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ROLE OF *VACHA* AND *BRAHMI* IN GROWTH AND DEVELOPMENT OF INFANTS

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ABSTRACT

Both mental and physical growth is rapid during first two years of life. Hence environmental influences during the early postnatal life can have a profound impact upon the pace and pattern of growth and development. *Ayurvedic* reference classics recommend the use of certain drugs in newborns for enhancement of memory, growth and development. This study was conducted to assess the effect of *Acorus calamus* Linn and *Bacopa monnieri* Linn on growth and development of infants. The study design was random controlled clinical trial in 65 newborns, divided into four groups including a control group. Anthropometrical assessment of growth at monthly intervals, developmental assessment by Gesell developmental schedule (at 4, 16, 28 weeks) and the first appearance of social smile, indicated that oral administration of *Vacha* &*Brahmi* twice daily in dose of 2 mg/kg/dose and 8mg/kg/dose respectively in the early infantile period enhanced the growth velocity mainly in terms of weight and length gain, along with a reasonably good effect upon motor and sensory development.

Key words: *Brahmi* (*Bacopa monnieri* Linn.), Growth and Development (G & D), Infants, Neonates, *Vacha* (*Acorus calamus* Linn.)

INTRODUCTION

Growth and development of any nation tomorrow is dependent upon the G & D of its baby born today. Hence every attempt should be made to ensure transformation of newborn to healthiest possible adulthood within the inherent genetic potential. Growth (Quantitative or physical maturation) and development (qualitative or mental maturation) are the unique characteristics of children, representing the two facets of dynamic change and are often used synonymously. But it is CNS, the seat of all sensorimotor pathways, which becomes dominant and unifies the whole organism, as the infant develops and moves from one cycle of growth to next. Hence, not only development but also growth is dependent upon maturation and myelination of central nervous system. [1] This is further supported by the fact that in babies affected by hypoxic ischemic encephalopathy, both mental

development and physical growth are negatively affected. So apart from the traditional use in mental development, some *Ayurvedic medhya dravyas* may also be used to facilitate physical growth in children. Both mental and physical growth is rapid during first two years of life. The human brain has 100 billion neurons at birth, with each neuron developing an average of 15,000 synapses by the age of three year. [2] An infant almost doubles his weight at 5 month age and achieves half the adult height by about two years of age. Hence, environmental influences during early postnatal life may significantly affect the pace and pattern of G & D. [3] *Vacha* and *Brahmi* are the two drugs that have been profusely recommended in *Ayurvedic* classics for promoting G & D of infants. [4] Albeit many scientific studies have been done on them, but paucity exists regarding those specifically supporting their use for promoting G & D in its crucial phase of infancy. Hence, this study was planned in order to scientifically assess the effects of oral administration of *Vacha* and *Brahmi* on G & D of infants.

MATERIALS AND METHODS

Sample Design

This study was a random, controlled clinical trial conducted upon the newborns delivered in IPD of Department of *Kaumarabhritya*, Institute of Medical Sciences, Banaras Hindu University and it lasted from Aug 2005 to Dec 2006. Hence, the total numbers of follow ups were variable for each case, as the study started with the birth of baby, but the end point of study was fixed at Dec 2006 or completion of a total duration of eight months, whichever was attained earlier. Consequently, a larger number of samples were available for initial observations. Post study follow up was not in the design of this study.

Inclusion criteria

- Healthy newborns (full term, appropriate for gestational age, no perinatal complications, timely breast fed and pathological jaundice not present).
- Born to healthy mothers (normal ante- and peri-natal course).

Exclusion criteria

- Infant criteria: Pre / post term, twins, perinatal complications, pathological jaundice, those receiving medications (even multivitamins) other than *Vacha* and/or *Brahmi* syrup.
- Maternal criteria: Infections during pregnancy, medical disorders of significance, use of drugs having profound impact on G & D of newborn.

Grouping of the sample: On the basis of above criteria, a total of 65 newborns were included in this study and divided randomly into following four groups. However, one baby from Group B was later on dropped from the study due to infective meningitis developing five months after birth.

	Treated groups			Control group
	Group A	**Group B**	**Group C**	**Group D**
Medication administered	*Vacha* syrup	*Brahmi* syrup	*Vacha* + *Brahmi* syrup	None
No. of newborns	16	16	15	18

in group (n)				

Preparation of *Brahmi* and *Vacha* syrup

Kwatha (decoction) of fresh *Brahmi panchanga* (all parts of the plant) was prepared by the method described in *Sharangdhara Samhita*. [5] Dry extract of this *Kwatha* was obtained and finally for the sake of ease of administration, *Brahmi* syrup was prepared in a concentration of 250 mg/ml, by standard methods of syrup preparation. Similarly, *Vacha* syrup was prepared from dry *Vacha* rhizome, in a concentration of 50 mg/ml.

Dose and administration of drugs

Vacha and *Brahmi* was administered orally to infants in a dose of 2mg/kg/dose and 8mg/kg/dose respectively, twice daily (once in morning & evening) after feed (*Adhobhakta*), via dropper bottles. The syrup was initiated in infant right after their birth and continued until the end of the study.

Assessment of drug response

In all four groups, growth was assessed at monthly intervals by anthropometrical evaluation; development was assessed at 4, 16, 28 weeks by Gesell's developmental schedule; first appearance of social smile was noted to have appeared before 4 wks /between 4 to 6 wks /after 6 weeks.

Statistical analysis

A cross-sectional as well as longitudinal analysis of the collected data was done. Anthropometry was analyzed in terms of mean, standard deviation paired 't' test, intergroup-one way ANOVA F-test, multiple comparison test (least significant difference test) and percentile charts; whereas various parameters of Gesell developmental examination and first social smile were analyzed in terms of chi-square test and percentages. In original study, there were a total of 23 variables and many sub variables, but only significant ones are being discussed here.

OBSERVATIONS AND RESULTS

It can be clearly seen from the gathered observations that although the babies of all four groups mostly demonstrated 'within normal limit' findings of anthropometry, Gesell's developmental scale and social smile; the babies of treated groups more often showed a general trend of demonstrating G & D on the higher side of normal range. But the overall G & D expectedly remained within normal range in all the four groups, as for this study only healthy baby was selected. An overall reduction in morbidity was also noticed in treated groups, probably due to the antibacterial, [6] antifungal, anti diarrheal, [7] immunomodulation and stress reliever properties of these drugs.

Anthropometry:

Weight (Table 1): On comparing the data of present study with the mean, standard deviation and selected centile of weight for age from birth to 8 months at 50th percentile,[8] the treated group achieved the weight at 5th month, while control group belonging to less than 25th percentile. At 6th and 7th month, the weight gain was found more significant in Group B in which achieved weight was near to the 75th percentile, whereas control group had not achieved the weight mentioned at 50th percentile (near to 25th percentile).

Table 1: Weight / Change in Weight (paired‘t’ test), in kilograms

Follow-up	Mean and SD				ANOVA test
	Group A	Group B	Group C	Group D	
a. At birth	2.87 ± 0.32 (n=16)	2.94 ± 0.43 (n=16)	2.97 ± 0.35 (n=15)	2.96 ± 0.39 (n=18)	f = 0.23 P > 0.05 (0.8719) N.S.
					MCT:NS
b. 1 month	3.95 ± 0.65 (n=16)	4.00 ± 0.55 (n=16)	3.77 ± 0.49 (n=13)	3.94 ± 0.52 (n=16)	f = 0.45 P> 0.05 (0.7183) N.S.
					MCT:NS
c. 1 month – birth (paired ‘t’ test)	1.08 ± 0.53 t = 8.11 P < 0.001 (HS)	1.06 ± 0.40 t = 10.55 P < 0.001 (HS)	0.85 ± 0.39 t = 7.83 P < 0.001 (HS)	1.00 ± 0.21 t = 18.83 P < 0.001 (HS)	-
d. 2 month – 1 month (paired ‘t’ test)	1.10 ± 0.36 t = 11.75 P < 0.001 (HS)	1.08 ± 0.36 t = 12.07 P < 0.001 (HS)	1.15 ± 0.19 t = 21.43 P < 0.001 (HS)	1.02 ± 0.16 t = 22.21 P<0.001 (HS)	
e. 2 month	5.01 ± 0.61 (n=15)	5.08 ± 0.58 (n=16)	5.01 ± 0.61 (n=15)	5.04 ± 0.51 (n=14)	f = 0.05 P > 0.05 (0.9837) N.S.
					MCT:NS
f. 3 month	6.03 ± 0.53 (n=16)	6.13 ± 0.65 (n=16)	6.14 ± 0.75 (n=15)	5.94 ± 0.67 (n=14)	f = 0.32 P > 0.05 (0.8090) N.S.
					MCT:NS
g. 3 month 2 month (paired ‘t’ test)	0.98 ± 0.26 t = 14.64 P < 0.001 (HS)	1.05 ± 0.23 t = 18.66 P < 0.001 (HS)	1.13 ± 0.36 t = 12.27 P < 0.001 (HS)	0.97 ± 1.16 t = 19.94 P < 0.001 (HS)	-
h. 4 month 3 month (paired ‘t’ test)	0.68 ± 0.20 t = 13.86 P< 0.001 (HS)	0.74 ± 0.21 t = 13.88 P < 0.001 (HS)	0.64 ± 0.29 t = 8.48 P < 0.001 (HS)	0.55 ± 0.09 t = 19.36 P < 0.001 (HS)	
i. 4 month	6.71 ± 0.57 (n=16)	6.87 ± 0.65 (n=16)	6.78 ± 0.72 (n=15)	6.35 ± 0.66 (n=15)	f = 1.88 P > 0.05 (0.1436) N.S.
					MCT:S*
j. 5	7.45 ± 0.63	7.48 ± 0.66	7.49 ± 0.78	6.84 ± 0.8	f = 2.46

month	(n=15)	(n=16)	(n=15)	(n=12)	P > 0.05 (0.0727) N.S.
					MCT:S*†, ‡
k. 5 month – 4 month (paired 't' test)	0.69 ± 0.21 t = 12.87 P < 0.001 (HS)	0.61 ± 0.13 t = 18.81 P < 0.001 (HS)	0.71 ± 0.20 t = 13.82 P< 0.001 (HS)	0.56 ± 0.12 t = 15.60 P< 0.001 (HS)	-
l. 6 month – 5 month (paired 't' test)	0.61 ± 0.14 t = 15.78 P < 0.001 (HS)	0.72 ± 0.19 t = 14.41 P < 0.001 (HS)	0.61 ± 0.11 t = 19.91 P < 0.001 (HS)	0.50 ± 0.11 t = 11.46 P < 0.001 (HS)	
m. 6 month	8.01 ± 0.61 (n=14)	8.21 ± 0.72 (n=15)	8.04 ± 0.8 (n=14)	7.41 ± 0.51 (n=10)	f = 2.94 P < 0.05 (0.0420) N.S.
					MCT:S*†, ‡
n. 7 month	8.52 ± 0.56 (n=13)	8.77 ± 0.84 (n=9)	8.64 ± 0.75 (n=11)	7.77 ± 0.37 (n=6)	F = 3.052 P < 0.05 (0.0415) N.S.*
					MCT:S*†, ‡
o. 7 month – 6 month (paired 't' test)	0.56 ± 0.15 t = 14.01 P < 0.001 (HS)	0.62 ± 0.10 t = 19.21 P < 0.001 (HS)	0.56 ± 0.08 t = 23.11 P< 0.001 (HS)	0.48 ± 0.12 t = 10.13 P< 0.001 (HS)	-
p. 8 month – 7 month (paired 't' test)	0.59 ± 0.15 t = 12.24 P < 0.001 (HS)	0.64 ± 0.10 t = 17.43 P< 0.001 (HS)	-	-	
q. 8 month	9.15 ± 0.66 (n=10)	9.61 ± 0.75 (n=7)	9.65 ± 0.07 (n=2)	8.5 ± 0.71 (n=2)	f = 1.78 P > 0.05 (0.1896) N.S.
					MCT:NS

Multiple comparison test (MCT) / least significant different test:*Gp B vs Gp D: significant difference (< 0.05); †Gp A vs Gp D: significant difference (< 0.05); ‡Gp C vs Gp D: significant difference (< 0.05)

Head circumference (Table 2): Inter group comparison of gain in head circumference in between subsequent months of different groups suggest that the gain in head circumference was highly significant except in gp D between the 5th and 6th month. Although the ANOVA test has shown the insignificant 'P' value in all the groups between different period of follow up, but the 'f' value on MCT at eight month suggests that the gp A had better response in

gaining head circumference in comparison to control group.

Table 2: Head Circumference/Change in Head Circumference (paired't' test), in centimeters

Follow-up	Mean and SD				ANOVA test
	Group A	Group B	Group C	Group D	
a. At birth	34.05 ± 1.31 (n=16)	34.19 ± 1.65 (n=16)	34.16 ± 1.47 (n=15)	34.33 ± 1.32 (n=18)	f = 0.11 P> 0.05 (0.9527) N.S.
					MCT:N.S
b. 1 month	36.29 ± 1.41 (n=16)	36.29 ± 1.64 (n=16)	36.22 ± 1.74 (n=13)	35.66 ± 1.33 (n=16)	f = 0.64 P > 0.05 (0.5914) N.S.
					MCT:N.S.
c. 1 month – birth (paired 't' test)	2.24 ± 0.85 t = 10.51 P < 0.001 (HS)	2.11 ± 0.55 t = 15.47 P< 0.001 (HS)	2.12 ± 0.71 t = 10.68 P < 0.001 (HS)	1.52 ± 0.52 t = 11.79 P < 0.001 (HS)	
d. 2 month – 1 month (paired 't' test)	1.10 ± 0.36 t = 11.75 P < 0.001 (HS)	1.08 ± 0.36 t = 12.07 P < 0.001 (HS)	1.15 ± 0.19 t = 21.43 P < 0.001 (HS)	1.02 ± 0.16 t = 22.21 P < 0.001(HS)	
e. 2 month	38.14 ± 1.45 (n=15)	38.14 ± 1.59 (n=16)	38.33 ± 1.94 (n=15)	38.05 ± 1.40 (n=14)	f = 0.08 P > 0.05 (0.9704) N.S.
					MCT:N.S.
f. 3 month	39.98 ± 1.62 (n=16)	40.13 ± 1.54 (n=16)	40.19 ± 2.06 (n=15)	39.87 ± 1.46 (n=14)	f = 0.11 P > 0.05 (0.9531) N.S
					MCT:N.S.
g. 3 month – 2 month (paired 't' test)	1.71 ± 0.47 t = 13.98 P< 0.001 (HS)	1.99 ± 0.30 t = 26.82 P< 0.001 (HS)	1.86 ± 0.36 t = 19.89 P< 0.001 (HS)	1.96 ± 0.17 t = 38.55 P < 0.001 (HS)	-
h. 4 month – 3 month	0.94 ± 0.31 t = 11.95 P < 0.001	1.09 ± 0.17 t = 25.45 P < 0.001	0.93 ± 0.15 t = 23.40 P < 0.001	0.95 ± 0.27 t = 11.79 P< 0.001(HS)	

(paired 't' test)	(HS)	(HS)	(HS)		
i. 4 month	40.91 ± 1.61 (n=16)	41.22 ± 1.58 (n=16)	41.12 ± 2.13 (n=15)	40.69 ± 1.44 (n=15)	f = 0.29 P> 0.05 (0.8342) N.S.
					MCT:N.S.
j. 5 month	42.05 ± 1.50 (n=15)	42.19 ± 1.51 (n=16)	42.18 ± 2.20 (n=15)	42.28 ± 1.69 (n=12)	f = 0.04 P > 0.05 (0.9893) N.S.
					MCT:N.S.
k. 5 month – 4 month (paired 't' test)	0.99 ± 0.29 t = 13.20 P < 0.001 (HS)	0.97 ± 0.22 t = 18.01 P < 0.001 (HS)	1.06 ± 0.32 t = 12.82 P< 0.001 (HS)	0.87 ± 1.64 t = 1.68 P > 0.05(NS)	-
l. 6 month – 5 month (paired 't' test)	0.89 ± 0.35 t = 9.50 P < 0.001 (HS)	1.02 ± 0.29 t = 13.70 P < 0.001 (HS)	0.89 ± 0.29 t = 11.33 P < 0.001 (HS)	0.14 ± 2.12 t = 0.18 P > 0.05 (NS)	
m. 6 month	42.89 ± 1.61 (n=14)	43.22 ± 1.60 (n=15)	42.89 ± 2.14 (n=14)	42.86 ± 1.41 (n=10)	f = 0.14 P < 0.05 (0.9382) N.S.
					MCT:N.S.
n. 7 month	43.44 ± 1.60 (n=13)	43.70 ± 1.85 (n=9)	43.85 ± 1.71 (n=11)	42.86 ± 1.34 (n=5)	f = 0.45 P< 0.05 (0.7175) N.S.
					MCT:N.S.
o. 7 month – 6 month (paired 't' test)	0.68 ± 0.21 t = 11.67 P< 0.001 (HS)	0.67 ± 0.13 t = 12.85 P < 0.001 (HS)	0.53 ± 0.08 t = 22.24 P < 0.001 (HS)	0.44 ± 0.11 t = 8.63 P < 0.01 (HS)	-
p. 8 month – 7 month (paired't')	0.64 ± 0.21 t = 9.55 P< 0.001 (HS)	0.63 ± 0.05 t = 30.04 P < 0.001 (HS)	-	-	
q. 8 month	43.75 ± 1.50 (n=10)	45.25 ± 1.40 (n=6)	46.20 ± 1.56 (n=2)	44.33 ± 1.53 (n=3)	f = 2.26P>0.05 (0.1182) N.S.
					MCT:S.*

MCT / least significant different test: *Group A and Group C: significant difference (< 0.05).

Crown to heel length (Table 3): On comparison of Crown to heel length (CHL) for age, the data of present study with the mean, standard deviation and centile of length for age from birth to 8 months at 50th percentile , gp B and C achieved the CHL at 3rd, 4th, 5th, month, while control group remained to < 25th percentile. At 6th and 7th month, the gain in CHL was found more significant in Gp B in which the CHL was achieved beyond the 50th percentile. The control group had not achieved CHL even at 50th percentile (25th percentile), whereas gp B achieved that at 75th percentile.

Table 3: Crown to Heel Length / Change in CHL (paired't' test), in centimeters

Follow-up	Mean and SD				ANOVA test
	Group A	Group B	Group C	Group D	
a.Atbirth	50.12 ± 1.84 (n=16)	49.62 ± 2.55 (n=16)	49.95 ± 2.38 (n=15)	49.22 ± 1.99 (n=18)	f = 0.56 P > 0.05 (0.6459) N.S.
					MCT:S.*
b.1month	53.89 ± 2.56 (n=16)	53.51 ± 2.62 (n=16)	53.78 ± 1.74 (n=13)	52.63 ± 2.23 (n=16)	f = 0.94P > 0.05 (0.4289) N.S.
					MCT:S.*
c. 1 month – birth (paired 't' test)	3.77 ± 1.50 t = 10.03 P < 0.001 (HS)	3.89 ± 0.64 t = 24.27 P < 0.001 (HS)	4.22 ± 1.69 t = 9.01 P < 0.001 (HS)	3.51 ± 0.78 t = 18.08 P < 0.001 (HS)	-
d.2month –1 month (paired 't' test)	3.55 ± 1.05 t = 13.17 P < 0.001 (HS)	3.52 ± 2.06 t = 6.83 P < 0.001 (HS)	3.65 ± 0.50 t = 26.12 P < 0.001 (HS)	3.32 ± 0.27 t = 43.24 P < 0.001 (HS)	
e.2month	57.43 ± 3.00 (n=15)	57.03 ± 3.23 (n=16)	58.01 ± 2.37 (n=15)	52.36 ± 1.61 (n=14)	f = 0.98P > 0.05 (0.4074)N.S.
					MCT:N.S.
f.3month	60.76 ± 2.36 (n=16)	61.20 ± 2.67 (n=16)	61.52 ± 2.35 (n=15)	59.38 ± 2.53 (n=14)	f = 2.09P > 0.05 (0.1121)N.S.
					MCT:S. †, ‡
g.3month –2 month (paired 't' test)	3.30 ± 1.09 t = 11.72 P < 0.001 (HS)	4.18 ± 2.66 t = 6.29 P < 0.001 (HS)	3.51 ± 0.55 t = 24.79 P < 0.001 (HS)	3.45 ± 0.28 t = 41.36 P< 0.001 (HS)	-
h.4month – 3month	2.18 ± 0.66 t = 13.27	2.54 ± 1.04 t = 9.76	2.05 ± 0.43 t = 18.61	2.02 ± 0.41 t = 16.55	

(paired 't' test)	P< 0.001 (HS)	P < 0.001 (HS)	P < 0.001 (HS)	P < 0.001 (HS)	
i.4month	62.94 ± 2.50 (n=16)	63.74 ± 3.17 (n=16)	63.57 ± 2.42 (n=15)	61.25 ± 2.56 (n=15)	f = 2.67P > 0.05 (0.0559)N.S.
					MCT:S. †, ‡
j.5month	65.13 ± 2.39 (n=15)	65.90 ± 3.25 (n=16)	65.61 ± 2.56 (n=15)	63.16 ± 2.82 (n=12)	f = 2.56P> 0.05 (0.0647)N.S.
					MCT:S.†
k.5month –4 month (paired t)	1.92 ± 0.25 t = 29.26 P < 0.001 (HS)	2.16 ± 0.19 t = 46.57 P < 0.001 (HS)	2.04 ± 0.30 t = 26.59 P < 0.001 (HS)	1.85 ± 0.29 t = 22.28 P<0.001 (HS)	-
l.6month –5 month (paired 't' test)	1.89 ± 0.48 t = 14.92 P < 0.001 (HS)	2.73 ± 2.47 t = 4.27 P < 0.01 (HS)	2.06 ± 0.50 t = 15.44 P < 0.001 (HS)	1.88 ± 0.21 t = 23.53 P< 0.001 (HS)	f = 3.05 P < 0.05 (0.0372) N.S. †
m. 6 month	67.24 ± 2.09 (n=14)	68.76 ± 3.74 (n=15)	67.46 ± 2.49 (n=14)	65.49 ± 1.18 (n=10)	
n.7month	68.44 ± 2.17 (n=13)	69.73 ± 4.17 (n=9)	69.07 ± 2.60 (n=11)	66.60 ± 1.20 (n=6)	MCT:S.†
					f = 1.65 P< 0.05 (0.1949) N.S. †
o.7 month –6 month (paired 't' test)	1.17 ± 0.45 t = 9.33 P < 0.001 (HS)	0.24 ± 3.37 t = 0.22 P > 0.05 (NS)	1.44 ± 0.38 t = 12.69 P < 0.001 (HS)	1.32 ± 0.18 t = 27.59 P < 0.001 (HS)	MCT:S.†
					-
p.8month –7 month (paired 't' test)	0.97 ± 2.20 t = 1.32 P >0.05 (NS)	1.26 ± 0.20 t = 16.73 P < 0.001 (HS)	-	-	f = 1.75 P> 0.05 (0.1963) N.S.
q.8 month	69.32 ± 4.00 (n=9)	72.40 ± 3.47 (n=7)	73.40 ± 0.99 (n=2)	67.95 ± 1.63 (n=2)	
					MCT: N.S.

*Gp A vs Gp D: significant difference (< 0.05); †Gp B vs Gp D: significant difference (< 0.05); ‡Gp C vs Gp D: significant difference (< 0.05)

Gesell's developmental examination:

Supine (Table 4): **At 4 wks**, all groups had achieved almost all the required development (i.e. side position head predominates, tonic neck reflex posture predominates and both hands fisted) except the '**rolls partway to side**', which was achieved by a maximum number of children of gp C (66.67%) and minimum number in control group. However, Chi square test does not show the upper hand over the control group (χ^2 test =1.77; P>0.05). **At 16wks**,'**Head engages**' and '**finger stretches, clutches**', are the two expected developments that had not been achieved by all children (35.29% and 47.06% respectively) belonging to control group. χ^2 test suggested that the difference in achieving expected development is highly significant.

Table 4: The Four Specific Milestones

Group	In supine (at 4 wk): Rolls partway to side		In Supine (at 16 wk): Head engages		In Supine (at 16 wk): Finger scratches, clutches		In Prone (4 wks) : Crawling movements		In Prone (16 wks): Verge of rolling	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
A (n=16)	8 (50%)	8 (50%)	16 (100%	0 (0%)	16 (100%)	0 (0%)	10 (62.5%)	6 (37.5%)	16 (100%)	0 (0%)
B (n=16)	9 (56.25 %)	7 (43.75 %)	16 (100%)	0 (0%)	15 (93.75%)	1 (6.25%)	14 (87.5%)	2 (12.5%)	15 (93.75 %)	1 (6.25%)
C (n=15)	10 (66.67 %)	5 (33.33 %)	15 (100%)	0 (0%)	15 (100%)	0 (0%)	12 (80%)	3 (20%)	15 (100%)	0 (0%)
D (n4=18) (n16=17)	8 (44.45 %)	10 (55.55 %)	11 (64.71%)	6 (35.29 %)	9 (52.94%)	8 (47.06 %)	10 (55.56%)	8 (44.44 %)	10 (58.82)	7 (41.18%)
Total (n4=65) (n16=64)	35 (53.85 %)	30 (46.15 %)	58 (90.63%)	6 (9.37%)	55 (85.94%)	9 (14.06 %)	46 (70.77%)	19 (29.23 %)	56 (87.5%)	8 (12.5%)
χ^2 test	χ^2 test = 1.77, P > 0.05 NS		χ^2 test = 18.30, P < 0.001 HS		χ^2 test = 21.20, P > 0.001 HS		χ^2 test = 5.33, P > 0.05 NS		X^2 test = 17.78, P < 0.001 HS	

Prone (Table 4): At 4 wks, in prone position the 'crawling movement' was achieved by maximum infants in gp B**.** At 16 wks, 41.18% infants had not achieved the 'verge of rolling' in control group, while those of treated groups had achieved almost all of expected development within due time.

Sitting (Table 5)*:* Except gp D, almost all the infants of treated groups had achieved expected development at 4th, 16th and 28th weeks. 29.41% of infants of control group had not achieved 'head steady, set forward' development at 16th week. χ^2 test suggested that the difference in achieving the development is highly significant in groups taking *Vacha* and *Brahmi*, in comparison to control group.

Table 5: The Other Four Significant Milestones

	Sitting (16 wks): Head steady, set forward		Standing (at 28 wks): Bounces actively		Dangling ring &Rattle (4 weeks): Regards line of vision only		Dangling ring and Rattle(16 weeks): Regards immediately	
	Yes	Yes	Yes	No	Yes	No	Yes	No
Group A ($(n_{4,16}=16)(n_{28}=13)$	16 (100%)	0 (0%)	13 (100%)	0 (0%)	16 (100%)	0 (0%)	16 (100%)	0 (0%)
Group B $(n_{4,16}=16)((n_{28}=11)$	16 (100%)	0 (0%)	11 (100%)	0 (0%)	16 (100%)	0 (0%)	16 (100%)	0 (0%)
Group C $((n_{4,16}=15)(n_{28}=11)$	14 (93.33%)	1 (6.67%)	10 (90.91%)	1 (9.09%)	15 (100%)	0 (0%)	14 (93.33%)	1 (9.09%)
Group D $(n_4=18)(n_{16}=17)$ $(n_{28}= 6)$	12 (70.59%)	5 (29.41%)	4 (66.67%)	2 (33.33%)	16 (88.89%)	2(11.11%)	13 (76.47%)	4 (25.53%)
Total $(n_4=65)(n_{16}=64)$ $(n_{28}= 41)$	58 (90.63%)	6 (9.37%)	38 (92.68%)	3 (7.32%)	63 (96.92%)	2 (3.08%)	60 (92.31%)	5 (7.69%)
χ^2 test	χ^2 test = 11.47, P < 0.01 HS		χ^2 test = 3.47, P >0.05 NS		χ^2 test = 3.32, P > 0.05 NS		χ^2 test = 8.57, P < 0.05 S	

Standing at 28 wks (Table 5): Infants of gp A and B achieved the 'bounces actively' development before 28 weeks, whereas few infants in other groups had not achieved the same, especially in gp D (33.33%).The children of these treated groups bounce vigorously with cheerful mood. However owing to small sample size, chi square test has not shown the value to be significant.

Dangling ring and Rattle (Table 5): In the present study, at 4 wks the 'line of vision' was not achieved by the 11.11% of the children of Gp D whereas in Gp A, B and C all the infants achieved this development, however the difference is not significant (Chi square=3.32). At 16th week, when 'regards immediately' milestone was observed, the difference was significant as suggested by early recognition and quick response to the object.

Social smile (Table 6): In present study, first appearance of 'social smile' was also carefully noted. When observed at 4 weeks, it had been achieved early by infants of Gp B (31.25%) followed by gp A (25%) and C (20%) in comparison to control group.

Table 6: Social Smile

Social smile	By 4 weeks			4-6 weeks			After 6 weeks		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Group A (n=16)	4 (25%)	3 (75%)	1 (25%)	12 (75%)	9 (75%)	3 (25%)	0 (0%)	0 (0%)	0 (0%)
Group B (n=16)	5 (31.25%)	5 (100%)	0 (0%)	11 (68.75%)	6 (54.55%)	5 (45.45%)	0 (0%)	0 (0%)	0 (0%)
Group C (n=15)	3 (20%)	1 (33.33%)	2 (66.67%)	12 (80%)	6 (50%)	6 (50%)	0 (0%)	0 (0%)	0 (0%)
Group D (n=18)	0 (0%)	0 (0%)	0 (0%)	16 (88.89%)	8 (50%)	8 (50%)	2 (11%)	0 (0%)	2(100 %)
Group– A+B+C 47)	12 (25.53%)	9 (75%)	3 (25%)	35 (74.47%)	21 (60%)	14 (40%)	0 (0%)	0 (0%)	0(0%)
Total	12	9	3	51	29	22	2	0	2(100

(n=65)	(18.46%)	(75%)	(25%)	(78.46%)	(56.83%)	(43.12%)	(3.08%)	(0%)	%)

DISCUSSION

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Nootropics’ are those ‘smart drugs’ which primarily enhance brain’s natural function by methods as - increasing brain’s oxygen supply, increasing glucose utilization, stimulating nerve growth, cleansing the brain of lipofuscin etc.[9] *Medhya dravyas* are an equivalent class of drugs described in *Ayurvedic* literatures, operating as *Rasayana* – at the level of *poshaka rasa* / *agni* / *srotas*. As CNS, the seat of all sensorimotor pathways plays a dominant role in unifying the G&D of an organism, medhya drugs can be expected to influence not only mental development, but also physical growth of an infant, as was evident from this study with the two such popular drugs, *Vacha* and *Brahmi*. Analysis of anthropometrical results (especially weight and CHL), showed that compared to untreated group, the growth in treated groups tended to remain towards the higher side of normal ranges of centiles, suggesting that these drugs probably enhance the bioavailability of the nutrients at cellular level, which reflect the *Rasayana* property of the *Brahmi* and *Deepana* - *Pachana* properties of *Vacha*. With prolonged drug administration, this intergroup difference in growth may become more pronounced on subsequent follow ups.

Coming to the developmental progress in different groups, children of treated groups had achieved almost all the indicated development for ‘prone position at 4 and 16 weeks within due time, probably because of a least effect of stress producing environmental factors or early maturation of prefrontal cortex that controls thought, behavior and mood. The children of treated groups were seen to ‘bounce vigorously’ with cheerful mood (Table 5) .This may be due to augmentative effect of these drugs on maturation of vestibulospinal spinal fibers, which act opposite to rubrospinal system (maintains the tightly flexed limbs in newborns) and as such more limb mobility occurred. Early recognition and quick response to the objects as ‘dangling ring & rattle’ (Table 5) indicated that the babies of treated groups had an improved early decision making capacity. These findings must be appreciated in the light of the fact that synaptic density increases from birth to eight month of age in visual cortex and to about twelve months of age in frontal cortex. [10] Early appearance of social smile (Table 6) in treated groups was probably because of acceleration in maturational progression of auditory, somatosensory and visual developmental sequences.

CONCLUSION

Maximum G&D within inherent genetic potential can be safely facilitated by *Ayurvedic medhya* drugs as *Vacha* & *Brahmi* and early infantile period seems to be the best period for introducing them. As CNS plays a dominant role in unifying the G&D of an organism and *Ayurvedic medhya drugs* promote a healthy development of brain, oral administration of drugs as *Vacha* and *Brahmi* can not only accelerate mental (motor and sensory) development, but may also enhance growth velocity of an infant, in terms of weight gain, mid arm circumference and length. But to affirm these results, a detailed study with larger samples is mandatory.

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