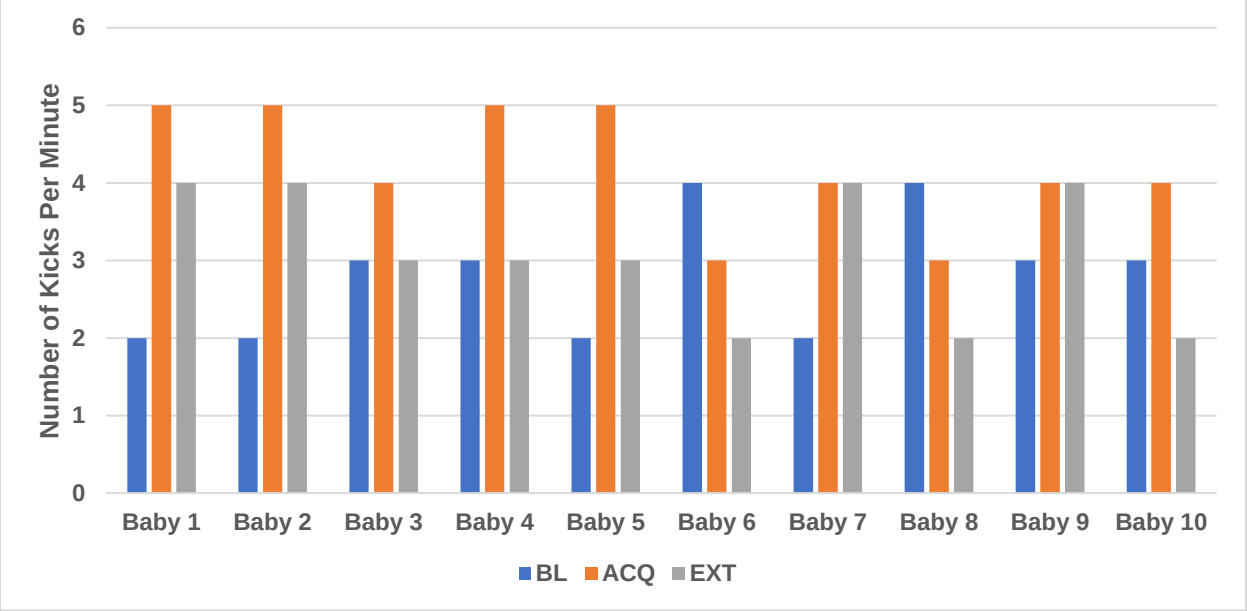

Fig 3: Individual baby total kicks per condition

This fig represents the relationship between the total number of leg movements and kicks produced per minute by each infant.

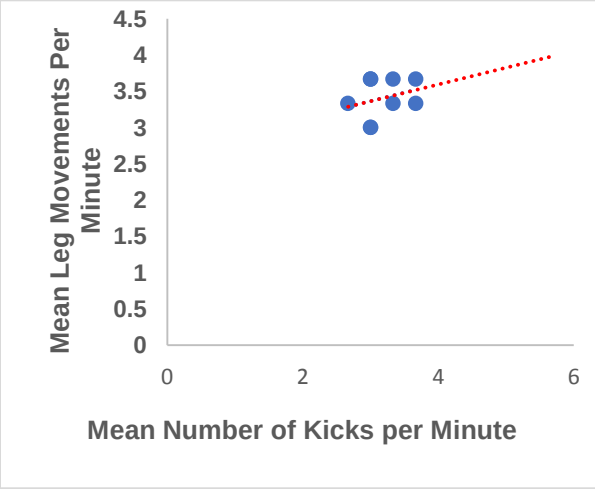

Fig 4:Leg Movements and Kicks

DISCUSSION

Keeping in view the concepts of neuroplasticity and self-organization, the current study was designed to assess the frequency and types of voluntary and goal directed leg movements and kicks by using conjugate reinforcement in SB infants. It was found that SB babies generate more leg movements and kicks in ACQ & EXT conditions as compared to BL condition when they are untethered by mobile paradigm. This result is in consistent with previous studies which showed that infants with SB produce more kicks and leg movements when tethered with overhead mobile as compared to untethered.[6,11] This shows that SB infants are sensitive to movements & therefore can produce goal directed leg movements and kicks.

The second outcome of the current study was that tethered leg produce more movements and kicks as compared to untethered leg and all the babies

in showed more movements in ACQ condition. This result is similar to previous study which showed that babies with Down's syndrome had more frequency of movements with tethered leg in ACQ condition.[12]

The results of current study have many clinical implications. The parents and attendants of the SB infants with lesion at lumbar and sacral level should positions the babies such that they move their legs more frequently and similarly avoid such conventional seats that inhibit their leg movements and kicks. The conjugate reinforcement by mobile paradigm couple with previous studies focuses on the concept that it will generate more leg movements and kicks that lead to strengthening of leg muscles and also strong neuromuscular coordination of lower extremities[8,13-15]

There are some limitations of the study such as small sample size (n=10), the age range (20 - 36 weeks) of the babies, tethering of only one leg, cross sectional study design. Further research having large sample size and tethering of both legs (one randomly at a time) should be conducted. It is suggested to check the response of SB infants if their legs are tethered with some therapeutic intervention, can lead to increased frequency of leg movements and kicks. This is a novel study in Pakistan to identify leg movements and kicks in SB infants.

CONCLUSION

The infants with Lumbar and sacral spina bifida generate more leg movements and kicks when tethered with mobile paradigm as compared to untethered leg. These increased movements lead to improved strength & neuromuscular control of lower extremities which can help SB babies to walk early.

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Conflict of interest: None

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