Indian J Physiol Pharmacol 2017; 61(4) : 392–397

Original Article

H-reflex Studies in Lumbosacral Meningomyelocele

Priyanka Bhagat[1]*, Aparna Debbarma[1], Sarita Chowdhary[2], A.N. Gangopadhyay[2], S.P. Sharma[2] and Udai Prakash[1]

Departments of Physiology[1] and Pediatric Surgery[2],
Institute of Medical Science,
Banaras Hindu University, Varanasi, India

Abstract

Objective of this work was to assess the effects of meningomyelocele (MMC) and its surgical intervention on spinal H-reflex. Twenty nine full term infants with age varying from 1-37 days were the study subject. Out of them 14 were normal infants and the rest were suffering from lumbosacral MMC. MMC babies were further investigated one week after surgical removal of sac. H-reflex latency (HRL) and related parameters (Hmax, Mmax and H/M ratio) were recorded at posterior tibial nerve-soleus muscle of right lower limb. H-reflex was absent in few MMC infants before surgery and their number were increased after surgery. Further, HRL and Mmax values were significantly less in MMC compared to normal infants. These observations suggest that some components of reflex arc were damaged in MMC, but the impulse conduction had increased in the viable neural tissue. Surgical intervention had limited role in restoration of neural function.

Introduction

Spina bifida is one of the most common congenital anomalies of the central nervous system that is compatible with life. The majority of cases belong to meningomyelocele (MMC), where primary neural tube fails to close (1) and portion of spinal cord along with nerve and meninges protrudes as a cyst. The impact of neurodevelopment malformation affects the segment of spinal cord. Neurological motor deficit in lower limb along with denervation potential in EMG in spina bifida were reported by Sival *et al* (2, 3). Non-invasive electrophysiological studies using Hoffmann reflex(4-6) may help in assessing the motor neuronal excitability and conduction in peripheral nerves (7).

The present study was designed to measure the electrophysiological parameters in MMC infants and compare them with normal infants of similar age group. The outcome of surgery was further assessed after surgical repair of meningomyelocele sac. Electrophysiological parameters viz: H-reflex latency (HRL), Hmax (maximum amplitude of reflexly excitable motor neurons), Mmax (maximum amplitude of motor response) and H/M ratio in % (proportion of reflexly excitable motor neuron) were measured in right lower limb of all infants (8, 9).

***Corresponding author :**

Dr. Priyanka Bhagat, Assistant Professor, Department of Physiology, Institute of Medical Science, Banaras Hindu University, Varanasi – 221 005, Mobile: +919651490665, Fax number: +915422367568, Email: drpriyanka.bhagat4@gmail.com

(Received on August 1, 2017)

Materials and Methods

The study protocol was duly approved by the ethical committee of Institute of Medical Science, Banaras Hindu University, India. The study population (both normal and MMC) comprised of 29 infants who were registered in the Department of Pediatric Surgery, S.S. Hospital, Banaras Hindu University. The period of study was from September, 2011 to August, 2015. These infants were full term appropriate for gestational age with birth weight above the 10th percentile of the Indian local standard (10). Fourteen infants were normal and remaining 15 were clinically diagnosed as meningomyelocele (MMC) of lumbosacral region. The average size of sac was 5 × 5 cm (Fig. 1). Infants were subjected to anthropometric measurements and electrophysiological studies. Electrophysiological investigations were undertaken only after obtaining a written consent from the parents. This is in compliance with declaration of Helsinski (1964) amended at Edinburgh (2000).

Infants born to diabetic mothers or those who suffered from birth anoxia, septicemia, meningitis, hypoglycemia and haemodynamically unstable were excluded. Infants with hydrocephalus or other chromosomal anomalies were also excluded. Pre operative investigations were done a day before the surgery and post operative evaluation was done one week after surgery. Surgical repair of the spinal herniation was done under general anesthesia involving release of neural tissue from surrounding structure and their restoration inside the vertebral canal. This was followed by watertight closure of duramater, vertebral approximation and closure of skin. Long term follow-up could not be done because of poor turnout of patients after post-operative care was over.

Fig. 1: Infant with meningomyelocele.

Electrophysiological investigations were performed at the Neurophysiology Research Unit of the Department of Physiology, Institute of Medical Sciences. Biopac Student Lab Advance System (Biopac Systems Inc., 42 Aero Camino, Santa Barbara, Calif 93117, USA) and GRASS stimulator model S88 (GRASS Technologies, 600 East Greenwich Avenue, West Warwick, RI 02893, USA) were used in this investigation. The procedure has been standardized over the years in our laboratory (7, 9, 11). Infants were neither restrained nor sedated during these tests. They were comfortably placed in prone position on the lap of mothers. A small pillow was placed underneath the right lower limb to keep it extended (7, 11). Surface electrodes (Ag-AgCl) were placed along with electrolyte jelly after proper cleaning of skin. Stimulating electrodes were placed over the posterior tibial nerve in popliteal fossa whereas the recording electrodes were placed over the calf muscle (soleus). Stimulus duration of 1ms was employed to preferentially activate the large Ia sensory fibers (12). The trigger level of the recorder was set above the baseline EMG amplitude. The H-reflex latency (HRL) was measured from the end of stimulus artifact to the onset of H wave (8). The investigations were concluded in a single sitting for each baby.

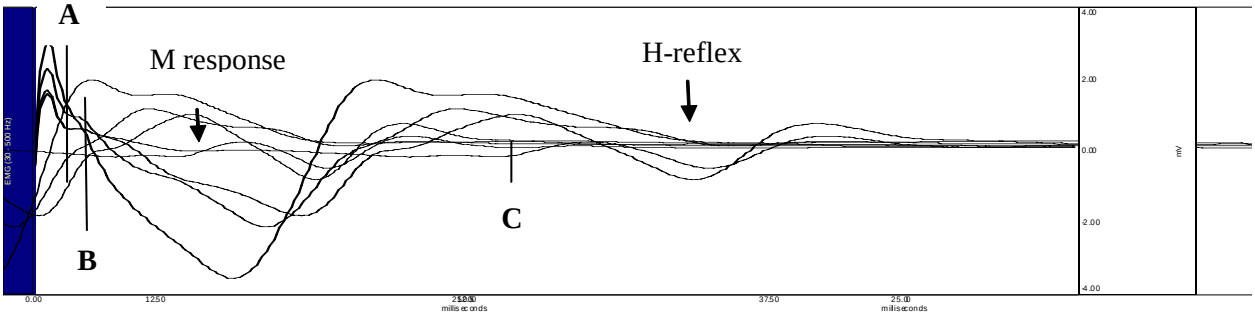
The arithmetic mean and standard deviation (SD) were calculated for quantitative variables. Unpaired student ‘t’ test was used for comparison between MMC and normal infants. ‘p’ value <0.05 was taken as significant. Sigma Plot 10.0 and MS Excel software were used for the statistical and graphical analysis.

Results

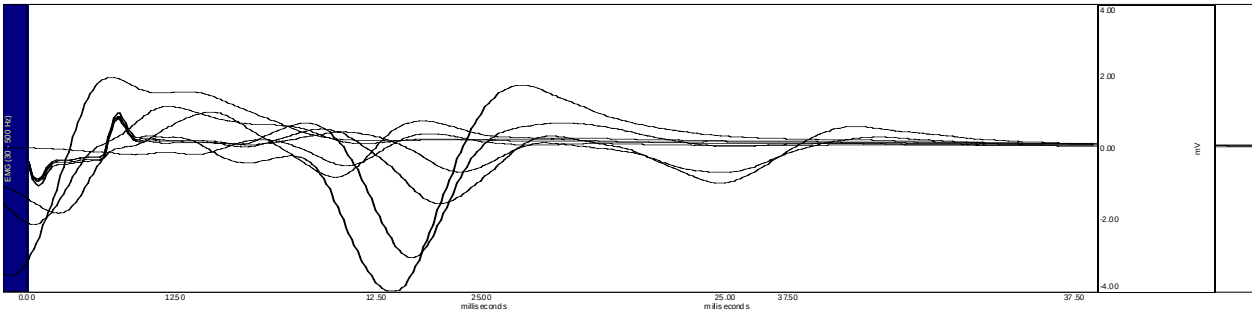
Anthropometric parameters (Age, weight, crown heel length [CHL], Head circumference [HC]) of three groups of infants (Normal, preoperative MMC and postoperative MMC infants) were given in Table I. CHL was comparable in both normal and MMC group whereas weight and HC were significantly more in MMC infants.

Table II represents the electrophysiological data of normal and MMC infants (pre and postoperative). Sample tracings of H-reflex and M response of normal and MMC (pre and postoperative) infants were given in Fig. 2. H-reflex was elicited in all the normal infants. But it was absent in 3 babies suffering from MMC. The MMC infants had comparatively less values of HRL, Hmax and Mmax compared to normal. However, statistically significant differences were found only in HRL (Fig. 3) and Mmax values (Fig. 4). The H/M ratio (in %) were similar in both the normal (44.98%) and MMC (46.44%) infants.

a) Normal infant



b) MMC infant



c) MMC infant after surgery

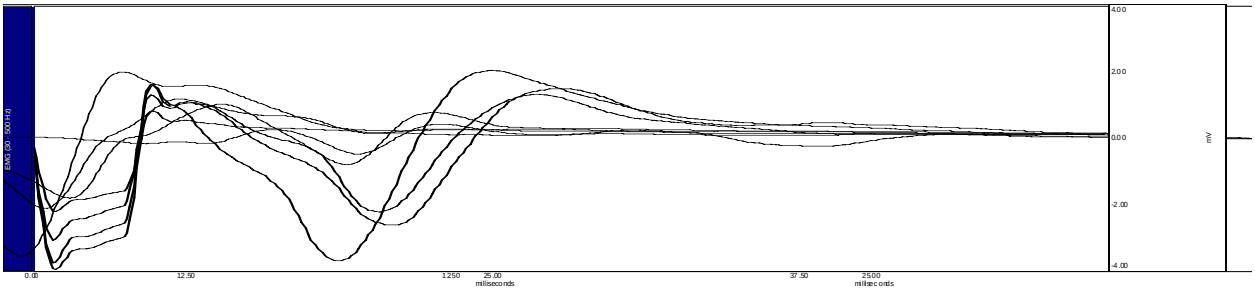


Fig. 2: Sample recordings of H-reflex and M response in right lower limb of infants
Top traces (a) - Normal infant,
AB=M response latency,
AC=H-reflex latency
Middle traces (b) - MMC infant
Bottom traces (c) - MMC infant after surgery
(Note: Pre and post operative recording were taken from the same infant.)

TABLE I : Anthropometric parameters and age (Mean±SD) of normal and MMC infants (pre-operative and postoperative).

Parameter	*Normal (n=14)*	*Pre op MMC (n=15)*	*Post op MMC (n=15)*	*p value*	
				Normal vs pre op MMC	*MMC vs post op MMC*
Age (days)	14.14±11.43	15.47±9.99	23.40±9.26	NS	NS
Weight (kg)	2.56±0.53	3.24±0.75	3.19±0.73	<0.05	NS
CHL (cm)	48.46±1.83	49.17±1.73	49.17±1.73	NS	NS
HC (cm)	32.59±0.93	34.54±1.41	34.67±1.55	<0.001	NS

NS = Not significant.

TABLE II : Electrophysiological parameters (Mean±SD) in right lower limb of normal and MMC infants (pre and postoperative). Figures in parenthesis denote the number of subjects where parameter was elicited. NS = Not significant.

Parameter	*Normal (14)*	*Pre op MMC (15)*	*Post op MMC (15)*	*p value*	
				Normal vs pre op MMC	*MMC vs post op MMC*
HRL (ms)	13.92±1.73	12.52±1.64 (12)	12.59±1.27 (8)	<0.05	NS
Hmax (mv)	2.06±0.80	1.74±0.85 (12)	1.45±0.46 (8)	NS	NS
Mmax (mv)	4.65±1.26	3.52±1.46	3.57±1.72 (13)	<0.05	NS
H/M%	44.98±14.45	46.44±20.34 (12)	39.34±19.19 (8)	NS	NS

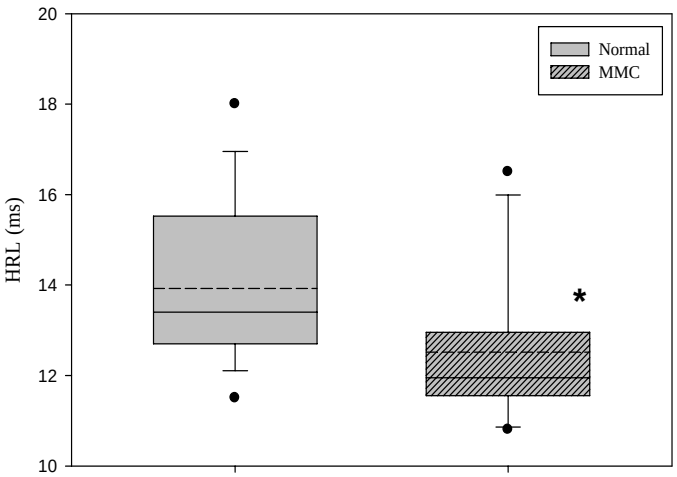


Fig. 3 : Boxplot representation of HRL in normal and MMC infants
Horizontal dashed line is mean,
Solid line is median
Lower and upper borders of each box mark 25th and 75th centiles respectively.
Error bars mark 5th and 95th centiles.
Points lying beyond error bar mark 5th and 95th centiles.
*=p<0.05 between normal and MMC infants.

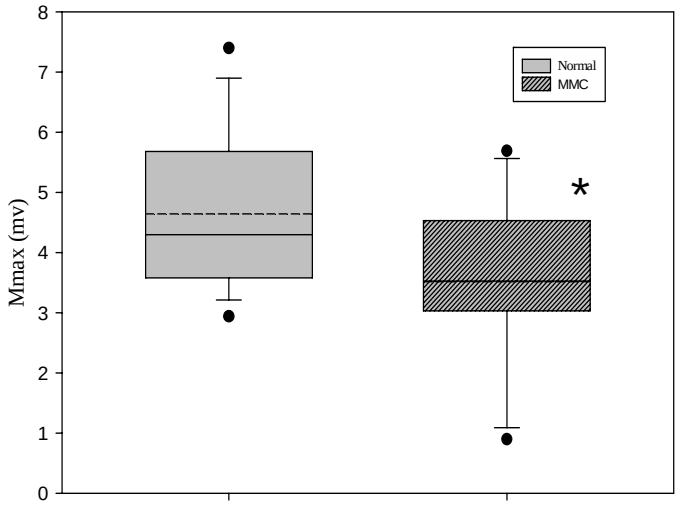


Fig. 4 : Boxplot representation of Mmax in normal and MMC babies
Horizontal dashed line is mean,
Solid line is median
Lower and upper borders of each box mark 25th and 75th centiles respectively.
Error bars mark 5th and 95th centiles.
Points lying beyond error bar mark 5th and 95th centiles.
*=p<0.05 between normal and MMC infants.

Electrophysiological parameters of MMC infants (pre and postoperative) were depicted in Table III. H-reflex was absent in 7 MMC infants after surgical repair of the sac. Further, M-response was not elicited in 2 postoperative MMC infants. Otherwise all the electrophysiological parameters were similar in both pre and postoperative MMC infants.

TABLE III : Effect of surgery on electrophysiological parameters (Mean±SD) in MMC infants. Figures in parenthesis denote the number of subjects where parameter was elicited.

Parameter	*MMC (15)*	*MMC after surgery (15)*	*p value*
HRL (ms)	12.52±1.64 (12)	12.59±1.27 (8)	NS
Hmax (mv)	1.74±0.85 (12)	1.45±0.46 (8)	NS
Mmax (mv)	3.52±1.46	3.57±1.72 (13)	NS
H/M%	46.44±20.34 (12)	39.34±19.19 (8)	NS

NS = Not significant.

Discussion

We observed higher values of weight and head circumference in MMC though they were within the normal range of Indian population (10th to 90th percentiles; (10)). Hayes-Allen in 1972 first identified short stature and obesity among children with spina bifida (13). Excessive adipose tissue deposition in MMC was also reported by others (14, 15). CHL values representing the body length were comparable in normal and MMC infants.

The neural elements (spinal cord with roots) which are exposed to body surface in meningomyelocele are always at risk to get injured (1). These tissues are also not well connected with the vasculature and therefore ischemia is prevalent (16). In this study, the parameter representing the quantum of motor units in spinal neuronal pool i.e. Mmax was significantly less in MMC. Further, H-reflex could not be elicited in 3 of these infants. The reduction in motor neuronal pool along with absence of H-reflex indicates that some neuronal components were damaged in these infants. The latency (HRL) was significantly reduced in cases where the reflex was elicited as compared to normal infants. These infants having comparable length with normal infants, the shorter latency (HRL) could be either due to faster conduction in the existing reflex pathway or reduction in the synaptic delay time.

Hmax values were less in MMC babies indicating that they had relatively smaller number of reflexly excitable neurons. Mmax was recorded in all the normal and MMC infants before surgical intervention, though the values were less in MMC. Our observations indicate an intact motor neuronal pool with viable motor units in MMC infants. The decreased amplitude of Mmax might be due to partial motor neuronal lesion in these cases. This parameter was absent in 2 cases after surgery.

Surgical intervention was essential for these infants to prevent rupture of meningomyelocele sac and the consequential complications. However, once these babies were operated upon and settled for one week after surgery, the electrophysiological parameters were not very encouraging as the H-reflex was absent in almost 50% cases (7 out of 15) and even M response was absent in two infants. In babies where the reflex was elicitable, the electrophysiological parameters were comparable in pre and post operative period. The study could not be carried out further in the post operative period of these babies because of their poor compliance after hospital discharge. The surgical maneuvers had little role in protecting the neural tissue in these infants.

Conclusion

H reflex latency was reduced in MMC babies with absence of reflex in few cases. Reduction in motor units was also observed in these babies. The outcome of surgery was limited role for neurological recovery.

Acknowledgements

We are grateful to Banaras Hindu University for carrying out this study in the Department of Physiology and Pediatric Surgery.

References

1. Kaufman BA. Neural tube defects. *Pediatr Clin North Am* 2004 Apr; 51(2): 389–419.
2. Sival DA, van Weerden TW, Vles JS, Timmer A, den Dunnen WF, Staal-Schreinemachers AL, et al. Neonatal loss of motor function in human spina bifida aperta. *Pediatrics* 2004 Aug; 114(2): 427–434.

3. Sival DA, Brouwer OF, Bruggink JL, Vles JS, Staal-Schreinemachers AL, Sollie KM, et al. Movement analysis in neonates with spina bifida aperta. *Early Hum Dev* 2006 Apr; 82(4): 227–234.
4. Pierrot-Deseilligny E, Mazevet D. The monosynaptic reflex: a tool to investigate motor control in humans. Interest and limits. *Neurophysiol Clin* 2000 Apr; 30(2): 67–80.
5. Magladery JW, Mc DD, Jr. Electrophysiological studies of nerve and reflex activity in normal man. I. Identification of certain reflexes in the electromyogram and the conduction velocity of peripheral nerve fibers. *Bull Johns Hopkins Hosp* 1950 May; 86(5): 265–290.
6. Hoffmann P. Beitrag zur Kenntnis der menschlichen Reflex mit besonder Berucksichtigung der elektrischen Erscheinungen. *Arch Anat Physiol* 1910; 1: 22.
7. Dereddy NR, Muthusami S, Bhatia BD, Prakash U. H-reflex and motor nerve conduction studies in growth retarded newborn babies. *Neurosci Lett* 2008 Feb 27; 432(3): 188–192.
8. Prakash U, Sinha B, Bhatia BD. Birth hypoxia and spinal reflex in newborn babies. *Electromyogr Clin Neurophysiol* 2005 Jan-Feb; 45(1): 59–63.
9. Prakash U, Sinha AK, Mukherjee B, Katiyar GP, Dey PK. Electrophysiological studies in children with paralytic poliomyelitis. *Electromyogr Clin Neurophysiol* 1995 Mar; 35(2): 73–76.
10. Bhatia BD, Bhargava V, Chatterjee M, Kota VL, Singh LI, Jain NP. Studies on fetal growth patterns: intrauterine growth percentiles for singleton live born babies. *Indian Pediatr* 1981 Sep; 18(9): 647–653.
11. Kumar S, Dereddy NR, Bhatia BD, Prakash U. Spinal motor neuron excitability in newborns following fetal distress: sub-clinical depression revealed by soleus H-reflex. *Clin Neurophysiol* 2005 Oct; 116(10): 2342–2347.
12. Bhatia BD, Prakash U, Gupta SK, Singh MN. Electrophysiological studies (MNCV, H-RL) in full-term newborn babies. *Indian Pediatr* 1989 Dec; 26(12): 1223–1226.
13. Hayes-Allen MC. Obesity and short stature in children with myelomeningocele. *Dev Med Child Neurol Suppl* 1972; 27: 59–64.
14. Ausili E, Focarelli B, Tabacco F, Fortunelli G, Caradonna P, Massimi L, et al. Bone mineral density and body composition in a myelomeningocele children population: effects of walking ability and sport activity. *Eur Rev Med Pharmacol Sci* 2008 Nov-Dec; 12(6): 349–354.
15. Roberts D, Shepherd RW, Shepherd K. Anthropometry and obesity in myelomeningocele. *J Paediatr Child Health* 1991 Apr; 27(2): 83–90.
16. Sival DA, Verbeek RJ, Brouwer OF, Sollie KM, Bos AF, den Dunnen WF. Spinal hemorrhages are associated with early neonatal motor function loss in human spina bifida aperta. *Early Hum Dev* 2008 Jul; 84(7): 423–431.
17. Prakash U. H-reflex latency: a maturity criterion for newborn babies. *Electromyogr Clin Neurophysiol* 1997; 37: 435–437.