A STUDY OF MLR WAVEFORMS IN TWO DIFFERENT AGE GROUPS OF GERIATRICS

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1991

RAJA AND VETRI

Who share small and great things from the start of time

CERTIFICATE

This is to certify that the Independent Project entitled: **"A Study of MLR Waveforms in two Different Age Groups of Geriatrics"** is the bonafide work in part fulfilment for M.Sc., in Speech and Hearing, of the student with Register No.M.9001.

Mysore
1991

Director
All India Institute of
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Mysore-6

CERTIFICATE

This is to certify that the Independent Project entitled: "A Study of MLR waveforms in Two Different Age Groups of Geriatrics" has been prepared under my supervision and guidance.

Mysore
1991

Dr.(Miss) S.Nikam,
GUIDE.

DECLARATION

This Independent Project entitled: "A Study of MLR Waveforms in Two Different Age Groups of Geriatrics" is the result of my own study undertaken under the guidance of Dr.(Miss) S. Nikam, Prof. and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore
1991 Reg. No.M.9001

TABLE OF CONTENTS

LIST OF TABLES

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INTRODUCTION

The history of science is marked by a slow but steady progress from the unknown to the known. The tower of knowledge about the ear has been built from bricks laboriously, fashioned over the years, even centuries. Each new finding provides as immediate solution for some problem bat for others it suggests still another question. Though the tower of physiological measures available to examine the audio-vestibular system is well based, it would never be considered completed. Today's edifice is the result of yesterday's efforts and is the structure on which to build tomorrow's achievements. This edifice, not built for the sake of knowledge alone but also for the better care and treatment for people with hearing impairment.

The bioelectric potentials of the central nervous system are utilized as nearophysiological indicaters of auditory function. Their applications to clinical audiometry are many. We can record the following starting at the periphery that is the cochlea and progress along the auditory pathways to the cortex.

1. Endocochlear potentils and compound auditory nerve action potentials.
2. Brain stem evoked potentials.

3. Middle latency responses
4. Cortical evoked potentials (V-potential)
5. Cortical d.c. potentials.

According to their latency the auditory evoked response have been classified into early (0-10 m.sec),middle (10-50 m.sec) and late (50-400 m.sec). The middle latency responses were first reported by Geisler, Frishkopt and Rosenblith (1958).

The origin of the middle latency responses is still in debate. Some studies prove that they are myogenic in origin and some others contend that they are neurogenic in origin. The dispute about the myogenic versus the neurogenic origin which was initiated by Bickford et al. (1964) has not been resolved as yet.

Like other responses such a early responses and cortical responses, the middle latency responses are also elicited utilizing averaging and summing techniques.

According to various studies the middle latency response waveforms are affected by the type of stimulus, its frequency, intensity, stimulus, repetition rate, the rise time of the stimulus and the muscle tone. Also both natural sleep and

drug induce sleep are said to have effects on the middle latency responses. Commonly used stimuli are tone bursts, tone pips and filtered click,. The stimulus repetition rate used ie 10/sec.

The studies done on middle latency responses for the past four decades should help as utilize them clinically. However there have been only a few studies of these Middle components in clinical situations. Measurement of middle latency responses is an useful way of determining low frequency auditory threshold according to Barajas, Exposits, Fernandez and Martin (1980). Middle latency response at 500 Hz is a sensitive measure of auditory threshold (Kavanagh, et al. 1984). The positive correlation obtained by conventional audiometry and electrophysiological response indicated that as the 500 Hz threshold obtained by conventional audiometry increases the threshold obtained by 500 Hz middle latency response also increases. The differences were ± 15 dB between the audiogram threshold and the middle latency response at 500 Hz tone pips (Kavanagh, at al. 1984). According to him middle latency response under sedation can be a good predictor of behavioural hearing at low frequencies.

The middle latency responses are the link between the auditory braing stemevoked response and auditory cortical

responses is the auditory propagation and are therefore also of importance in the analysis of the quality, of the auditory afference (Ozdamer et al. 1982). However the clinical utility of middle latency responses is questioned due to the controversy concerned with myogeaic and aeurogenic origin of them.

Though the origin of the middle latency response is not known as yet, there have been many attempts to compare the middle latency response waveforms of neonates, young children and adults. They are mainly attempted to see if middle latency response waveform change with age and how they could be used clinically for differential diagnosis. The present study is one such attempt to study the age related variations in the middle latency response waveforms comparing young normal adults with geriatrics.

The three main aims are:

1. To study the morphology of the middle latency response waveforms ia geriatrics.
2. To compare the geriatric middle latency responses with young adult normal waveforms.
3. To compare the middle latency response waveforms between two groups of geriatrics 50-55 years and 60-65 years and to see if there are some changes in terms of latencies.

REVIEW OF LITERATURE

We must welcome the future, remembering that soon it will be the past, and we mast respect the past, remembering that once it was all that was humanly possible. (George Santayana, 1957).

These words of George Santyana may be considered good connsel for and a challenge to the disheartened clinician or researcher. What was not possible yesterday is possible today bat whatever is possible today is made possible from the base of yesterday. This chapter produces a brief summary of events that took place in the yesterdays of middle latency response (MLR).

Berger first reported human brain potentials (Bezger, 1929). After ten years Davis gave effects of auditory stimulation on human brain wave (Davis, 1939). These effects were termed as electroencephalic responses. With the advancement of electronic and computer technology, the electro-encephalic response audiometry came into pietare. In the mid 1950s and 1960s determination of hearing sensitivity by the use of auditory evoked cortical potentials became the subject of research(Davison, 1954; Derbyshire, et al. 1956; Walter, 1961). Electroencephalic response audiometry

(ERA) or averaged evoked response audiometry is an objective test for central lesion.

As electronic and computer technology grow so did the ability to detect and analyze lower voltage cortical evoked response (Goldstein, 1965) and the brainstem or early evoked response (Walter, 1964; Jewett et al 1970; Jewett and Williston, 1971) was able to demonstrate a very late component of the evoked cortical response. Sometimes referred to as very slow (1300 m.sec. to several seconds) whose presence was contingent on some foregoing event/stimulus. Later they found four types of electroencephalic responses.

1. Early responses with latency of 0-10 m.sec.
2. Middle responses with latency of 10-50 m.sec.
3. Late response with latency of 50-300 m.sec.
4. Very late responses with latency of greater than 300 m.sec.

(Picton, et al, 1974; Davis, 1976; Picton, et al. 1977).

Although described more than 30 years ago (Geislon, Frishkopt, and Rosenblith, 1958) relatively little is known about the MLR in comparison with the ABR (Auditory brainstem response) and the late Auditory evoked potential (AEP). When the middle latency components were initially reported (Geisler, Frishkopt, and Rosenblith, 1958) they were called the early

AER response but have more recently been termed the MLRs (Picton, Hillyard and Krausz et al. 1974; Davis, 1976b) due to the definition and increased interest in the auditory brain stem response which occurs before the middle latency group (Jewett and Williston, 1971; Skianer and Glattke, 1977; Starr, Sohmer and Celesia, 1978). Middle latency AER components occur at a latency of 10-50 msec. and have amplitude ranging from 0.5 to 3.0 /u V.

Origin of the MLRs:

There has beea much controversy over the origin of the MLR of the auditory evoked cortical potential. Geisler et al (1958) believed that this component was generated neurally rather than by musculature beneath the surface of the electrodes. The MLR waveform changed greatly or disappeared altogether when neck and head muscle tonus was systematically varied. So it was believed that MLRs were myogenic in origin (Bickford et al. 1964; Mast, 1963; 1965). There are numerous studies which support and reject the neurogenic versus myogenic origin of MLRs.

Geisler (1964) felt that only the amplitude of the response was affected by muscle and that the basic of the response was neural.

Geisler et al (1958) said MLR originated from the cortex. They came to this conclusion because of the following reasons:

- Repeated evaluation in the same subject gives the same results.
- MLR can be recorded from a wide area of scalp.
- Bilateral response is evoked even on a monoaural stimulation.
- Symmetrical placement of electrodes show same response.
- Latencies are comparable to onset latency of somatosensory and visual systems.

Ruhm et al (1967) recorded MLRs from the exposed cerebral cortex of humans and found MLRs with similar intensity and morphological characteristics. They said this indicate that MLR is a neurogenic response.

Harket et al; Celesia et al, Celesia and Puletta support these findings:

Rome (1981) listed a few reasons as to the non-agreement about site of origin.

- The electrodes are placed away from the neural generators.
- Ipsilateral and contralateral pathway are present.
- Simultaneous activity of generators.
- Overlapping activity of multiple sites.

All these factors would make it difficult to come to a dicision about the exact point of origin of MLR in the brain.

The earlier middle latency components (Na, Po and Ha) might arise from the medial geniculate and polysensory nuclei of the thalamus while the later portions of the waveforms are found over wide areas of association cortex (Geisler et al. 1958; Picton, Hillyard and Krausz et al. 1974; Davis, 1976b). During intracranial surgery, when electrodes were placed on the superior surface of the temporal lobe recordings yielded a large positive wave similar to Pa in the latency range qaite similar to the vertex of the scalp (Celesia and Pulette, 1969; Celesia, 1976).

Comprehensive scalp distribution studies of the middle latency range (Goff, Massumasya and Allison et al. 1974; Goff, Allison, Klyone, et al. 1977) suggested that these response are primarily neural in origin, especially for stimuli of low to moderate intensities and when electrodes is not overlying the inion (Mast, 1963; 1965; Picton, Woods and Braibeau-Braun et al. 1977). Some authors Jarcho, 1949? Chang, 1950) had recorded potentials with similar latencies directly from the cortex in animals. However recent clinical evidence with bilateral auditory cortical damage suggest that these MLRs don't arise fromprimary auditory cortex (Parving,

solomoni and Elberling et al 1980). Goldstein and Rodman (1967) believed that MLRs are neurogenic predominantly when used stimulus intensities dose to the auditory threshold.

Flanign (1967) suggested the presence of a cochleoneurogenic response at low intensities.

Using a multiple coronal electrode array, Cohen (1982) found a revenal for Pa at the level of the sylvian fissure, suggestive of a depole source in the superior temporal plane. Animal experiments showed a generator site of Pa in the anterior part of the contralateral primary auditory cortex (Kaga et al. 1980). Buckwald et al.(1981) localized the source of Pa in the medial restral midbrain reticular formation projection of the thalamus and for Po in the primary auditory propagating system from the brain stem to several forebrain systems were postulated.

Hashimoto (1982) attributes No, Po and Ha or the SM_{10} to post-synaptic activity from the inferior colliculi.

Parving et al (1980) reported that middle components of the auditory evoked potentials are nearogenic origin. They do not regard the integrity of the primary auditory cortex to be of major importance for the generation of the late components.

Furthermore they disagree with Mendel (1979) that the middle components are generated in the primary auditory cortex.

In 1977 McFarland et al used tone pips of 500 Hz 1 KHz and 3 KHz having a rise/fall time relatively to peripheral hearing loss in the patient and to corresponding normative templates. Based upon the combined procedure its concluded that the middle components cannot be generated exclusively if at all in the primary auditory cortex, located in the temporal lobe. Furthermore the responses are found to be of neurogenic origin according to the methodological procedures applied.

The MLRs in humans are similar to that of animal cortical responses. They reflect activation of thalamus and cerebral cortex (Picton and Smith, 1978). In a rhesus monkey P_{12} is originated from the primary auditory cortex. Others is N_{70}, N_{100}, N_{140} arise from the other parts of cortex. P_{12} is only potential which is generated from supra-temporal plane (Arezzo et al. 1975).

MLR in cats under general anaesthesia was studied. Effect of unilateral and bilateral MGB destruction was noted. It was found that MLRs were generated at upper level of superior colliculus. The Na component is due to contralateral MGB While Pa is a compound response from a wide area (Ucheda, Ichikawa, Koh, and Harada, 1979).

There are a few studies which may that MLR is not exclusively generated from the auditory cortex (Ozdamer et al. Krausz et al. and Parving, et al. 1983).

The musculature hypothesis was first put-forth by Bickford et al. (1964); Mast,(1963, 1965) when they found that the response waveform changed greatly or disappeared altogether when neck and head muscle tonus was systematically varied. Several reports have noted that sound evoked activity from scalp muscles occur at the same latencies as that of the latencies recorded during intracranial surgery (using electrodes placed on the superior surface of the temporal lobe), especially when the stimulus is relatively intense (Bickford, Jacobson, and Cody, 1964; Bickford, 1972; Picton, Hillyard and Krausz et al. 1974).

Some evidence which did not accord with the concept of neurogenic origin was that the largest response were recorded when the active electrode was placed over the inion (a small bony protuberance on the midline of the skull immediately above the neck muscles). In 1963 Bickford and his colleagues (Bickford,Galbraith and Jacobson 1963a; Bickford, Jacobson and Galbraith 1963b) provided experimental evidence which showed with little doubt that the major components of the 8-30 ms response recorded from such sites

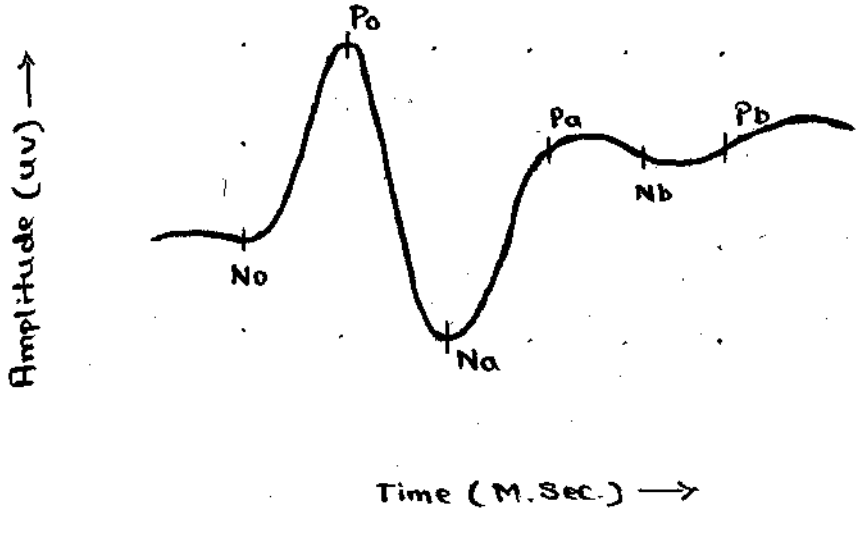
as the inion is post auricular region were neurogenic. Apart from the indirect nature of the myogenic responses which were found to vary considerably on altering muscle tone further doubt was east on their clinical application when it was shown that the inion responses could be obtained even while stimulating a deaf ear acoustically provided the vestibular function of the ear was intact (Cody, Jacobson, Walker and Bickford, 1964). Some authors did not accept that the 8-30 ms responses were entirely myogenic. Goldstein and Rodman (1967) believed that when stimulus intensities dose to the auditory threshold were used they provided predominantly neurogenic responses. Ruhm and Flanign (1967) suggested that the presence of a cochleonearogenic response at low intensities and a vestibulo-myogenie response at high intensities. There are many studies in animals, patient and normal subjects using multiple scalp electrodes and intracranial recordings which have accumulated which support the contemporary view that the MLRs coasists of both myogenic and neurogenie components.

The dispute about the myogenic versus neurogenie origin of the MLR initiated by Bickford et al (1964) has not yet been resolved. Although the MLRs are thought to be generated central to the brainstem an understandiag of the specific generator site is necessary before they can be maximally

utilized clinically, at present, consensus is lacking regarding the origin of MLRs in humans (Vaughn and Ritter, 1970; Picton, at al. 1974; Celesia, 1976; Goff, Mateumiya, Allison and Goff, 1977; Cohen, 1982; Kraus, Ozdomer, Hier and Stein, Ozadamer,
1982; /Kraus, Carry, 1982; Wood and Wolpaw, 1982) or animals (Arezzo, Pickoff and Vaughn, 1975; Teas and Kiang, 1964; Kaga, Hink, Shinoda and Suzuki, 1980a; Buchward, Hinman, Herman, Huang and Brown, 1981; Hinman and Backward, 1983).

Waveform:

The MLR typically have a waveform with two major positive peaks (vertex referred to mastoid) and three negative peaks. These peaks were labelled No, Po, Na, Pa and Nb by Goldstein and Rodman (1967).



Using band-pass settings of 25-175 Hz with a slope of 6 dB/octave and a stimulus of 60 dB SL, the onset latencies of each of these peaks of the response waveform are No = 8-10 ms; Po = 10-15 ms; Na = 16-30 ma; Pa = 30-45 ms Nb = 40-60 ms and occasionally Pb caa be identified with an onset latency of between 55 and 80 ms. MLR waves Na, Pa, Nb were the only components consistently recorded in all subjects for all the filter band-pass configuration and stimulus levels (Kavanagh, et al. 1984). These findings are in agreement with previous results by Seherg and Volk (1983) and Ozdamar and Kraus, 1983. The waveform Geisler (1958) described included only one peak occurring at approximately 30 m.sec. post stimulus.

Different investigations have used various time windows to view the MLR depending on how much of the waveform is required for study often only Pa, Pb, Na and Nb are analyzed as they are greater in amplitude and more stable than the other MLR waves (Mendel-Goldstein, 1969). More specifically its the Pa wave which appears to be the most robust and consistent MLR wave (Museik, Geurkink, 1981).

Mendel and Goldstein (1972) have given the following latencies:

Po = 11.3 m.sec Na = 20.8 msec.

Pa = 32.8 msec. Nb = 45.5 msec.

which are in agreement with Goldstein and Rodman's values.

Po = 10.7 msec. Nb = 47.2 msec.

Na = 19.7 msec. Pb = 64.0 msec.

Pa = 29.7 msec. (Lane, et al.1974.

Mendelson, Salamy (1981) - latency of Po shorter than Pb but longer than as reported by other authors. These differences in latencies are due to brief duration stimuli or wide band pass filter or a combination of both.

Auditory evoked potentials for tone pips within 0-25 m.sec. showed components $P_{10,}$ N_{15}, P_{20} , 10, 15, 20 etc. refer to latency values (Suzuki, Yashuhito, Horiauchi, 1981). There are several animals studies indicating the presence of MLR. The waveforms were measured at the vertex in unaesthesized rat two positive peaks which unify at 30 msec. with increasing age and two negative peaks were noticed (Iwara and Polsic, 1982). When done in eats using subdermal electrodes 2 positive and two negative peaks were noticed. The latencies of positive peaks fall within 20-50 m.sec. (Walsh et al. 1986 a, b) .

In non-human primates ie a six month orangutan and 15 month old macaquil a negative component of 7-13 m.sec. latency and a positive component of 25-35 m.sec. were noticed (Krausz etal 1985 b) . In adult Gerbil, MLR was obtained from contralateral temporal lobe two positive and one negative peaks were noticed

(Krausz et al. 1987a). In young gebrils wave B is first and then wave C appears (Krausz, Smith, McGee, Stein and Carter, 1987).

Factors affecting MLR:

There are two types of parameters which affect the MLRs. They are exogenous factors and endogenous factors exogenous factors are - factors which are related to stimuli, instrument used for the test and recording parameters like filter characteristics etc. Endogenous factors are subject related factors such as sleep, drag inducing drug, or anaesthesia, muscle tone etc.

Stimulus related factors are -

1. Type of stimulus
2. Frequency of stimulus
3. Intensity of stimulus
4. Number of stimulus
5. Rate of stimulus presentation
6. Rise-fall time and duration

Types of stimuli:

There are different stimuli using which MLR can be elicited. They are tone pips, tone bursts, filtered clicks.

unfiltered clicks, logans etc. Ideal stimuli should be exact ia timing so that the latency of the response is clear and it should be frequency specific and its intensity mast be known. Aa acoustic stimuli good for one purpose may be bad for another eg. an unfiltered click ia rich in increase frequencies and is good with respect to synchronization of the nerve impulses. It provides a precise stimuli for timing purposes as it stimulates the whole basal portion of cochlea almost instantaneously and results in close synchrony of firing of the individualnerve fibres in this area. Hence it produces a large, clear evoked response. Click stimuli is acceptable for qualitative assessment of basal turn, but its bad because it is acoustically complex and is not frequency specific.

Click stimulus:

Response with short latencies AP; Ecochg, MLRs are best evoked by clicks. Fast onset of clicks result in good synchronization of the neural impulses. A click stimulus stimulates the whole of the cochlea although the synchronization of the neural impulses from the apical region is poor due to the nature of the naturally wave. Analysis of a typical click stimulus reveals that it contains a wide

spectrum of frequencies and its oneset the increasing frequencies predominate. Virtually all acoustic click, Used for ERA have a maximum energy lying between 2-4 KHz. The raw click is not as simple acoustically as the electric pulse that excites the transucer. From the point of seeking frequency specific information, click stimuli is not very good and perhaps a high frequency filtered click or a tone pip or tone burst with short rise time should be considered.

Filtered clicks: A click may be passed through high and low pass filters to eliminate all frequencies except those within a limited band width. Eberling (1976 a) describes a method of obtaining frequency specificity from click like stimuli. Transducer resonates at desired frequency. Eg. TDH-39 used to obtain a 2 KHz click.

Tone,Pips:

This is a morefrequency specific stimuli and obtained by passing a single sinusoidal wave which starts and stops at zero crossing through increase and decrease pass filters.

Shapes of a tone pip can modified by manipulating the rise-fall time and plateau for given freqenucy of pure tone or by varying the steepness of the band pass filter and its bandwidth.

Tone bursts:

These are helpful in eliciting cortical response and it allows for excellent frequency specificity. Longer duration stimuli may be produced by passing more than one sinusoidal wave through the increase and decrease pass filters.

A study by Maurizi, Oitaviani, Paludette,Rosignoli, Almadori, Tassoni (1984) indicate a good reliability of MLC when using alow and mid frequency tone pips compared to Clicks. Responses show Po, Na, Pb, and Nb latencies are greater and amplitude is smaller when compared to corresponding waves elicited by clicks. While click stimuli tend to evoke, somewhat longer latencies and greater amplitude changes compared to tone bursts (Zerlin and Naunton,1971; Mowry Zerlin and Naunton, 1974) tonal stimuli have been found to provide reasonably sensitive frequency specific responses (Mouschgean, Rubert and Stillman, 1973; Kupperman and Mendel 1974, McFarland, Vivion and Goldstein, 1977, Thorton et al. 1977).

The optimum stimulus is a click with a rise time of 10-100 μ s such a fast rise time limits the frequency specificitory of the stimulus.So we can use tone pips, tone bursts/filtered clicks (Zerlin, Mowry and Naunton, 1971,

Zerlin, Naunton and Mocory, 1973; Kupperman and Mendel, 1974; McFarland, Vivion and Goldstein, 1974; Thorton, Mendel and Anderson, 1977).

Stimulation for MLR can be electrical or acoustical in nature. No significant difference between latencies of electrically and acoustically evokeawaveforms in guinea pigs have been reported (Burton, Miller and Kileny, 1989), In profoundly deaf ears electric MLRs were present. Latency of most electric MLR was present. Latency of most prominent positive peak was similar around 20-30 ms to the latency of acoustic MLR (Kemink, Kileny and Arbon, 1989).

Clicks have rise fall time of about 2-3 m.sec. and a duration of about 2 m.sec. (Mendel, 1982). Effective response for clicks stimuli is noticed in awake adults (Museik, Geurkink, 1981). Low frequency tone bursts were found effective in awake adults (Brown, Shallop, 1981). MLR waveform was obtained for clicks as well as tone pips in 20 normal subjects of 26-32 years. Results indicated good frequency specificity while using tone pips. Po, Na, Pb, Nb showed greater latency but smaller amplitudes for tone pips. This may be due to asynchrony of response evoked by tone pips (Maurizizi, Ottavians, Paludetle et al. 1984).

Number of stimuli:

The MLRs are usually obtained after 400-500 stimulus presentations although McFarland, Vivion, Wolf and Goldstein (1978) manage to obtain clear recordings after only 125 stimuli. Like other responses used for electric response audiometry (ERA) the MLRs are also can only be distinguished from the background of physiological noise by utilizing averaging and summing techniques. Hortwitz and Larson and Sances (1966) have stated that between 200-40 stimuli should be presented to obtain an average response. Lane, Kupperman and Goldstein used 1024 stimuli to obtain an average increasing the number of stimuli increases the amplitude of the waveform. The response smoother out and noise reduces. But several authors say that increasing the number of stimuli from 1000 to 4000 does not increase the ease of identification of MLR.

McRandle et al (1974) found a number of 256 stimuli sufficient with a stimulation rate of 4.5/sec. and 512 stimuli with a rate of 9.6/sec.

Rate of stimuli:

MLR may undergo augmentation at rate 1/sec. 2.5/sec. (Jerger et al 1987). McRandle et al (1974) found a number

of 256 stimuli sufficient with a stimulation rate of 4.5/sec. and 512 stimuli with a rate of 9.0/sec. A repetition rate of 10/sec. is suggested for clinical purposes (Mendel, 1973). He said that there is little effect on the amplitude of averaged responses by the rate of repetition.

Usage of late 9/sec.as this has the advantage of being out of phase with common main power frequency (Mendel, 1977).

A rate of 1-l0/sec. has no effect on amplitude of wave-form. Increase in the repetition rate leads to an overall reduction in amplitude (Goldstein, Kodman et al. 1972; McFarland, Vivion et al. 1979). Click rates when reduced from 1/63 sec. to 1/100 sec. produced increased amplitude. Presenta-tion at rates slower than 10/sec. the amplitudes were not larger (Lowell et al. 1960). MLR may undergo rapid adaptation and augmentation at rates 1/sec. and 2.5/sec. (Jerger, Gloze, Erost et al. 1987).

Increase in repetition rate may serve to decrease the amplitude of MLR (Geisler et al. 1958; Goldstein, and Rodman, 1967; McFarland, Vivien and Goldstein, 1977).

A summed MLR which is designated as the 40/sec. MLR has been recently described by Galambos et al. 1981).

According to them the 40/sec. MLR tasks takes longer because typically a 50/100 m.sec. time window is used. These 40/sec. MLRs are used clinically for the purpose of measuring hearing threshold. 40/sec. response is based on an interpeak latency of 25 m.sec. According to Galambose the subject has to be wide awake during examination in order to be successful. A series of MLR with 40 stimuli presentation reflects the basilar membrane location of auditory nerve fibre excitation. This can be a promissing new approach to clinical applications (Galambose, Macherg, Talmachoff, 1981). The amplitude of 40 Hz AEP are almost twice as large as MLR amplitude for clicks and only slightly larger than amplitude for 500 Hz tone bursts.

Intensity of the stimulus:

Intensity level has effects on the amplitude of MLR waveforms. When intensity is increased the amplitude also increase (Goldstein and Rodman, 1967). They found that latencies appear stable but the peaks became less defined as the stimulus intensity reaches near threshold levels. Meadel (1979) reports that the amplitude of MLR increases and latency decreases slightly with increasing stimulus intensity upto moderate levels. The moderate levels according to Dzdanan and Krauaz (1983) is 50-60 dB HL.

Mendel and Goldstein (1992); Picton et al (1977); Mendel and Anderson (1977) report that with increase in stimulus intensity there is a slight decrease in latency as well as the invcrease in amplitude. But with increase in intensity of tone pips did not show systemic growth in amplitude for Na-Pa peaks, (Kupperman and Mendel, 1974). Rate of latency changes of MLR may bear a close relationship to latency-intensity function of sonomotor response. (Gibson, 1978). At higher intensities the waveform changes quite suddenly and this has been attributed to inclusion of myogenic components (Thornton, 1975).

Frequency of the stimulus:

There are not many studies to show the clear effects of frequency on MLR waveforms. This is because of stimulus envelope constituents demanded by fast repetition rates used to elicit average responses. Tonal stimuli have not been found effective. Instead, filtered clicks or tone pips with low frequency band pass filters have been used. Latency for each peak reduces with increased stimulus frequencies. Amplitude input-output characteristics also vary with stimulus frequency. The characteristics show linearity for early peaks and for an increase in frequency of stimulus (Thornton, Mendel and Anderson, 1977).

Rise-fall time duration:

The MLR response mainly depends on onset of stimulus. so its called an response. In order to facilitate identification of response, a stimulus with shorter rise-decay time and longer duration should be used (Kupperman and Goldstein, 1974). They used a 1000 Hz,50 dB SL tone burst, rise times of 5,10,15 and 25 m.sec. with duration of 20-40 m.sec. when used, The early compoents of MLR are not affected by a combination but later waves show an increase in amplitude when 25 m.sec. rise-decay time was used. An increase in rise/decay time or equivalent duration results in increase of about 1-3 m.sec. in latencies for all MLR peaks. At the same time, there is an overall reduction in amplitude at all intensity levels (Vivien, Hirsch, Feye-Osier and Goldstein, 1982). A fast rise time is very important for elicitation of MLR. But rise time greater than 25 m.sec are not found to be effective (Skinner and Antinoro, 1969).

Electrode placement:

There are teo kinds of electrode arrays -ipsilateral mastoid (-) to vertex (+) and ipsilateral mastoid (-) to high forehead (+).Kawanagh and clark (1989) found that

both these arrays have equal efficiency in recording ABR and MLR in open as well as in closed filter conditions.

Forehead placement of the electrode is preferred usually because -

- it eliminates placement of electrode gel and adheslves in hair.
- it moves electrodes away from ear phone head band which can cause discomfort and dislodgement of electrode.
- allows easy achievement of low electrode impedance.

Mastoid to high forehead array was preferred by several authors (Beatti, Beguwalla, Mills and Boyd, 1986; Davis, and Hirsch, 1979; Hall, Morgan and Mackey-Horgadine, et al. 1984; Beatti and Boyd, 1984). Beatti, et al. (1986) say that forehead array results in 34% reduction in response amplitude. It was noticed that mean Po-Na amplitude was larger in forehead electrode array. Mean Na-Pa and Pa-Nb amplitude was larger in vertex array. The amplitude of Nb-Pb was small and ill defined in both cases.

Cohen (1982) and Wood and Wolpaw (1982) also report that the maximum evoked amplitude is obtained on the midscalp anterior to C_z . But very little difference in waveforms or magnitude between these two electrodes has been reported by Suzuki et al.1981).

Recording Parameters:

Filter characteristics:

Filtering limits the bandwidth of a stimulus. Thus may lead to distortion of waveform. Both phase and amplitude distortions were noticed (Lane,Mendel and Kupperman,1974). They also suggested that amplitude distortion can be used to estimate the threshold while phase distortion serve, very little purpose. The latencies of individual peaks are prolonged by reducing low pass filter setting. A band pass filter of 25-175 Hz with a slope of 6 dB/octave is recommended (Mendel, 1977). A latency reduction of 5 ms. between 500 Hz and 4000 Hz was seen in 4 awake subjects for 1/3 octave clicks centered at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz (zerlin et al. 1973). With low pass filtering the P wave splits Na through into Na_1 and Na_2 (Mendel and Kupperman, 1974). P wave corresponds to SN_{10} described by Dewis and Hirsch (Kavanagh, 1979).

Digital phase shift filtering does not affect the waveform and latency much. But analog filtering shows how early activity of MLR is folded onto later components leading to a much longer late activity than what is present physiologically

So analog filtering should not be used (Scherg, 1982). Power spectral analysis and digital filtration for MLR show frequency components located at 30-50 Hz. If activity is present below 30 Hz, detection of Pa and Nb is difficult.

If these activities are eliminated using, a high pass digital filtering Na, Pa, Nb and a positive peak at 60-70 m.sec. latency can be recognized. But if HPF is set at 40 H z positive peak disappears and Nb is followed by two positive peaks of 30-55 m.sec. and 80-85 m.sec. after the onset of stimulus (Suzuki, 1982). Large portions of MLR energy is produced by phase shifting the response energy from other portions of time bases (Izumi, 1980; Scherg, and Volk, 1983). Phase shift reduces amplitude of wave Po-Na complex with augmentation of MLR waveforms Pa and Pb peak. Pb can be noticed only on analog filtering and not on digital filtering (Kavanagh, Domico, 1987; Suzuki, Hirabayashi and Kobayashi, 1989). With los pass analog filtering with a cut off frequency of 100 Hz the first positive peak Po has a latency of 11-75 m.asec. If open recording filters is used Po shows a reduction in latency and will be recorded in ABR time domain (Kavanagh and Domico, 1987).

MLR was found at a level of 8-11.5 dB nHL. This threshold level did not differ much with different configurations of

filter settings like 10-100 Hz, 10-250 Hz, 10-1500 Hz, 10-3000 Hz, 30-100 Hz etc. The stimuli were 500 Hz tone pips with a rise decay time of 4 m.sec. and repetition rate of 9.3/sec. (Barajas, Exposito, Fernandez and Martin, 1985).

Masking:

Presentation of contralateral masking stimuli of moderate intensity does not appear to affect component amplitude. (Goldstein et al.I978). The shift in amplitude is $\pm$ 0.7 dB which is in significant. The ipsilateral masking noise shows a peak to peak amplitude variation which varies directly with signal to noise ratio (Smith and Goldstein, 1973).

Monaural vs. Binaural stimulation:

Monaural and binaural clicks of equal loudness yield equal response amplitude and latency (Peters and Mendel, 1974). Binaural interaction for MLR is reported to be much larger than monoaural response when elicited by 20-30 dB less intense stimuli. This difference may be due to neural mechanism underlying MLR generation. But there are contradictory studies which say the response for binaural and monaural stimulation are exactly similar (Denker and Howe,

1982). The early components of MLR have larger amplitudes for binaural stimulation (Kodobayashi et al. 1984). A slight augmentation was noticed between ipsilateral and contra-lateral side of stimulation (Mendel et al.1987). This was in contrast to (Wolf and Goldstein, 1978) the study which noted latency differences as well. When intensities are greater than 70 dB nML, overall reduction in component amplitude was noticed for binaural stimulation (Dobie and Norton, 1980). Binaural interaction in cats can be recognised within 20 m.sec. In humans this interaction is recognized for Pa-Na components but patterns of interaction are variable (Harada, Kawamura, Ichikawa, et al. 1984).

Endogenous factors:

Sleep:

Latencies of major peaks remain constant across different stages of sleep. Amplitudes are larger during REM 1 and 2 stages than 3 and 4 (Mendel and Goldstein, 1971). Sleep deprivation has little effect on MLR (Mendel and Goldstein, 1969b). Light sedation does not diminish the overall response Kupperman, Mendel, 1974? Mendel and Hosick, 1975; Mendel, HosicX, Windman et al. 1977). MLR is fairly stable during early stages of sleep (Mendel and Hosack, 1975). They also say that no change is seen in MLR due to drug induced sleep.

The middle components remain constant in amplitude for temporarily induced muscle paralysis (Harker, Mendel, Voots and Hosick, 1977). But complete anaesthesia may eliminate MLR completely (Goff, Allison et al. 1977). Conditions like hypoxia, hyperventilation, body acceleration through space, all have effect of increasing latency and decreasing amplitude. But there will be no changes in the on going BBS activity. Thus changes in the waveform of MLR is a sensitive indicator of increased stress (Mendel and Goldstein, 1969a).

Effect of endogenous factors on MLR are minimal. They remind essentially unchanged with attention to the stimulus train or ignoring the stimulus as in reading a book or sitting with eyes closed in a dark room or sitting with eyes open in a bright room (Mendel and Goldstein, 1971? Picton and Hillyard, 1974; Mendel and Kupperman, 1974). The amplitude of Pb and Pc of MLR are reduced during sleep (Brown and Shallop, 1982). As stages of sleep deepen, latencies of peaks except Po gradually increase and amplitude decreases During Deep sleep Nb and Pb tend to disappear. During sleep Na shows one of the double peaks Na_1 and during stage of waXefulness Na_2 is seen. Effect of deep sleep on MLR is not much in adults as in children (Okitzn, Shibahana, 1981). Pa can be easily detected in awake children and stage of sleep.

During stage 4 detectability is poor (Krausz et al. 1985). The MLR threshold to be 40 dB higher in children who were asleep than their threshold when they were awake (Kankkumen and Rosenthal, 1985).

Other endogenous factors like movement of jaw,neck tension etc. which produce artefacts remain unexplained so far.

Middle latency response in different disorders:

Hearing impaired show a slightly increased amplitude and small reduction in latencies (McFarland, Vivion, Goldstein 1977). Significant latency delays but no amplitude abnormalities in response obtained from patients with multiple-sclerosis are noted (Robinson and Radge, 1977). A normal Pa component in bilateral temporal lobe infarction was noticed (Parving et al. 1980). The bilateral lesion noted in Alzheimer's disease is not generally sufficient to disrupt the Pa potential. But absence of Pa was also noticed in bilateral temporal lobe lesions (Ozdamar et al. 1982). In 15 subjects with evidence of neurologic involvement of age range of 6 weeks - 15 years, unclear waveforms were obtained. MLR in such cases is better suited to determine the function rather than threshold or specific site of lesion (Kileny and

Berny, 1983). MLR in mentally handicapped also does not show any significant difference in detectability of Na and Pa bat ABR has better repeatability (Smith, Reed,Stein et al. 1985).

Harker and Buckoff (1981) studied MLR in acoustic neuroma cases. There was generality in latency. Also eases with large tumors showed low false negative responses competed to cases with small tumors. So they say that it can be used as a predictive tool for size of tumors.

Effects of age:

Most aging brains show a group of structural changes which are progressive in nature. The electric potentials picked up from the brain may mimic these changes in terms of their waveform morphology and latencies. In order to find out if this assumption is true, we have to study the difference in waveform morphology and other factors as a function of aging. MDR in adults and to a lesser extent also in young children are reported to be remarkably stable and to be insensitive to changes in the stage of vigilance and age (Mendel, 1980 and 1982). Several authors (Mendel et al. 1977; Mendelson and Salamy, 1981) have shown interest

in the latency and amplitude difference in infants and adults.

While Mendel (1977) reported changes in morphology between young infants and adults, Mendelson and Salamy (1981) reported significant reduction of latency for P_Z between infancy and adulthood.

Few investigators (Engel, 1972; McRandle, et al. 1974; Mendel et al.1977; Wolf and Goldstein, 1978; Ozdamar and Krausz,1983) have tried to obtain normative data for newborns and infants. Engel, (1971) Davis et al (1974); Skinner and Glattke, (1977) say that its diffecult to obtain reasonably clear waveforms in neonates. Successful threshold estimation was possible in a11 but one of 28 idfants between 1 Month to 2 years of age in a study done by Mendel et al (1976). Rotteveel, Stegeman.deaf. Colon et al.(1984) report that identifiable Po, Na, Pa peaks were obtained from 64 pre-mature infants as early as 25 weeks of CA. This indicates as early functioning structure in auditory pathway with most prominent changes in latency and amplitude occuring before and after term date.

Some other studies note little difference between adult and infant morphology of MLR waveform as a function of intensity or rate of presentation (McRandle. Smith et al. 1974; McRandle and Goldstein, 1974, Mendel. Adkinson and Harker, 1977; Frye-Osler, Goldstein et al 1982). Mendel. Adkinson and Harker

(1977) report of an increase in the latency of Pa with increase in neonatal age from 1-8 months. Goldstein, McRandle, (1978 and 1980) say that the neonates demonstrate slightly shorter latency and smaller amplitudes than admits. They also report of no significant activity after 60 m.sec. According to them, ipsilateral stimulation produces more well defined waveforms than contralateral stimulation. Goldstein and Madell (1972) found that consistent responses with similar latencies and slight amplitude differences were noticed at different occasions. So MLR can be used as am auditory diagnostic tool for very young children (Davis, 1976a; Mendel, 1977; Vivision, 1980; Wolf and Goldstein, 1980).

Though Po and Na may not be significant always some differences are noticed in the latency values of these components (McRandle et al. 1974; Madell et al. 1977; Mendelson and Salamy, 1981). This may be due to band pass characteristics selected for the studies (Lane et al. 1974; Goldstein et al 1979; Scherg, 1982). In terms of amplitude, significant differences are noticed in different age groups. The amplitudes of Po, Pa and Pb found tobe increasing till 3-4 years of age and reducing in the adult (Mendelson and Salary, 1981).

Krausz et al (1985) say that detectability of component Pa increases systematically from birth to adolescent. But MLRs of children are found to differ substantially from that of the adults by researchers (Davis, 1976; Suzuki, Hirabayashi, Kobayashi, 1983; Krausz, Seed, Smith et al. 1984b).

Not many studies are there on MLR in the geriatric population. One study by Lanzi, Chiarelle, Sumbalaro (1989) reported certain changes in the morphology, latency as well as amplitude in geriatrics. The subjects were 70-90 years in age. The morphology was different from that of adult latencies of different components were increased amplitude were decreased in geriatrics. Reproducibility of the waveform was poor. Further the shorter latencies noticed in 30 year old males compared to females were not observed in the elderly subjects.

Allison et al (1983) reported that differences due to age are more stronger in males. These latency differences may be explained terms of differences in the auditory pathway length. Such differences may be seen in the MLR waveforms.

Clinical utility:

MLR is used as a means of establishing threshold because of its frequency specificity, easy recognizability in infants

and stability during ,sleep. The level for MLR agree closely with behavior threshold (Goldstein, Rodman, 1967, Madell and Goldstein. 1972, Kupperman, Mendel, 1974; Mendel, Hsoick Windman, Davis, Hirsch, Dings, 1978). Goldstein et al using click stimuli got response within 30 dB SL of the behaviour threshold. But difficulty in normal hearing subjects than in partial hearing loss csses was also reported (Horowitz, Larson, Sances, 1966). At near threshold levels, Na, Pa and Nb are considerably recorded (scherg, Volk, 1983; Ozdamar, Krausz, 1983). The idea that just detectable wave Pa is more significant measure of auditory threshold than the exact latency of the components is supported in recent literature (Maurlzi et al. 1984).

The MLR threshold willbe within 10-30 dB Kb of behaviour measure (Madell and Goldstein, 1972; Mendel, Hsick, Windman et al (1975; Vivision, Mc Farland, Goldstein, 1977, Skinner and Glattke. 1977; Vivion, Wolf Goldstein, et a1. 1979; Frye-Osin,Vivion et al 1980). Stability of reversibility of MLR is studied at just above threshold levels of 0,10,20 and 30 dB. Po,Na,Pa are fairly stable at dB SL. Complete reversibility is not possible even at 30 dB SL (Vehara, Ischikawa,Uchida,1982).

Cramon, 1986). It can also be used as an objective index of cochlear implant function (Gurali, 1985). Indicaters differ arpusal states of the subject (Kileny, 1983? Hall, 1985; Erwin, and Buchwald, 1986).

An accurate electrophysiological measure of low frequency threshold is a boon to the appropriate management of the hearing impaired. Though interest has been renewed in MLR over the recent years, no general consensus is present about any aspect of MLR.

Regarding the effect of aging on MLR not many studies are there at present to show how the development of the CNS may be responsible for the change in the waveform morphology, latencies and amplitude is not known. In Indian population such studies are not undertaken so far. This studyis attempted to compare the adult normals MLRs with geriatric group and to find out exactly if there are some significant changes in the latencies and amplitudes of MLRS.

METHODOLOGY

This chapter explains the criteria which was used to select the subjects for the present study, the equipment. used, the environment in which the test was performed and the experimental procedure.

Subjects:

Twelve subjects both males and females between the age range of 18 to 25 years were selected. They were graduates and undergraduates who volunteered for the study. They had normal hearing according to the ANSI-1969 Standards that is their hearing thresholds being within 20 dB for paretones. Middle latency response waveforms obtained from these subjects were compared with middle latency response waveforms of geriatrics.

The experimental group of this stady consisted of ten subjects, of both sexes males and females between the age range of 50-65 years. The tea subjects were divided into two groups according to their age. The first group had five subjects between the age range of 50-55 years and the second group had five subject, between the age range of 60-65 years.

Group	Age Range	Mean age
Group-I	50-55	52.2
Group-II	60-65	62.0

The following csiteria was used to select the subjects:

1. For both ears hearing levels should be within 40 dB for the octave range of 250 Hz to 8000 Hz.
2. History of acute or chronic ear infections, headache, tinnitus, vertigo or any other otological problems were ruled eat.
3. The subjects should be in good general health.
4. The subject should not have had any neurological problems such as apraxia, aphasia, disarthria etc.
5. They should be able to relax for the duration of the teat with the electrodes in position.

Only one ear of each subject was tested. The test ear was selected at random.

Equipment used for the experiment:

1. A diagnostic audiometer (Madsen OB 822). This was used to assess the pure tone thresholds between the frequency range of 250 Hz to 8000 Hz. The audiometer was calibrated for air conduction, bone conduction and speech audiometry.
2. An electrophysiological test unit (Nicolet Compact Auditory system).

This was used for obtaining MLR waveforms. This instrument is the ideal cost effective portable system for -

1. Auditory evoked potential testing.

2. Electroneurography (ENOG)
3. Electronystagmography(ENG)
4. Pattern-Reversal visual evoked potential testing.

Test Environment:

The tests were conducted in the sound treated room. The room was away from noisy areas and bright light, humidity temperature conditions were maintained at the specified levels. Power source was the main AC supply for the instruments.

Procedure:

The first step in the procedure was selecting the subject. The criteria mentioned under the sub-division "subjects" were considered, for it. Once the subject is chosen, conventional audiometry was done first using the audiometer (Madsen OB 822). If the person's thresholds fell within 40 dB he was taken for MLR testing.

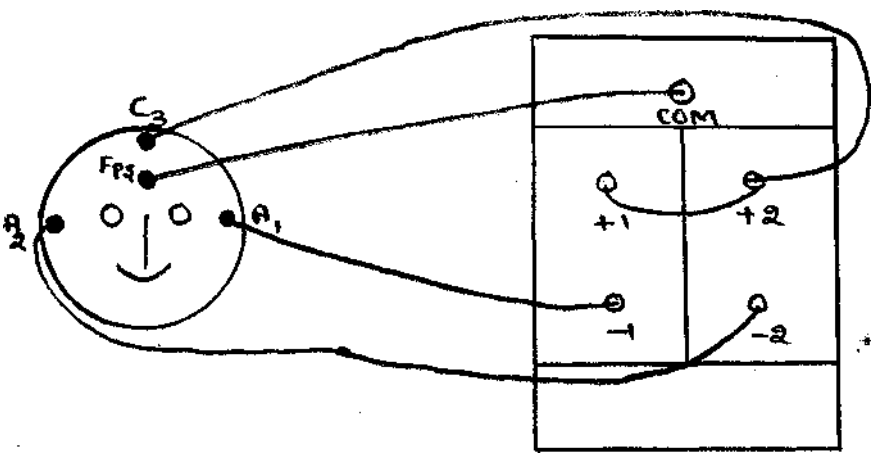
As mentioned earlier for obtaining MLR. Nicolet Compact Auditory System, which is an electrophyslological unit was used. The subject was made to sit on a chair which had a arm rest and he was asked to relax.

Instructions: "You need not indicate the presence of sound by raising your finger or by any other means. You can just sit and relax. Please do not move your arms, head, jaw, shoulder and neck. Inform me if you are uncomfortable. The test will take atleast 40 minutes. The instructions were given in English, Kannada, Tamil, Malayalam according to the mother-tongue of the subject. If the subject had not understood, instructions were repeated.

The Instrument was switched on and the program and data discs were inserted in their respective compartments.

Electrode placements: The area of placement of electrode was cleaned with cotton dipped in rectified spirit. The rubbing was done till the surface appears red indicating high vascularity. Electrodes were cleaned and checked for continuity. Required amount of get was put on the electrodes and using pieces of plaster they were placed in positions.

There were four electrodes which were used for MLR testing. One was placed on the vertex (C), second on forehead (FP_2) and the third and fourth on mastoid region behind the auricle. The electrode on vertex serves as positive, the electrode on forehead serves as common electrode and the electrodes on Mastoid serve as negative electrodes.



The above diagram illustrates how the electrodes were placed and how they were plugged into the electrode head box.

Site			Headbox
Forehead			com
Vertex			1 + 2 + disked)
Left ear	mastoid	A_1	1-
Right ear	mastoid	A_2	2-

After the electrodes were placed the impedance matching was done. The operating program is loaded into system memory from program disc when the Nicolet Compact Auditory System is put on. The program disc has to remain in the program drive since the Nicolet Compact Auditory System repeatedly refer the program disc during normal operation. The date was continuously updated by a battery powered internal clock/calender. The system stored this information also with data.

Te match the impedance the procedure given in Nicolet Compact Auditory System manual was adopted. After the impedance matching the earphones were placed without dislodging the electrodes. Blue earphone was used for the left ear and red earphone for the right ear. Earphone diaphragm should be directly over the ear canal so that accurate stimulus intensity levels could be delivered to the ear.

Stimulus parameters:

Stimulus	-	Tone bursts
Frequency	-	500 Hz
Rise tone	-	Instantaneous
Plateau	-	50 /usec.
Decay	-	Instantaneous
Rate	-	9.7/see.
LLF	-	1 Hz.
HFF	-	1000 Hz
Sample number	-	2000

The test procedure and the storing procedure were adopted from the Nicolet Compact Auditory System manual. The testing was done for different levels 60, 50, 40, 30 and 20 until a clearer response was got. For each intensity 2000 stimuli were presented the response was stored, in respective memory blocks for further analysis. Later the waveforms were recalled and analyzed. The latencies for the difference peaks were then tabulated.

RESULTS AND DISCUSSION

MLRs were elicited for twelve adult normals and ten geriatric normals and the peak latencies were tabulated. The latencies of the two peaks Na and Pa which were consistently identified have been subjected to the following statistical analysis -Mean, standard Deviation, Range aad T-tests. In terms of these latencies the MLRs of adult normals were compared with MLRs of geriatric normals. Also the geriatric group was divided into two depending on age and were compared. The findings and interpretations are discussed in this chapter.

Table-1: Data of MLR waveforms elicited at 60 dB KHL in 12 adult normals of both sexes (17-24 years.

Sub-ject	Ear	No	Peak latencies (m.sec)					
			Po	Na	Pa	Nb	Pb	Nc
1	Left	16.6	19.4	24.0	32.4	48.6	-	-
2	Right	-	13.0	21.2	34.4	48.4	-	-
3	Right	-	-	20.0	29.4	44.4	-	-
4	Right	-	—	21.8	30.6	46.2	-	-
5	Right	-	16.4	24.4	38.4	48.4	-	-
6	Left	-	—	22.6	32.8	46.2	59.8	-
7	Left	-	—	22.2	35.0	-	-	-
8	Right	-	-	21.8	29.2	41.0	-	-
9	Left	-	—	22.4	33.4	41.4	-	-
10	Left	-	-	17	28.2	42.6	-	-
11	Right	-	-	22.6	28.4	-	-	-
12	Left	-	10.4	20.6	31.4	47.2	-	-

Tabl 2: Data of MLR waveforms elicited at 60 dB nHL in fivegeriatric normals of both sexes age ranging from 50 years to 55 years

Sub-ject	Ear	Peak latencies (msec)						
		No	Po	Na	Pa	Nb	Pb	Nc
1	Right	14.8	18.6	22.8	30.2	43.0		
2	Left	-	14.2	19.8	29.2	40.2	-	—
3	Right	12.0	16.6	22.6	-		-	-
4	Right	-	13.6	22.2	30.6	-	-	-
5	Left	-	12.4	20.0	30.8	-	-	-

Table-3: Data of MLR waveforms elicited for five geriatric normals of both sexes at 60 dB nHL age ranging from 60 years to 65 years.

Sub-ject	Ear	Peak latencies (m.sec)						
		No	Po	Na	Pa	Nb	Pb	Nc
1	Left		17.0	21.0	32.8	44.4	55.4	
2	Left	-	16.0	22.6	34.0	45.6	-	
3	Right	-	-	19.2	29	42.2	-	
4	Left	-	14.8	22.0	30.0	40.4	52.6	
5	Right	12.0	14.8	23.4	32.1	41.4	52.1	

Table-1 gives the data of MLR waveforms elicited at 60 dB nHL in twelve adults normals of both sexes. Table-2 gives the data of MLR waveforms elicited at 60 dB nHL in five geriatric normals between the age range of 50 years to 55 years. Table-3 gives the data of MLR waveforms elicited at 60 dB nHL in five geriatric normals between the age range of 60 years to 65 years.

Of the twelve adult normals No was found in only one subject and the latency was 16.6 msec. Inthe fifty to fifty five years geriatric group No was found in two subjects the latencies being 14.8 msec, and 12 msec. In the 2nd geriatric group (60-65 years) No was found in only one subject's waveform and the latency was 12 msec.

Of the twelve waveforms elicited in the twelve adult normals Po was identified only in four waveforms, the latency ranging between 10.4 m.sec. to 19.4 m.sec. In the first geriatric group Po was identified in all the five wave forma and the latency ranged between 12.4 m.sec. to 18.6 m.sec. In the second geriatric group Po was found in four out of five waveforms and the latency ranged between 14.8 m.sec to 17 m.sec.

Na was found in all the twelve adult normal MLR waveforms as well as in all the ten geriatric MLR waveforms. The mean latency of Na for the adult normal group was 21.7 m.see. The standard deviation was 1.9 and the range was 17 msec, to 24.4 m.sec. The mean latency of Na for the first geriatric group (50 years - 55 years) was 21.48 m.sec. standard deviation was 1.5 and the range was 19.8 m.sec. to 22.8 m.sec. The mean latency of Na for the second geriatric group (60-65 years) was 21.64 m.sec. the standard deviation was 1.6 and the range was 19.2 m.sec to 23.4 m.sec.

Pa was also found in all the subjects of both adult normals and geriatric normals. The mean latency of Pa for the twelve adult normals was 31.9 m.sec, the standard deviation was 3.1 and the range was 28.2 to 38.4 msec. The mean latency of Pa for the Ist geriatric group (50-55 years) was 30.14 m.sec, the deviation was 0.6 and the range was 29.2 msec, to 30.8 m.sec. The mean latency of Pa for the 2nd geriatric group (60-65 years) was 31.58 m.sec, the standard deviation was 2.04 and the range was 29 m.sec. to 34 m.sec.

Of the twelve adult normal's Nb was found only in waveforms of ten subjects and the latency was ranging from 4110 m.sec. to 48.6 m.sec.

Of the five 1st geriatric group Nb wsa identified only in two waveforms and the latencies were 43.0 m.sec. and 40.2 msec. In all the five waveforms in the 2nd geriatric group (60-65 years) Nb could be identified and the latency was ranging between 40.4 msec, to 45.6 m.sec.

Of the twelve adult normal group only in one waveforms Pb could be found and the latency was 59.8 msec. In none of the five waveforms of Ist geriatric group (50-55 years) Pb was found. In three out of five waveforms Pb was identified in the 2nd group of geriatrics aad the latencies were 50.2 msec. 52.6 msec, and 55.4 m.sec.

The peak Nc was not identified in any of the waveforms of both adult group and the geriatric group.

Table-4: Data of MLR waveforms elicited at 40 dB nHL 12 adult normals of both sexes (17-24 years)

Sub-jects	Ear	Peak latency (msec)						
		NO	PO	Na	Pa	Nb	Pb	Nc
1	Left		19.8	24.4	36.2	49.2	60.8	-
2	Right	- -		18.2	34.8	-	-	-
3	Right	--		22.0	29.0	42.8	-	-
4	Right	- -		21.4	32.2	47.0	-	-
5	Right		16.2	24.6	41.2	51.0	-	-
6	Left	- -		24.2	34.0	47.4	-	-
7	Left	- -		23.8	36.0	-	-	-
8	Right	- -		24.0	30*8	43.6	53.4	67
9	Left		13.0	21.4	32.6	42.2	-	-
10	Left		10*0	19*2	35.4	42.8	-	-
11	Right		10*0	23.4	31.4	40.6	—	-
12	Left		11.2	24.0	33.6	48.2	-	-

Table-5: Data of MLR waveforms elicited at 40 dBnHL in five geriatric normals of both sexes between the age range of 50 years to 55 years.

Sub-ject	Ear	Peak latency (in msec)						
		No	Po	Na	Pa	Nb	Pb	Nc
1	Right -		19.2	22.2	31.6	43.8	-	—
2	Left -			20.4	33	41.8	-	-
3	Right -		17.2	24.2	36.9	42.8	50.8	-
4	Right -		18.6	24*6	33.6	44.4	53.0	-
5	Left -		16.6	22.6	32.8	38.2	-	-

Table-6: Data of MLR waveforms elicited at 40 dB nHL in five geriatric normals of both sexes between the age range of 60 years to 65 years.

Sub-ject	Ear	Peak latency (m.sec)						
		No	Po	Na	Pa	Nb	Pb	Nc
1	Left		21.0	24.2	33.2	43.6	-	-
2	Left			20.0	35.2	44.2	-	-
3	Right		11.2	23.6	31.0	43.8	52.6	-
4	Left	11.6	13.4	23.6	31.6	43.2	-	-
5	Right		19.6	24.2	33.6	-	-	-

Table- 5, 6 give data of MLR waveforms elicited at 40 dB nHL. In table & latencies of MLR waveforms of twelve adult normals are recorded. In Table 5, latencies of MLR waveforms of five geriatrics between the age range of 50 years - 55 years (Ist group of geriatrics) are recorded. In Table-6 latencies of MLR waveforms of five geriatfics between the age range of 60-65 years (2nd group of geriatrics) are recorded.

Of the twelve adult normal MLR waveforms at 40 dB nHL No was not found in any of them. It was not found in any of the five Ist geriatric (50-55 years) group MLR waveforms too. No was found in one of the waveforms of the five wave-forms obtained in the five geriatrics between the age range of 60-65 years that is the 2nd geriatric group and the latency was 11.6 m.sec.

Of the twelve adult normal waveforms Pa was found only in six of them and the latency was ranging between 10.6 msec, to 19.8 m.sec. Po was found in four out of five waveform in the 1st geriatric group (50-55 years) and the latency range was 17.2 m.sec. to 19.2 m.sec. In the 2nd geriatric group (60-65 years) also Po was found in four out of five MLR waveforms and the latency range was between 11.2 m.sec. to 21.0 msec.

Na was found in all the subjects of both adult group and geriatric groups. The mean latency of Na was 23.48 msec, the standard deviation was 3.6 and the range was 18.2 m.sec. to 32.6 m.sec. for the twelve adult normal group. The mean latency of Na for the Ist geriatric group was 22.3 m.sec. the standard deviation was 1.7 and the range was 20.4 m.see. to 24.6 m.sec. For the 2nd geriatric group the mean latency of Na was 23.16 msec, the standard deviation was 1.8 and the range was 20 msec, to 24.2. m.sec.

Pa was also found in all the waveforms of both the adult and geriatric groups. The mean latency of Pa was 34.8 msec, the standard deviation was 3.9 and the range was 29 msec, to 42.2 m.sec. for the adult group. The mean latency of pa was 33.4 m.see. the standard deviation was 1.6 and the range was 31.6 msec, to 36 msec, for the Ist geriatric group (50-55 years).

In the 2nd geriatric group (60-65 years) the mean latency of Po was 32.92 m.sec the standard deviation was 1.7 and the range was 31 msec, to 35.2 msec.

Of the twelve adult normal waveforms Nb was found only in ten of them and the latency range was 42.2 msec. to 51.0 msec. Nb was found in all the five waveforms of the first geriatric group (50-55 years) and the latency range was 41.8 msec.44.4 msec. Nb was found in four out of five waveforms in the second geriatric group (60-65 years) and the latency range was 43.2 msec. to 44.2 msec.

Pb was found is two of the twelve adult normal MLR waveforms and the latencies were 60.8 msec.to 53.4 msec. In the Ist geriatric group (50-55 years) Pb was found only in two of the five waveforms and the latencies were 50.8 msec, and 53.0 msec. In the 2nd group of geriatrics (60-65 years) Pb was found in only one waveform and the latency was 52.6 msec.

Nc was found in only one waveform in the adult group and the latency was 67 msec. Nc was not obtained in any of the waveforms in both the geriatric groups.

Table-7: Data of MLR waveforms elicited at 30 dB in 12 adult normals of both sexes (17 years to 24 years)

Sub-ject	Ear	Peak latency (msec.) No	Po	Na	pa	Nb	pb	Nc
1.	Left			Not clear				
2.	Right			22.2	34.2			
3.	Right			-	Not clear			
4.	Right	15.8	19.4	22.8	33.6	52.2		
5.	Right	8.6	17.2	24.2				
6.	Left			26.2	36.2	45.8		
7.	Left		20.0	25.2	36.2	44.6	53.4	69
8.	Right			24.0	37.0	47.2		
9.	Left	9.6	13.4	24.0	34.4	45.4		
10.	Left		14.6	19.4	-	-		
11.	Right		10.8	24.4	23.4	-	52.8	
12.	Left		11.2	25.0	34.6	48.2		

Table-8: Data of MLR waveforms elicited at 30 dB nHL in five geriatric normals of both sexes between the age range of 50-55 years.

Sub-jects.	Ear	No	Po	Na	Pa	Nb	Pb	Nc
				(Peak latency in msec)				
1	Right		-	Not clear			-	
2	Left	11.8	14.6	19.6	36.2	-	—	—
3	Right		-	Not clear			-	
4	Right		-	-	26.2	34.2	46.2	52.6
5	Left		-	Not clear			-	

Table-9: Data of MLR waveforms elicited at 30 dB nHL in five geriatric normals of both sexes between the age range of 60-65 years.

Subjects	Ear	Peak latency (m.sec)						
		NO	Po	Na	Pa	Nb	Pb	Nc
1	Left	-	Not clear	-				
2	Left	-	-	27.0	34.8	49.4	-	-
3	Right	-	17.0	27.0	33.2	45.2	-	-
4	Left	-	-	23.8	34.8	-	-	-
5	Right	-	20.0	23.5	35.4	-	-	-

Table-7, 8, and 9 give the latencies of different components of MLR waveforms obtained at 30 dB nHL for twelve adult normals, and ten geriatric normals between the age range of 50-55 years and 60-65 years respactively.

(Of the twelve adult normals, MLR waveforms were found only in twn subjects. Of the ten waveforms, No was obtained only in three and the latencies were 9.6 m.sec., 8.6 msec, and 15.8 msec. Of the five subjects, clear responses were obtained only for two in the Ist geriatric group (50-55 years) and No was obtained for only one of the two. The latency of it was 11.8 msec. Of the five subjects, clear responses were obtained for four in the 2nd geriatric group and No was not found in any of them.

Of the ten clear waveforms in the adult group Po was found only in seven waveforms and the latency range was 10.6 msec, to 20.0 msec. Of the two clear wavefosms in the 1st group of geriatrics. Po was obtained in only one and the latency was 14.6 msec. Of the four clear waveforms in the 2nd geriatric group Po was found in two of them and the latencies were 17.0 msec, and 20.0 msec.

Na was found in all the ten clear waveforms in the adult normal group and the latency range was from 19.4 m.sec. to 26.2 msec. Na was obtained in both the clear waveforms in the Ist geriatric group and the latencies were 19.6 msec, and 26.2 msec. Na was found in all the four clear waveforms in the 2nd geriatric group (60-65 years) and the latency range was 23.8 msec, to 27.0 msec.

Pa was found only in 8 of the 10 waveforms elicited in the adult normal group and the latency range was 23.4 msec, to 37.0 msec. Pa was found in both the clear waveform in the Ist group of geriatrics (50-55 years) and the latencies were 34.2 m.sec. to 36.2 m.sec. It was also found in all the four clear waveforms in the 2nd geriatric group and the latency range was 33.2 m.sec. to 35.4 msec.

Of the 10 clear waveforms in the twelve adult normal group. Nb was obtained in 7 and the latency range was

44.6 msec.to 52.8 msec. Nb was found in only one waveform of the two clear waveforms in the Ist group of geriatrics (50-55 years) and the latency was 46.2 msec. Pb was found in two oat of four in the 2nd geriatric group (60-65 years) and the latencies were 49.4 m.sec. and 45.2 msec.

Of the ten clear waveforms in the twelve adult normal group Nc was obtained in only one and the latency was 69 msec. Nc was not seen in any of the geriatric waveforms in both group.

It was observed that the morphology of the geriatric normal waveform was not different from that of adult normal waveform. As the intensity was decreased the responses also gave changes in and near the threshold level the responses were absent. This trend was seen both in adult normals as well as geriatric normals.

Na and Pa were obtained consistently for all the subjects of both the adult and geriatric groups and hence they were subjected to the following statistical analysis Mean, Standard Deviation, Range and T-tests.

Table-10: Latency of Na of MLR waveforms elicited at SO dB nHL in 12 adult normals and 10 geriatric normals.

Subject	Na latency (Msec)	Subject	Na Latency (msec)
Adult Normal		Geriatric normal	
1	24.0	1	22.8
2	21.2	2	19.8
3	20.0	3	22.6
4	21.8	4	22.2
5	24.4	5	20.6
6	22.6	6	21.0
7	22.2	7	22.6
8	21.8	8	19.2
9	22.4	9	22.0
10	17	10	23.4
11	22.2		
12	20.6		
Mean	21.7		21.56
S.D. .	1.9		1.5
Range	17 ms - 24.4 ms		19.2 ms - 23.4 ms
Z = 0.0989 P '= 0.9212.			

Table-11: Latency of Na of MLR waveforms elicited at 40 dB nHL in 12 adult normals and 10 geriatric normals.

Subject	Na latency (Msec)	Subject	Na latency (msec.)
Adult normal		Geriatric normal	
1	24.4	1	22.2
2	18.2	2	20.4
3	22.0	3	24.2
4	21.4	4	25.6
5	24.6	5	22.6
6	21.6	6	24.2
7	23.8	7	20.0
8	24.8	8	23.8
9	32.6	9	23.6
10	19.6	10	24.2
11	23.4		
12	24.6		
Mean	23.48		22.98
SD	3.6		1.5
Min.Max.	18.2 - 32.6		19.2 - 23.4

z = 0.0981 P = **0.9212.**

Table-12: Latency of Na of MLR waveforms elicited in two groups of geriatric normals at 60 dB nHL

I group (50-55 years)	Latency of Na (msec.)	II group (60-65 years)	Latency of Na (M.sec.)
1	22.8	1	21.0
2	19.8	2	22.6
3	22.6	3	19.2
4	22.2	4	22.0
5	20.0	5	23.4
Mean	21.48		21.64
SD	1.5		1.6
Min Max.	19.8 - 22.8		19.2 - 23.4

Z = 0; P = 1.000

Table-13: Latencies of Na of MLR waveforms elicited in two groups of geriatric normals at 40 dB nHL

I group (50-55 years	Latency Na (msec.)	II group (69-65 years)	Latency Na (msec.)
1	22.2	1	24.2
2	20.4	2	20.0
3	24.2	3	23.8
4	22.6	4	23.6
5	22.6	5	24.2
Mean	22.8		23.16
SD	1.7		1.8
Min.Max.	20.4 - 24.6		20.0 - 24.2

Z = 0.40 452? P= 0.6858

Table-10 gives latencies of peak Na of MLR waveforms elicited in 12 adult normals and 10 geriatric normals at 60 dB nHL. Na was obtained for all the subjects consistently The mean latency of Na for 12 normal adults was 21.7 msec, and the mean latency of Na for geriatric normals was 21.56 msec. The standard deviation for adults and geriatric were 1.9 msec, and 1.5 msec, respectively. The latency range for adults was 17 msec, to 24.4. msec, and for geriatrics was 19.2 msec, to 23.4 msec. 'T' tests were done for comparing the groups and the '2' score was 0.0989 at 'P' of 0.09212. So there was no significant difference seen in terms of Na latency at 60 dB nHL between the two groups.

Table-11 gives latency of Na of MLR waveforms elicited in 32 adult normals and 10 geriatric normals at 40 dB nHL. Na was seen in all the waveforms of both the groups. The mean latency of Na for the 12 adults was 23.48 and for the ten geriatrics was 22.98 msec. The standard deviation of the adult group was 3.6 msec, and for the geriatric group was 1.5 msec. The latency for the adult group was 18.2 msec, to 32.6 msec, and for the geriatric group waw 19.2 to 23.4 msec. The Z score was 0.0981 at P of 0.9212. So at 40 dB nHL also there was no significant difference in terms of Na latency between the adult and geriatric groups.

Table-12 gives latency of peak Na of MLR waveforms elicited in two groups of geriatrics at 60 dB nHL. The Ist group of geriatrics were between the age range of 50-55 years and the 2nd group of geriatrics were between the age range of 60-65 years. The means latency of Na for the Ist group was 21.48 msec, and for the 2nd group was 21.64 msec. The standard deviation of the Ist group of geriatrics was 1.6 and for the 2nd group of geriatrics was 1.6. The latency range for the Ist group was 19.8 msec, to 22+8 msec, and the 2nd group was 29.2 msec.to 23.4 msec. The Z score of the two groups was 0 at P of 1.000 level. So there was no significant difference seen in terms of Na latency between the two groups of geriatrics of different ages.

Table-13 gives latencies of Na of MLR waveforms elicited in two groups of geriatrics normals at 40 dB nHL. The Ist group of geriatrics were between the age range of 50-55 years, and the 2nd group of geriatrics were between the age range of 60-65 years. The mean latency of the Ist and 2nd groups of geriatrics were 22.8 msec, and 23.16 msec, respectively. The standard deviation for the 1st group was 1.7 and for the 2nd group was 1.8. The latency range was 20.4 msec.to 24.6 msec, for the Ist group and 20 msec, to 24.2. msec, for the 2nd group. The T-tests were done for comparing these two groups and the Z score was 0.40452 at P of 0.6858. So there was no significant difference seen at 40 dB nHL in terms of Na latencies between the two groups.

Table-14: Latencies of PA of MLR waveforms elicited in twelve adultsnormals and ten geriatric normals at 60 dB nHL

Subject Adult normal	Latency of PA (msec)	Subject Geriatric normal	Latency of Pa (msec)
1	32.4	1	30.2
2	34.4	2	29.2
3	29.4	3	30.2
4	30.0	4	30.6
5	38.4	5	30.8
6	32.8	6	32.8
7	35.0	7	34.0
8	29.2	8	29+0
9	28.2	9	30.0
10	33.4	10	32.1
11	28.4		
12	31.4		
Mean	31.9		30.8
SD	3.1		1.62
Min.-Max.	20.2 - 38.4		29.0 - 34.0
Z = 0.06264; P = 0.5310			

Table-15: Latency of Pa of MLR waveforms elicted in twelve adult normals and tea geriatric normals at 40 dB nHL

Subject Adult normal	Latency of Pa (m.sec.)	Subject Geriatric normal	Latency of Pa(msec.)
1	36.2	1	31.6
2	34.8	2	33
3	29.0	3	32.8
4	32.2	4	32.8
5	41.2	5	33.2
. 6	34.0	6	35.2
7	30.8	7	31.6
8	36.0	e	31.0
9	42.2	9	33.6
10	31.4	10	32.6
11	35.4		
12	33.6		
Mean	34.8		33.16
SD	3.9		1.57
Min.-Max.	29 - 42.2 msec.		31 - 36 msec,
Z = 1.869; P. 0.2353.			

Table-16: Latencies of Pa of MLR waveforms elicited at 60 dB nHL in two groups of geriatrics.

I group (50-55 years)	Latency of Pa (msec)	II Group (60-65 years)	Latency of Pa (msec)
1	30.2	1	32.8
2	29.2	2	34.0
3	30.2	3	29.0
4	30.6	4	30.0
5	30.8	5	32.1
Mean	30.14		31.58
SD	0.63		2.05
Min.- Max.	29.2 - 30.8		29 - 34
Z = 1.2136; P. = 0.2249.			

Table-17: Latencies of Pa of MLRwaveforms elicited in two groups of geriatrics at 40 <3B nHL.

I group (50-55 years)	Latency of Pa (msec.)	II group (60-65 years)	Latency of Pa (msec.)
1	31.6	1	33.2
2	33	2	35.2
3	36	3	31.0
4	33.6	4	31.6
5	32.8	5	33.6
Mean	33.4		32.9
SD	1.6		1.7
Min. - Max.	31.6 - 36		31 - 35.2
Z = -0.13484	P 0.8927		

Table-14 gives latency of Pa of MLR waveforms in twelve adult normals and 10 geriatric normals elicited at 50 dB nHL The Pa was found in all the waveforms consistently. The mean latency of Pa for the adult group was 31.9 msec, and for the geriatric group was 30.8 msec. The standard deviation for the adult group was 3.1 and for the griatric group was 1.62. The latency range of the adults was 28.3 m.sec. to 38.4 m.sec. and for the geriatrics was 29.0 msec, to 34.0 msec. The T-tests indicate that Z was 0.06264 at P of 0.5310 level So there was no significant difference seen in terms of Pa latencies at 60 dB between the adult and geriatric groups.

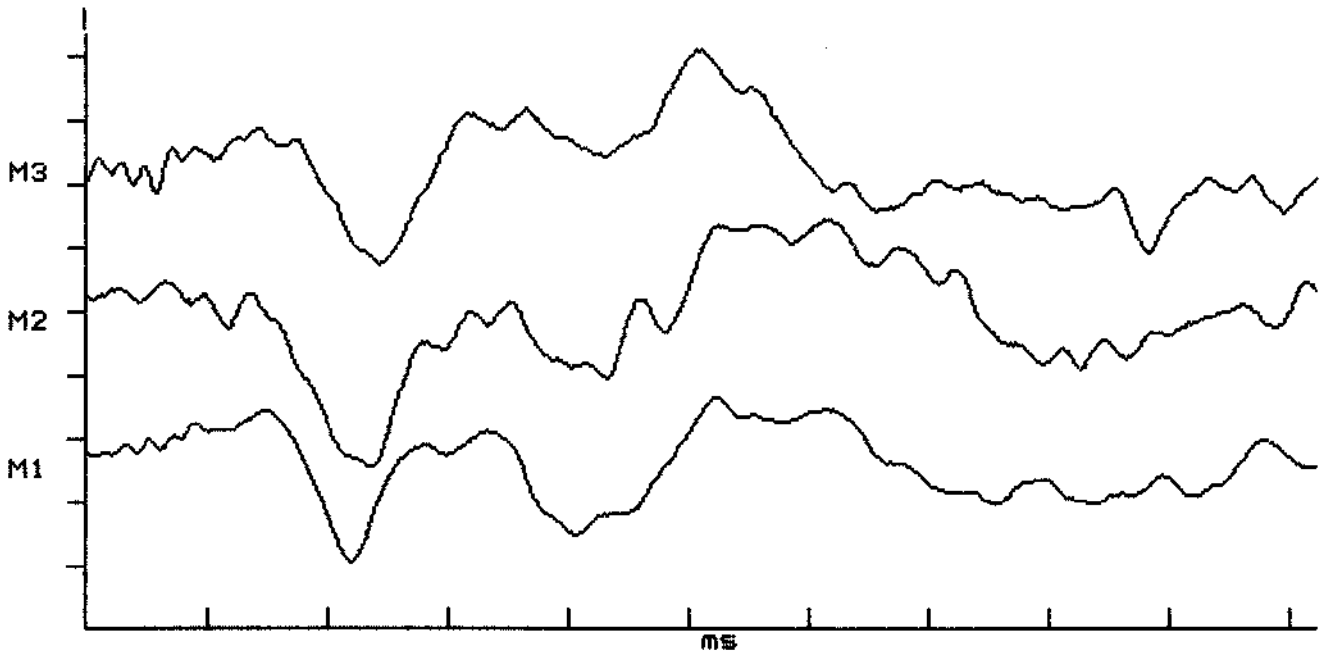
Table-15 gives latencies of Pa of MLR waveforms elicited in twelve adult normals and ten gariatric normals at 40 dB nHL The mean latency of Pa for the 12 adults was 34.8 msec, and for the ten geriatrics was 33.16 msec. The standard deviation was 3.9 for adults and 1.57 for the geriatrics. The latency range was 29 to 42.2 m.sec. for adults and 31 to 36 msec, for the geriatrics. The T-tests indicate Z scores to be 1.869 at P of 0.2353 for the 2 groups here. So there was no significant difference seen between the adult and geriatric groups in terms of latency of Pa at 40 dB NHL.

Table-16 gives latencies of Pa of MLR waveforms elicited at 60 dB nHL in two groups of geriatrics. The Ist group was between the age range of 50-55 years and the 2nd group was between the age range of 60-65 years. The mean latency of Pa for Ist group of geriatrics waz 30.4 msec, and for the 2nd group of geriatrics was 31.58 msec. The standard deviation for the Ist group was 0.63 and for the 2nd group was 2.05. The minimum to maximum latency range was 29.2 to 30.8 msec, for the Ist group and 29 msec, to 34.msec, for the 2nd group. The 'z' score was 1.2136 at P of 0.2249. So there was no significant difference between the two groups of geriatrics in terms of Pa latency at 60 dB nHL.

Table-17 gives latencies of Pa of MLR waveforms elicited in two groups of geriatrics at 40 dB nHL. The Ist group was between the age range of 50-55 years and the 2nd group was between the age range of 60-65 years. The mean latency of Pa for the Ist group was 33.4 m.sec. and for the 2nd group was 32.9 msec. The standard deviation was 1.6 for the Ist group and 1.7 for the 2nd group. The latency range was 31.6 to 36 msec, for the Ist group and 31 msec, to 35.2 msec, for the 2nd group. The Z score for these groups was 0.13484 at P of 0.8927. So there was no significant difference between the two groups at 40 dB nHL/in terms of Pa latencies.

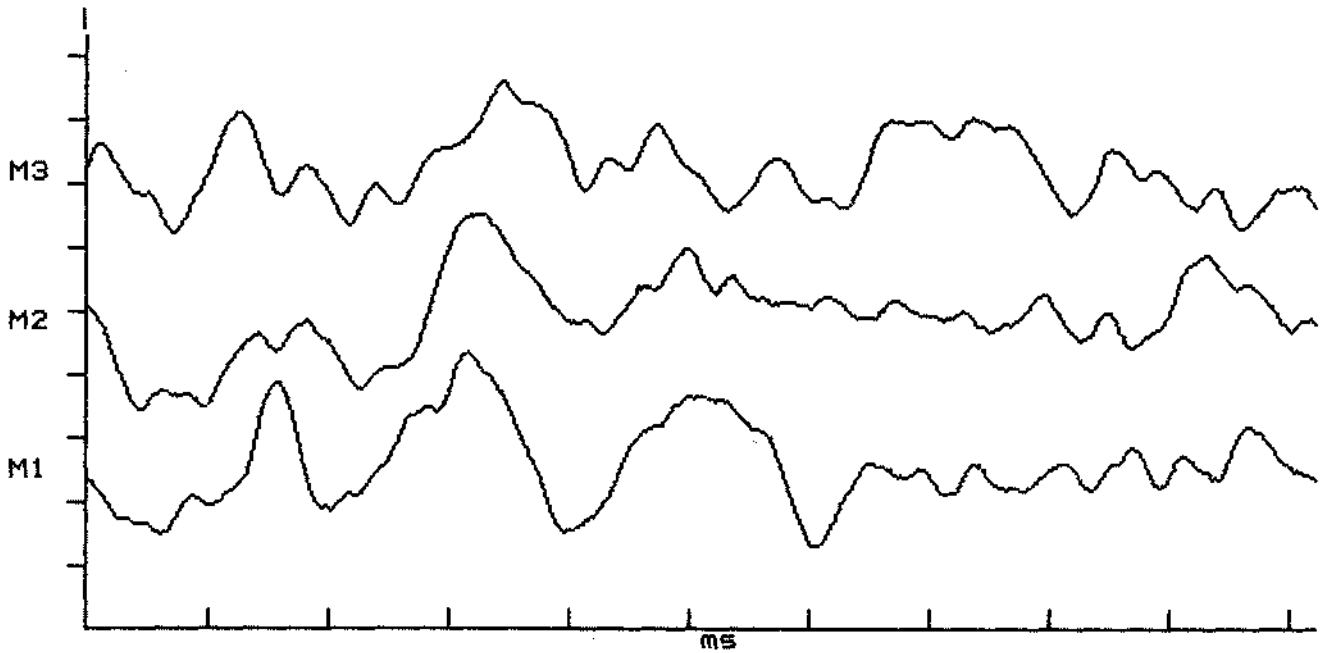
In most of the subjects it was observed that as the intensity was decreased the latency increased. This pattern was found both in adults normals and geriatric normals. However the increase was not significant. A_t 30 dB nHL in some of the subjects MLRs were not present. This was also true with adults as well as geriatrics.

There are not many studies on MLR in the geriatric population. A study by Lenze, Chiarelle, Sumbalaro (1989) reports that certain changes were found in the morphology latency as well as amplitude in geriatrics. This contradicts from the present study. But the age group of this study was/70 years to 90 years.



M	AMP/DIV		ms/DIV	TESTTIME	REMARK	OFFLINE ROUTINE
1	0.61	uV	10.0	19:58:4		/BLC
2	0.30	uV	10.0	20:7:54		/BLC
3	0.30	uV	10.0	19:44:33		/BLC

^*



M	AMP/DIV	ms/DIV	TESTTIME	REMARK	OFFLINE ROUTINE
1	0.30 uV	10.0	19:8:35		/BLC
2	0.30 uV	10.0	19:16:29		/BLC
3	0.30 uV	10.0	19:30:12		/BLC

This study shows no significant difference between the adult normals and the geriatric normals in terms of latencies of different components of MLR waveforms. When comparing with two groups of geriatrics of different age groups. It was also found that there was no significant differences seen between them. Based on these results one cannot comment on the integrity of auditory pathway in geriatrics since the amplitude, repze&dcibility etc. of the MLR waveforms were not studied here and also the sample size was less to generalize anything. To confirm these results studies can be done on larger population and also above the age rage of 65 years.

Threshold estimation:

The idea that a just detectable wave Pa is more significant measure of auditory threshold than the exact latency of the other components is supported in recent literature (Maurizi et al. 1984). This can be supported to some extent by this study because Pa was present consistently even at 30 dB nHL in almost all the subjects,if MLR were present. The hearing threshold of the subjects was within 25 dB HL according to ANSI standards which considers it as normal.

The MLR threshold will be within 10-30 dB of behavioural measures (Madell and Goldstein, 1972; Mendel, Hosick, Windman et al 1975; Vivion, McFarland, Goldstein, 1977; Skinner and Glattka, 1977; Vivion, Wolf, Goldstein et al. 1979; Fryo-Osien, Vivion et al. 1980). This is supported by the present study because at 40 dB nHL all the subjects gave MLR. To confirm this MLR waveform can be studied in different adult pathological cases and compared with the normals and find out at what level the MLRs are occuring consistently in normals and how they occur in pathological cases. To conclude anything in MLR and to include them in the daily audiological test battery, much more exploration is needed.

SUMMARY AND CONCLUSION

Twelve adult normals between the age range of 17 years to 24 years and 10 geriatrics between the age range of 50 years to 55 years and 60 years to 65 years were chosen for the study. Of the ten geriatrics five were between the age range of 50 years to 55 years and five were between the age range of 60 years to 65 years. The aims of the study were as follows:

i) To study the morphology of the middle latency response waveforms ia geriatrics.

ii) To compare the geriatric middle latency responses with that of young adult normals waveforms.

iii) To compare the middle latency response waveforms between the two different age groups of geriatrics (50 years to 55 years and 60 years to 65 years).

The pure tone thresholds of the subjects were obtained using a diagnostic audiometer (Madsen OB 822). If their hearing thresholds were considered to be within normal limits (25 dB as per ANSI-1969 Standards), the MLR waveforms were obtained using a electrophysiological unit (Nicolet Compact Auditory System). The MLR waveforms were elicited for 60 dB, 40 dB and 30 dB. It was observed that the peaks Na and Pa were present in all the waveforms consistently. The data were subjected to the following statistical analysis - Mean,

Standard Deviation, Range and T-tests. The results showed that there was no significant differences in terms of latencies of peaks between the adult normals and geriatric normals. The morphology of the geriatric MLR waveforms were not different from that of adult normal waveforms. Comparison of latencies of different components of the two geriatric groups also showed no significant difference.

In conclusion as per the results of the above study aging does not seem to affect the MLR responses in Indian population, since no significant difference was observed in terms of latencies between the adult normal group and the geriatric group and between the two groups of geriatrics itself.

Limitations of the study:

1. Only latency has been considered to compare the weveforms. Amplitude has not been studied.
2. A very small sample of the population was undertaken in this study.
3. The geriatric group chosen was between the age group of 50 years to 55 years and 60 years to 65 years.Hence one cannot conclude that the MLR waveforms of geriatric normals are not different from that of adult normals,as subjects above the age of 65 years were not studied for MLR responses.

Recommendations for further studies;

1. The same study can be undertaken for a larger sample.
2. The changes in amplitude with aging caa be studied and also reproducibility can also be studied.
3. Age related variations can be studied in geriatrics above the age of 65 years.

We have just set our foot in the first step in this area of MLRs. so much exploration is needed to learn the MLRs thoroughly. As in the words of Moore

Yesterday - I never thought that these efforts would come to fraction

Today - I am happy its materialized.

Tomorrow - I hope those in the field of audiology will be inspired to much more ..... in the field of MLRs.

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