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Type of Matured Pincer Grasp and Fine Motor Development in Preterm Children at The Age of 3-4 Years

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ABSTRACT

Background: Preterm children (PTC) are at a risk of subtle deficits in manual dexterity, sensory-motor integration and eye-hand coordination which are found to affect their academic competencies and daily functioning skills. Efficient grasping requires the attainment of force control, coordinated hand movements and effective in-hand manipulation with translation which concords with appropriate fine motor skill development. Different types of mature pincer grasps are identified in a child's development which includes tripod, quadrupod and lateral tripod. This current study intends to identify the type of mature pincer grasp and level of fine motor development of preterm children at 3-4 years.

Subjects and Methods: This cross sectional study was carried out in 25 preterm children recruited from Karthikeyan Child Developmental Unit. Preterm children of 3-4 years of age who met the inclusion criteria were included in the study. Type of mature pincer grasp was assessed by observation and level of fine motor development was assessed with Peabody Developmental Motor Scale.

Results: Out of 25 children who participated in the study, 11 children were found to use tripod grasp, 10 children used quadrupod grasp and 4 children used lateral tripod grasp. The mean fine motor quotient was 97, 87.7 and 70 in children with tripod, quadrupod and lateral tripod grasp. Spearman's correlation showed strong correlation with r_s value of -0.71 and significant p value ≤ 0.05 conveying that PTC with tripod grasp have higher performance in fine motor skills followed by PTC with quadrupod and lateral tripod grasp.

Conclusion: The study conveys that fine motor development is reduced in PTC and tripod grasp is the most efficient grasp with appropriate fine motor development which would be helpful in carrying out fine functional activities. The result of the study emphasizes that typical mature tripod grasp should be trained at an early age along with fine motor skills in PTC.

Keywords: *Preterm children, Fine motor development, Mature pincer grasp, Peabody Developmental Motor Scales.*

1. INTRODUCTION

Preterm birth is defined as children born before 259 days or before 37 weeks of completed pregnancy. Around 15 million babies are born preterm yearly with a mortality of 1 million children due to complications of preterm birth and survivors face deficits and disabilities including visual, learning disabilities, and hearing problems (WHO). The increased risk of

complications due to prematurity arises from an increased demand over the immature organ systems to support a functional transition from intrauterine to extrauterine life which can have an impact on neurodevelopmental outcomes both over gross and fine motor when compared with full term-infants (1).

The nature of developmental outcomes in preterm children (PTC) is heterogeneous and the degree of prematurity highly influences the rate of gross and fine motor milestone attainment in PTC (2). The structural neuronal differentiation, synapse formation, dendritic and axonal growth expeditiously occurs during 23-32 weeks of gestation which is altered in preterm resulting in increased risk of motor skill deficits in PTC (3). Increased survival rate of PTC has a likelihood of subtle changes in gross and fine motor development. Gross motor resolves by 2 years of age as a child becomes ambulant but fine motor impairments are found to be more pronounced in PTC (4).

Fine motor skills (FMS) involve the action of small muscle groups which brings about precise movements of the hands and feet. The ability to use hands involves two components namely grasping and visuomotor integration (VMI). Grasping includes abilities such as finger dexterity, motor sequencing, fine motor speed and accuracy whereas VMI involves the organization of small muscle movements in the hand and fingers through the processing of visual stimuli (5,6).

PTC are at risk of subtle deficits in manual dexterity, sensory-motor integration and eye-hand coordination which in later years are closely associated to affect both academic competencies like learning of writing skills and several aspects of daily functioning such as buttoning, lacing shoes and eating (7,8). Preschool years (3-5 years) is called the golden age for motor skill development and addressing learning of FMS can be optimal at this age which can be practiced and reinforced (9). As child spends 31% to 60% of the day performing fine motor tasks during school times, persistence of fine motor difficulties may affect integration and performance at school, leading to lower self-esteem (10–12).

Efficient grasping requires attainment of force control, coordinated hand movements with proximal stabilization and efficient in-hand manipulation with translation which concords with appropriate FMS. Grasp involves efficient positioning of the object in functional position and having good in-hand manipulation skills which comprise of three types of skills namely translation which involves moving object from palm to finger, shifting which entails moving objects along the surface of the fingers and rotation for turning objects around (13).

Typical grasp development emerges from primitive grasp by 3.5 months which involves pencil grasped across the palm evolving from radial cross palmar grip, palmar supinate grasp, where a child barely scribbles, followed by transitional grasp where the pencil is held between the thumbs and fingers developing through the digital pronate grasp, grasp with extended fingers, cross thumb grasp. Later around 3-4 years mature pincer grasp emerges which includes tripod, lateral tripod and quadrupod where forearm is stabilized and involves intrinsic activity (14). The tripod grasp is commonly used by children which accounts for about 50-70% than lateral tripod and quadrapod grasp which is observed in 25-50% of children (15).

Literature reveals delayed fine motor development in PTC but inconclusive about problems prevalent in preschoolers which might interfere with their academics in the effective grasping and primitive self-care activities at 3-4 years of age. Continuous follow-up examinations for hand function in children with a history of prematurity after 24 months is highly recommended (16,17). This study intends to identify the type of mature pincer grasp used and the level of fine motor development of PTC at 3-4 years of age.

2. M:ETHODOLOGY

This cross sectional study was approved by the Research Advisory Committee of Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research. Subjects were recruited from Karthikeyan Child Developmental Unit (KCDU). PTC of 3-4 years of both genders with normal cranial ultrasonography findings at the time of birth were included in the study. Children with any neurological impairments, congenital abnormalities, hearing and vision loss were excluded from the study.

3. INSTRUMENTATION

PEABODY DEVELOPMENTAL MOTOR SCALE (PDMS -2): It is a pediatric tool to assess motor development in children from 0-72 months. It consists of 6 subscales (reflex/stationary/locomotion/object manipulation/grasping/visual motor integration) based on Harrow's taxonomy of psychomotor domain. The test was conducted based on the instructions provided in the manual. The summation of scores from 2 subscales, Grasping and VMI gives a fine motor quotient (FMQ) which is a combination of the results of the subtests that measure the use of the small muscle systems. The standard scores, age equivalent, quotient scores were obtained from raw scores. The standard scores which were converted into FMQ scores, indicates fine motor development of children (18).

Fine Motor Components of PDMS-2

Grasping: This 26-item subtest measures a child's ability to use his or her hands. It begins with the ability to hold an object with one hand and progresses up to actions involving the controlled use of the fingers of both hands.

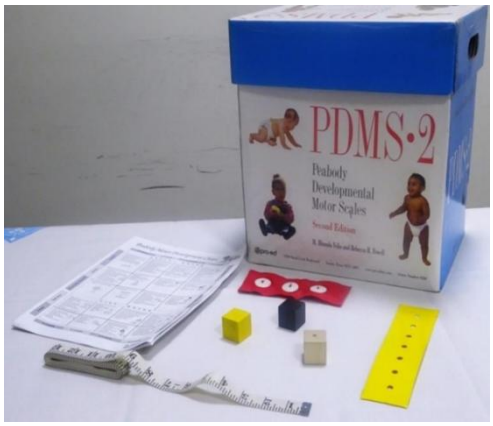
Visual-Motor Integration: This 72-item subtest measures a child's ability to use his or her visual perceptual skills to perform

complex eye-hand coordination tasks such as reaching and grasping for an object, building with blocks, and copying designs.

Procedure:

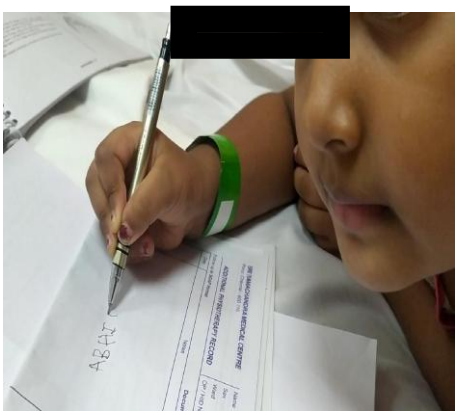
Subjects were recruited from Karthikeyan child developmental unit (KCDU) when they return back for neurodevelopmental assessment. PTC who met the inclusion criteria participated in the study after receiving informed consent. PTC at 3-4 years were assessed for the type of mature pincer grasp by encouraging the child to write and observe the grasp. Fine motor development was assessed with PDMS-2.

FIGURE - 1



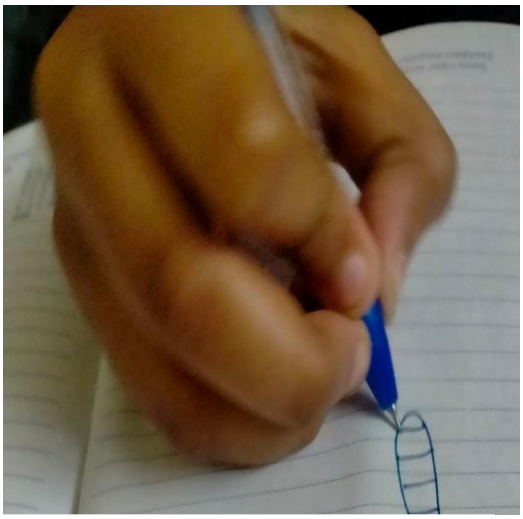
PEABODY DEVELOPMENTAL MOTOR SCALE

FIGURE - 2



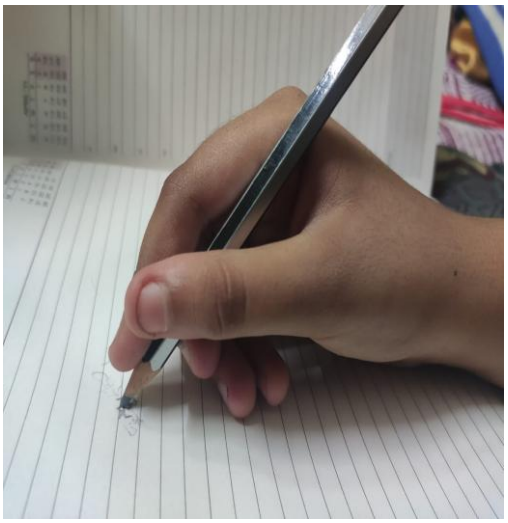
TRIPOD GRASP

FIGURE - 3



QUADRUPOD GRASP

FIGURE - 4



LATERAL TRIPOD GRASP

4. RESULTS

Out of 25 children who participated in the study, 11 children were found to use tripod grasp, 10 children used quadrupod grasp and 4 children used lateral tripod grasp. The overall mean FMQ was 88.96 which denotes below average performance in PTC at 3-4 years of age (Table: 1). The mean FMQ of PTC with tripod grasp was 97, quadruped grasp was 87.7 and lateral tripod grasp was 70 (Table: 2)

Spearman's correlation between the type of grasp adopted by the child and the level of fine motor development showed a strong correlation with r_s value of -0.71 and statistically significant p value ≤ 0.05 conveying that PTC with tripod grasp have good fine motor skills followed by PTC with quadrupod and lateral tripod grasp (Table: 3)

TABLE 1: DEMOGRAPHIC CHARACTERISTICS

VARIABLE		MEAN (SD)
AGE (Months)		43.24 (3.41)
GENDER		M=14 F=11
FMQ		88.96 (12.12)
GRASP	TRIPOD QUADRAPOD LATERAL TRIPOD	N = 11 N = 10 N = 4

TABLE 2: TYPE OF GRASP WITH MEAN SCORES

TYPE OF GRASP	N	GESTATIONAL AGE	FMQ	MEAN (SD)	
			MEAN (SD)	GRASPING	VIS-MOT INTEGRATION
TRIPOD	11	33.8	97 (9.29)	10 (3.03)	9 (1.34)
QUADRAPOD	10	32	87.7 (6.39)	6.9 (2.37)	9 (0.81)
LATERAL TRIPOD	4	34	70 (6.48)	4.75 (1.5)	5 (0.81)

TABLE 3: CORRELATION OF FMQ AND TYPE OF GRASP

	N	MEAN (SD)	r_s	p value
TYPE OF GRASP/FMQ	25	88.96 (12.12)	-0.71	0.00

Spearman's correlation p $\leq$ 0.05 is significant

5. DISCUSSION

FMS involve purposeful refined manual dexterity which is crucial for early emergent learning, readiness to school, self-care activities of the child and later academic competencies. Ideal FMS achievement is through the contributions from both precision of movement or grasping adapted and visuomotor integration which are vital for many aspects of higher-order cognitive skills, language development, communication and handwriting proficiency. Subtle changes in fine motor development may considerably hamper child's functional ability in daily life. This study was conducted to find out the type of mature pincer grasp and the level of fine motor development of PTC at 3-4 years.

The overall composite score of mean FMQ of all PTC was found to be 88.96 which denotes a "below average" performance. The results were consistent with the longitudinal studies done up to the age of 24 months where delayed hand functions and FMS were evident and concluded that PTC are at risk for clinically relevant developmental delays which includes the fine motor subsets (19). Fine motor behaviour requires highly efficient and integrated brain networks to feed online sensory information rapidly from multiple sensory cortices to motor cortex. PTC are vulnerable to stealthy neuronal damage as they have an increased predisposition to white matter damage, along with injury to pre-oligodendrocytes which may delay the

emergence of FMS considerably and hamper the children's functional abilities in daily life (20,21).

Grasp is an integral part of FMS which involves visually monitoring the shape, form of the objects and feedback guided touch and exploration of object by proper stabilized grasp pattern.

The mean FMQ of children with tripod grasp was 97 which showed average performance, of quadrapod grasp was 87.7 which showed below average performance and that of lateral tripod was 70 which showed poor performance. There was a strong correlation between the type of grasp and level fine motor development which showed that PTC with tripod grasp had higher performance in FMS than PTC with other two grasp.

The dynamic tripod grasp is the most desirable and is found to be offering high level of precision and control mechanically and is considered typical mature pincer grasp and standard grasp while other grasp are even though called as mature pincer grasp are said to be atypical because they lack mechanical efficiency which could be attributed for their decreased fine motor performance (22,23).

The subtest component of PDMS 2 in visual motor integration for children with tripod and quadrupod grasp showed an average performance but for children with lateral tripod showed mean standard score of 5 which denotes poor performance. This may be attributed to the reason that VMI skills have more affinity and are intimately linked to other factors of cognition, environmental influence and maternal interaction with the child which is not similar with grasping skills (24).

The subtest component of PDMS 2 in grasping for children with tripod grasp showed an average performance, but children with quadrapod and lateral tripod grasp scored mean standard scores of 6.9 and 4.75 which denoted a below average and poor performance respectively. The age equivalent of grasping subtest in PDMS was 33 months in quadrapod grasp and 23 months in lateral tripod grasp which showed the child started having a block in performing the activities from grasping a marker and moving the hand as a unit when drawing, unbuttoning buttons, buttoning, touching fingers to thumb etc. and thereby resulting in a delay.

The deficit in grasping component of fine motor subtest may primarily be due to improper activation of distal musculature and lack in control to have a minute mature pincer hold which leads to ineffective positioning of the fingers. Voluntary attainment of intricate motor control over the small muscles of hand which help in manipulation, precise movements and interaction with smaller objects and their environment is not provided by these atypical grasp (22,23).

The dynamic tripod is used by only 50% to 70% of children in a given sample which could be due to lack of awareness and inadequate training for the use of tripod grasp, where the child is not effectively learning to use it emphasizing the need to encourage dynamic tripod grip before the child develops a fixed grasp or writing posture (25).

The developmental trajectory of PTC is different due to the interplay between gestational age at birth, brain plasticity, and the starting points of their interaction with the environment which includes both nature and nurture factors emphasizing that nurturing skills can reduce the delay in the development of PTC. The findings of the study show that fine motor development is reduced in PTC and that tripod grasp is the most efficient grasp with appropriate fine motor skills which need to be trained appropriately.

6. CONCLUSION

The findings of the current study reveal that FMS development is reduced in PTC and that tripod grasp is the most efficient grasp with appropriate fine motor development and thus would be helpful in carrying out fine functional activities. The result of the study emphasises that typical mature tripod grasp should be trained at an early age along with fine motor skills in PTC simultaneously.

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