NORMAL HUMAN SLEEP – AN OVERVIEW

Sleep was thought as a passive process till a modern investigator J Allan Hobson in his book SLEEP published in 1989 wrote that sleep is a dynamic behaviour. It is not simply the absence of waking; sleep is a special activity of the brain, controlled by elaborate and precise mechanisms (9). Sleep is defined as a reversible behavioural state of perceptual disengagement from and unresponsiveness to the environment. It is complex amalgam of physiological and behavioural processes.

Within sleep, two separate states have been defined on the basis of a constellation of physiological parameters:

1. **Non Repetitive Eye Movement Sleep (NREM):** A normal adult human enters sleep through NREM. It is 75 to 80% of total sleep in a night. It is divided into four stages :

a) **Stage – I:** The first cycle of sleep begins with stage I. It generally persists for only a few minutes – 1 to 7 minutes on the onset of sleep. It comprises about 2 to 5% of sleep. It has lowest arousal threshold and occur as a transition stage throughout night. Increase in the percentage of stage I sleep means disturbed sleep. Electroencephalogram (EEG), electrocardiogram (ECG) and electromyogram (EMG) determine physiological criteria for different stages of sleep. In stage I, alpha waves (8 to 13 Hz) of wakefulness diminish to less than 50% in an epoch (generally a 30 second segment) and it of low voltage and mixed frequencies changes occur after the start of slow eye movements. Person is arousable on simply calling the name or closing the door.

b) **Stage – II:** It comprises about 45 to 55% of the sleep. It begins 10 to 12 minutes after stage I sleep. Sleep spindles (12 to 14 Hz) and K complexes, high voltage slow wave rhythm (<4 Hz) theta and delta waves comprising less than 20% of the epoch on EEG are the characteristics of the stage II. In fact sleep onset coincide with sleep spindles. There are certain behavioural concomitants with sleep onset such as altered visual and auditory responses and hypnic myoclonia. An intense stimulus is required to produce arousal.

c) **Stage III & IV:** Also called slow wave sleep (SWS). Person goes into deep sleep. During stage III, delta wave occupies 20 to 50% of the epoch and during stage IV

delta wave occupies more than 50% of the epoch. An incrementally larger stimulus is required to produce arousal from SWS. Stage III usually lasts only few minutes in the first cycle and is transitional to stage IV. The stages are shown in fig. 1.

NREM sleep can be summarized as relatively inactive yet actively regulating brain in a movable body.

2. Repetitive Eye Movement Sleep (REM): REM sleep is defined by EEG activation, muscle atonia, and episodic burst of rapid eye movements. It is divided into two stages phasic and tonic type. Tonic REM is characterized by desynchronised EEG and muscle atonia whereas Phasic REM is characterized by burst of rapid eye movements, phasic swing in blood pressure and heart rate, irregular respiration and tongue movements. There may be period of apnoea or hypopnoea during REM sleep. The pattern of EEG during REM sleep is fast rhythm and theta waves, which may have saw tooth appearance. The mental activity of human REM sleep is associated with dreaming. Inhibition of spinal motor neurons via brainstem mechanism mediates suppression of postural motor tonus in REM sleep. REM sleep does not occur until 80 minutes or longer after the first cycle of NREM. The average length of NREM-REM sleep cycle is approximately 70 to 110 minutes. REM is usually 20 to 25% of sleep occurring four to six discrete episodes. A shorthand definition of REM sleep is a highly activated brain in a paralysed body. The REM sleep tonic and phasic is shown in fig. 2.

Factors Modifying Sleep Stage Distribution

Age:

Age affects pattern of sleep stages across the night. Newborn enters sleep through REM called active sleep in newborn. The same situation in adults would invite the diagnosis of narcolepsy. At the age of 2 to 6 months slow wake sleep (SWS) becomes quite prominent. SWS are maximal in young children and it is qualitatively and quantitatively different from that of older adults. It is nearly impossible to wake youngsters in SWS. It decreases markedly with age. This may be due to parallel loss of cortical synaptic density. REM sleep is maintained well into healthy old age and absolute amount of REM sleep in the night correlates with intellectual functioning, frequent

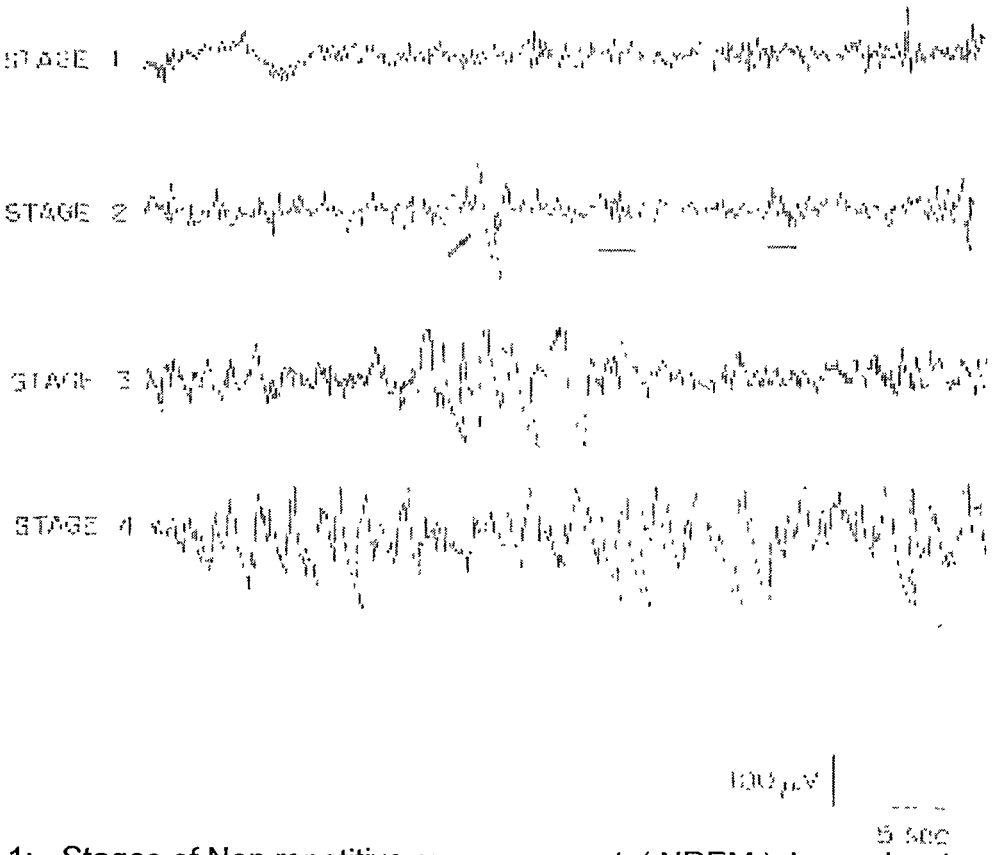

Fig- 1: Stages of Non repetitive eye movements(NREM)sleep showing K complexes & sleep spindles

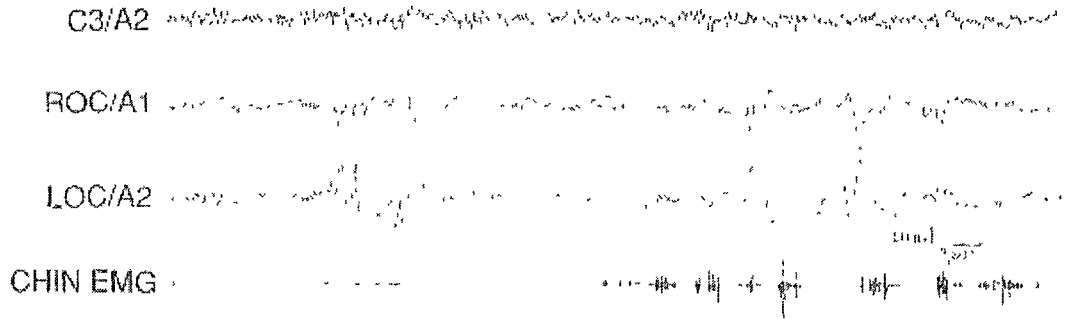

Fig- 2: Repetitive Eye movement (REM) sleep showing several rapid eye movements

arousals, periodic body movements and sleep related breathing irregularities are frequently seen in the elderly.

Prior Sleep History:

Sleep loss on one or two nights will show rebound of slow wave sleep on first night and REM sleep on subsequent nights. If there is deferential sleep deprivation for example REM sleep, REM sleep rebound will occur on sleep onset misleading clinical picture or exacerbate a sleep disorder such as sleep apnoea or even it may simulate narcolepsy if REM sleep is also associated with hypnagogic hallucinations, sleep paralysis, therefore it is very important to know prior sleep history.

Circadian Rhythms:

The circadian phase at which sleep occurs affects the distribution of sleep stages. REM sleep occurs with a circadian distribution that peaks in the morning hours coincident with the trough of body temperature (10). If sleep is delayed until to peak of REM phase of circadian rhythm – that is, the early morning REM sleep tend to dominate and may even occur at the onset of sleep. This reversal of normal pattern can occur in persons who acutely undergo phase shift either due to work shift change or jet leg. Studies have shown that persons sleeping in the environments free of all cues of time, their sleep onset and length of sleep occur as a function of circadian phase.

Temperature:

Accumulated evidence from humans and other species suggest that mammals have only minimal, if any, ability to thermo regulate during REM sleep that means that control of body temperature is virtually poikilothermic in REM sleep. Sweating or shivering in response to extremes of ambient temperature occurs in NREM sleep and ceases in REM sleep.

Effects of Drugs:

Since some of the drugs tend to modulate the stages of sleep, it is worthwhile to mention their effects on sleep. Benzodiazepines tend to suppress SWS and have no consistent effect on REM sleep. Tricyclic antidepressants and Monoamine oxidase inhibitors tend to suppress REM sleep. Acute withdrawal of these drugs will

cause rebound of SWS or REM sleep perhaps leading to false positive diagnosis of narcolepsy. Acute pre sleep alcohol intake produces REM sleep suppression early in the night that is often followed by REM sleep rebound in the later portion on night as alcohol is metabolised.

Effects of Sleep Disorders on Sleep Structure and Distribution

Narcolepsy:

It is characterized by REM sleep onset; associated with unusual symptoms like hypnagogic hallucinations, sleep paralysis and catalepsy. Other causes of REM sleep onset are:

- In infancy
- Sleep reversal or Jet leg
- Withdrawal from REM suppressant compounds
- Chronic restriction or disruption of sleep
- Endogenous depression

Sleep Apnoea Syndrome:

It may be associated with suppression of slow wave or REM sleep, secondary to the sleep related breathing problems. Successful treatment of this condition produces huge rebounds of SWS or REM sleep.

Fragmentation of Sleep:

Fragmentation of sleep and increased frequency of arousals occur in association with a number of sleep disorders involving physical pain or discomfort or periodic limb movements (PLMS) in sleep, sleep apnoeas, chronic fibrositis may be associated with thousands of arousals each night.

Ontogeny of Sleep

There are dramatic changes in the requirement of sleep from infancy to old age. Newborn have a polyphasic sleep pattern with 16 hours of sleep a day. By 3 to 5 years it falls to 10 hours a day. Polyphasic pattern changes to biphasic in preschool children. Adults exhibit monophasic pattern with an average duration of 7 to 8 hours a

day but it again changes to biphasic in elderly. In newborn REM sleep occupies about 50% of total sleep time those later changes to 25% in adults.

Phylogeny of Sleep

Sleep is present both in mammals and non-mammals but architecture and stages differ. Dolphins do not have REM sleep. Dolphin's brain may show sleep in one half while wakeful activity in the other half. Rhythm then reverses after 30 cycles but they are of very short duration. Sleep is also noted in reptiles, fish and invertebrates.