

**EFFECT OF CYCLIC MEDITATION ON SLEEP
ARCHITECTURE AND SUBJECTIVE SLEEP RATING**

Thesis submitted by

SANJIB KUMAR PATRA

Towards the partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

OCTOBER 2010



SWAMI VIVEKANANDA YOGA ANUSANDHANA SAMSTHANA
A Yoga University under Section 3
of the UGG Act, 1956 vide Notification Number F.9-45/2001-U.3
dated 8/05/2001 of the Government of India, Bengaluru, India

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Under the Guidance of

SHIRLEY TELLES M.B., B.S., M.Phil., Ph.D.
H.R. NAGENDRA M.E., Ph.D.

SWAMI VIVEKANANDA YOGA ANUSANDHANA SAMSTHANA

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dated 8/05/2001 of the Government of India, Bengaluru, India

D E C L A R A T I O N

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA), Bangalore, under the guidance of Dr. Shirley Telles, Prof. & Head, Dept. of Biosciences and Dr. H.R. Nagendra, Vice Chancellor, Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Bangalore.

I also declare that the subject matter of my thesis entitled 'EFFECT OF CYCLIC MEDITATION ON SLEEP ARCHITECTURE AND SUBJECTIVE SLEEP RATING' has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

Date: 19.03.2011

Place: Bengaluru

SANJIB KUMAR PATRA

(Candidate)

A C K N O W L E D G E M E N T

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ABSTRACT

BACKGROUND

Cyclic meditation (CM) is a technique in which yoga postures are interspersed with periods of supine rest in recurring cycles. Earlier studies have shown that CM is a potent stress reduction strategy with facilitated cognitive performance. Such mind-modifying practiced during the day may influence night – time sleep. Hence, the present study aimed at studying quality of sleep following the practice of CM and supine rest.

AIM AND OBJECTIVES

The present study was designed to

- To compile the ancient information on sleep from ancient Indian scriptures and allied literature.
- To study whether practicing cyclic meditation would influence the sleep structure in normal persons.
- To compare the effects of practicing cyclic meditation in the day time with the effects of supine rest practice, on the heart rate variability during sleep.

SUBJECTS AND DESIGN

Whole night polysomnography measures and the self-rating of sleep were studied on the night following a day in which the participants practised cyclic meditation twice (approximately 23 minutes each time). This was compared to another night when they had two, equal duration sessions of supine rest (SR) on the preceding day. Recordings were

made on thirty volunteers (all males, group mean age \pm S.D., 26.3 ± 4.6 years), from F4, C4 and O₂ electrode sites (EEG) referenced to linked earlobes, and bipolar electroculography (EOG) and electromyography (EMG) sites. The sessions were one day apart and the order of sessions was randomized. HRV was recorded (i) while awake and (ii) during six hours of sleep (based on EEG, EMG and EOG recordings). This was similarly recorded for the night's sleep following the day time practice of SR.

RESULTS

On the night following CM practice the percentage of slow wave sleep (SWS) was significantly more than the night following relaxation in SR, the percentage of rapid eye movement (REM) sleep was less, and the number of awakenings per hour was also less. Following CM the self rating of sleep based on visual analog scales showed an increase in the feeling that sleep was refreshing, an increase in feeling 'good' in the morning, an impression of an overall increase in sleep duration, a decrease in the degree to which sleep was influenced by being in a laboratory, as well as any associated discomfort. During the night following day time CM practice there were the following changes; a decrease in heart rate, LF power (n.u.), an increase in the HF power (n.u.) and, the total index of NN intervals, TINN ($p < 0.001$), in many cases, comparing sleep following CM compared with sleep following SR). No change was seen on the night following SR.

CONCLUSION

Practicing cyclic meditation twice a day appeared to improve the objective and subjective quality of sleep on the following night and a shift towards parasympathetic dominance during sleep on the following night.

Meditation has been shown to reduce stress and increase feelings of peace and calm (Oman, et al., 2008). This suggests several applications and possible benefits related to practicing meditation. One of them is possibly an improvement in sleep. This assumption may be made based on the fact that real-world stress influenced cardiorespiratory functions during sleep, hence influencing the restorative function of sleep (Sakakibara, et al., 2008). In keeping with this, meditation techniques have been found to improve the quality of sleep, though this was chiefly based on subjective measures (Winbush, Gross & Kreitzer, 2007).

The association between sleep and meditation has been of interest and an early study actually showed that experienced practitioners of Transcendental Meditation (TM) spent appreciable parts of meditation sessions in sleep stages 2, 3, and 4 (Pagano, et al., 1976). However, this did not further the understanding about whether practicing meditation can actually alter the sleep structure. A more recent study on TM practitioners, using standard polysomnography did attempt to answer this question (Mason, et al., 1997). There were eleven long term practitioners, nine short term practitioners, and eleven non practitioners. While there were no significant differences between groups in standard sleep measures, visual inspection of slow EEG records did show specific differences between the groups for the first three cycles of stages 3 and 4 slow wave sleep. Long term practitioners had significantly greater theta 2-alpha 1 relative power than the other two groups. In this report the increased theta-alpha activity co-existing with delta activity of deep sleep was interpreted as suggestive of the practitioners having reached periods of transcendental consciousness.

Changes in sleep architecture related to the practice of meditation were described in another study (Sulekha, et al., 2006). Meditators were categorized as young (with ages between 20 and 30 years) and middle – aged (ages between 31 and 55 years). Comparisons were made with age-matched non-meditators. Middle-aged practitioners of two types of meditation techniques [viz. *Vipassana* and *Sudarshan Kriya Yoga (SKY)*] spent 12.0 percent of time in slow wave sleep (S3 and S4) compared to age matched non-meditators, who spent 3.7 percent of time in those stages. *Vipassana* meditators also spent significantly more time in rapid eye movement (REM) sleep compared to SKY meditators and non-meditators. The study was interpreted as suggesting that yoga practice helps to retain slow wave sleep and enhance the REM sleep state in middle-aged meditators.

The recovery experiences during leisure time, sleep, and affect the next morning are inter-related (Sonnetag, Binnewies & Mojza, 2008). Psychological detachment from work on the preceding day predicted negative activation and fatigue the next morning, whereas mastery experiences during the evening predicted positive activation, while relaxation predicted serenity. Also, the quality of sleep showed a relation with all affective variables. The results hence suggest that events on a particular day impact the quality of sleep at night and the affect the following day. Various factors of diverse behavioral and chemical origins are known to influence sleep (Jurkowski & Bobek-Billwicz, 2007). Among the well recognized factors are sleep deprivation and high intensity exercise (Dworak, et al., 2007).

In persons with sleep-onset and/or sleep-maintenance insomnia, as well as those with primary or secondary insomnia, eight weeks of yoga practice improved the sleep

efficiency, total sleep time, total wake time, sleep onset latency, and the wake time after sleep onset (Khalsa, 2004).

Also, a combination of yoga practices (i.e., physical postures, voluntarily regulated breathing, relaxation techniques, and lectures on yoga philosophy), improved the self-rated quality of sleep in older persons, compared to a group receiving an ayurveda poly-herbal preparation and another wait-list control group (Manjunath & Telles, 2005). The following benefits were self-rated by the older participants after six months of yoga practice viz., a decrease in the time taken to fall asleep, an increase in the total number of hours slept and in the feeling of being rested in the morning.

Among yoga techniques, meditation particularly has been shown to reduce stress and increase feelings of calm (Oman, et al., 2008). Meditation in fact, forms the sixth and seventh stages of the eight limbs (*astanga*) described by the sage Patanjali [Patanjali, circa 900 B.C.] (Taimini, 1986). While many practitioners do learn meditation directly, others find it easier to pass through the other stages, learning yoga postures (*asanas*) and regulated breathing (*pranayamas*), first (Nagendra & Nagarathna, 1997). For those who find it difficult to commence the practice of meditation there are two possible risks. Some people may find that they feel drowsy and even fall asleep other people may have a series of thoughts rushing through their minds preventing them getting into a meditative state. For this reason a technique of ‘moving meditation’, which combines the practice of yoga postures with guided meditation was devised, called cyclic meditation (CM), by H.R. Nagendra, Ph.D., which is conducive to getting into a meditative state. This technique has its’ origin in an ancient Indian text, *Mandukya Upanishad* (Chinmayananda, 1984a). It is interesting to note that CM does induce a quiet state of mind, which is compatible with

the description of meditation (*dhyana* or effortless expansion), according to Patanjali. This description states that ‘*Tatra pratyayaikatanata dhyanam*’ (Patanjali’s *Yoga Sutras*, Chapter 3: Verse 2). This means that the uninterrupted flow of the mind towards the object chosen for meditation is *dhyana* (Taimini, 1986). Indeed, all meditations, irrespective of the strategies involved are believed to help reach this state. There are several strategies in meditation. These include breath awareness, awareness of internal sensations, directing the attention to a *mantra* or a *koan*, and keeping the eyes open with the gaze fixed on the object of meditation, among other methods.

This technique i.e., CM consists of recurring cycles of physical postures (*asanas*) and supine rest in a meditative state of mind. In normal volunteers cyclic meditation practice reduced psychophysiological arousal based on a decrease in oxygen consumption (Telles, Reddy & Nagendra, 2000; Sarang & Telles, 2006a); and changes in the heart rate variability suggestive of a shift towards vagal dominance (Sarang & Telles, 2006b). Despite these changes suggestive of reduced physiological arousal, practitioners performed better in a cancellation task requiring selective attention (Sarang & Telles, 2007) and showed an increase in the P300 event related potential amplitude following the practice (Sarang & Telles, 2006c), also suggestive of enhanced sustained and selective attention.

More directly a two-day yoga program which involved the practice of cyclic meditation decreased occupational stress levels and baseline autonomic arousal (Vempati & Telles, 2000). Specifically, when participants were categorized based on the occupational stress index (OSI) at baseline, those with high OSI levels showed a decrease

in breath rate and a change in the heart rate variability suggestive of vagal dominance, while those with low OSI levels to begin with showed no change.

There have been studies which have shown that day time stress influences the sympathetic/parasympathetic balance during sleep. For example, reduced parasympathetic activity, based on the heart rate variability was recorded during sleep in the symptomatic phase of severe premenstrual syndrome (Baker, Colarin & Trinder, 2008).

Hence, considering that (i) day time activities influence sleep, including the level of parasympathetic activity during sleep, and (ii) cyclic meditation is a relatively easy to learn technique which influences the heart rate variability, with specific changes associated with the levels of mental stress and cyclic meditation appears to help in stress reduction and since stress influences sleep the present study was designed to compare the effects of practicing cyclic meditation in the day time with the effects of supine rest practice, on the heart rate variability during sleep and to study whether practicing cyclic meditation would influence the sleep structure in normal persons.

“A sleep that intimates death in his repose”, writes Sri Aurobindo in describing our ordinary sleep which is characterized by a fall into a state of semi-consciousness and a discontinuity of conscious existence. In contrast to ordinary sleep of the yogi in which there is full and unbroken consciousness while the outer being –physical, vital and mental-is in a state of complete repose.

The spiritual value of sleep, however, does not depend solely on one’s ability to understand one’s dreams. As previously stated, sleep is going inward and entering inner realms of our being which are not aware of in our waking state because the physical consciousness which dominates our waking state because the physical consciousness which dominates our waking state is too much turned to things of the outer world. Thus, “sleep gives us a right of secret entry” to deeper parts of our being which are normally sealed to our waking consciousness. In ordinary sleep, in which the being is submerged in the subconscious, we do not become aware of these deeper parts of our being. But if one can learn to make sleep more and more conscious (Dalal, 2004).

Sleep is a valuable opportunity to become conscious within because it is easier to do so in sleep than in the waking consciousness. The immobility and semi-consciousness of the outer being during sleep enables the inner being to become “independent of the physical form, conscious in itself and master of its own life.”

The agility of our mind flashes innumerable varieties of thoughts and imaginations in the awakened state. Random reflections of similar fluctuations continue in the subconscious state of sleep too and manifest their arbitrary mingling in variegated expressions of dreams in general. Therefore, dreams most often appear vague and meaningless. Unfolding the secrets of this free entertainment has been the center of attraction of the inquisitive human mind since the time of yore. Equally important has

been the quest for identifying the nature, cause and mode of interpretation of the rare but significant occurrence of meaningful dream.

In the early days of modern civilization, people in some parts of the occident world used to believe that during the state of the deep sleep the soul traverses in a ‘new’ world out of the body. The information gathered by it during this visit of the extraterrestrial world is expressed via dreams. So strong was this conviction that waking up someone fast asleep was regarded risky because of the apprehension that his soul may not have returned to his body before its ‘scheduled time’ and so waking up during this period may amount to his untimely death (Acharya, 2005).

प्रमाणविपर्ययविकल्पनिद्रास्मृतयः ।६॥

Pramāṇaviparyayavikalpanidrāsmṛtayaḥ ।6।।

Modification of mind is of four types and they are right knowledge, wrong knowledge, fancy, sleep and memory. [P.Y.S.1.6]

बहिष्प्रज्ञयो विभुर्विश्व ह्यन्तः प्रज्ञस्तु तैजसः घनप्रज्ञस्तथ प्रज्ञय एक एव त्रिधा स्मृतः ॥ १ ॥

Bahisprajñayo vibhurviśva hyantaḥ prajñastu taijasaḥ ghanaprajñastatha prajñaya eka eva tridhā smṛtaḥ ॥ 1।।

Viswa, the first quarter (Pada) is he who is all pervading and who experiences the external , the gross objects (the Waker) . Taijasa, the second quarter (Pada), is he who cognizes the internal , the subtle bodies (the dreamer) . Prajnya is he, who is a mass of consciousness . He is one alone who is thus known as three in the different planes of consciousness. [M.K.1.1]

प्र तद्वोचे अमृतं तु विद्वान् गन्धर्वो नाम निहितं गृहासु ।

त्रीणि पदा निहिता गृहासु यस्तद्वेद सबितुः पिता सत् ॥१५॥

*Pra tadvoce amṛtaṁ tu vidvān gandharvo nāma nihitaṁ gṛhāsu ।
trīṇi padā nihitā gṛhāsu yastadveda sabituḥ pitā sat* ॥15।।

He in whom this universe originates and into whom it is absorbed . He who exist as the warp and woof in all created beings. He by whom the three states of waking , dream, and deep sleep are appointed in the intellects hidden in creature. He in whom the universe finds a single place of rest having seen that Paramatman , the Gandhrva named vena became a true knower of all the worlds and proclaimed (to the disciples for the first time) that reality as immortal. He who knows that all pervasive one becomes worthy of receiving the honour due to a father even from his own natural father. [M.N.U.1.15]

2.1 JĀGRAT (THE WAKING STATE)

जागरितस्थानो बहिष्प्रज्ञः सप्ताङ्ग एकोनविंशतिमुखः स्थूल भुग्बैश्वनरः प्रथमः पादः ॥ ३ ॥
*Jāgaritasthāno bahiṣprajñah saptāṅga ekonaviṁśatimukhaḥ sthula
 bhugbhaiśvanarah prathamah pādah ॥ 3 ॥*

The first quarter is vaiśvanārah whose sphere of activity is the waking state, who is conscious of the external world of objects, who has seven limbs and nineteen mouths, and who enjoys the gross objects of the world. [M.K.1.3]

जाग्रदब्रूतावपि त्वन्तश्चेतसा कल्पितं त्वसत् ।
 बहिश्चेतगृहितं सद्युक्तं बैतथ्यमेतयः ॥ १० ॥

*Jāgradabṛtābapi tvantaśchetasā kalpitam tvasat ।
 bahiścetaogrhitam sadyuktam baitathyametayaoḥ ॥ 10 ॥*

Even in the waking state, whatever is imagined by the inner consciousness is false and whatever is perceived by the outer consciousness is true. It is reasonable that both these should be unreal. [M.K.2.10]

यथा स्वप्ने दुयाभासं स्पन्दते मायया मनः ।
 तथा जाग्रददुयाभासं स्पन्दते मायया मनः ॥२९ ॥

*Yathā svapne duyābhāsam spandate māyayā manaḥ ।
 tathā jāgradaduyābhāsam spandate māyayā manaḥ ॥29 ॥*

As in dream the mind vibrates, as though having dual aspects, so in the waking state the mind vibrates as through with two facets. [M.K.3.29]

चरञ्जागरिते जाग्रदिक्षु बै दशसु स्थितान् ।
अण्डजान् स्वेदजान् बाऽपि जीबान्पश्यति यान्सदा ॥६५ ॥
जाग्रच्चित्तेक्षणियास्ते न विद्यन्ते ततः पृथक् ।
तथां तददृश्यमेवेदं जाग्रतश्चित्तमिष्यते ॥६६ ॥

*Carañjāgarite jāgraddikṣu bai daśasu sthitān |
aṇḍajān svedajān bā'pi jībānpaśyati yānsadā ||65||
Jāgraccitekṣaṇiyāste na vidyante tataḥ pṛthak |
tathām tadadr̥śyamebedam jāgrataścitamīṣyate ||66||*

The creatures be they born from eggs or from moisture which the experiencer of the waking state ever sees as existing in all the ten directions, While he is roaming in the places of the waking state are but the objects of perception to the consciousness of the man in the waking state, and they do not exist separately from that consciousness. Similarly, this consciousness of the waking man is admitted to be only an object of perception to the waking man. [M.K.4.65,66]

सबस्तु सोपलम्भं च दूयं लकिकमिष्यते ।
अबस्तु सोपलम्भं च शुद्धं लकिकमिष्यते ॥८७ ॥

*Sabastu sopalambhaṁ ca dūyaṁ laokikamiṣyate |
abastu sopalambhaṁ ca śudghaṁ laokikamiṣyate ||87||*

The ordinary (waking) state is admitted to be that quality, coexisting with things of empirical reality and fit to be experienced. The object less ordinary (dream) state is admitted to be without any object and yet as though full of experience. [M.K.4.87]

यथा स्वप्नमयो जीवो जायते म्रियतेऽपि च ।
तथा जीवा अमी सर्वे भवन्ति न भवन्ति च ॥ ६८ ॥

*Yathā svapnamayo jīvo jāyate mriyate'api ca |
tathā jīvā amī sarve bhavanti na bhavanti ca || 68||*

As dream jiva comes into being and disappears , so also all egos available in our waking state appear and disappear. [M.K.4.68]

यथा मायाम्यो जीवो जायते म्रियतेऽपि च ।

तथा जीवा अमी सर्वे भवन्ति न भवन्ति च ॥ ६९ ॥

Yathā māyāmyo jīvo jāyate mriyate'api ca ।

tathā jīvā amī sarve bhavanti na bhavanti ca ॥ 69 ॥

As the conjured up entity comes into being and passes away , so also all the jivas perceived our waking hours appear and disappear. [M.K.4.69]

यथा निर्मितको जीवो जायते म्रियतेऽपि च ।

तथा जीवा अमी सर्वे भवन्ति न भवन्ति च ॥ ७० ॥

Yathā nirmitako jīvo jāyate mriyate'api ca ।

tathā jīvā amī sarve bhavanti na bhavanti ca ॥ 70 ॥

As all artificial ego centers come into being and pass away , so also all the jivas perceived in the waking condition appear and disappear. [M.K.4.70]

सवस्तु सोपलम्भं च द्वयं लौकिकं मिष्यते ।

अवस्तु सोपलम्भं च सुद्धं लौकिकं मिष्यते ॥ ८७ ॥

Savastu sopalambham ca dvayaṁ laukik miṣyate ।

avastu sopalambham ca suddham laukika miṣyate ॥ 87 ॥

Vedanta recognized the empirical state of waking in which plurality made up of the contacts with the objects and ideas is known. If further recognizes another subtle state in which is experienced a plurality, wherein the ideas come in contact with objects which do not really exist. [M.K.4.87]

वैधर्म्याच्च न स्वप्नादिवत् ॥ २९ ॥ ।

Vaidharmyāccha na svapnādivat ॥ 29 ॥

Consciousness between the waking and the dream state the experience of the waking state is not like dreams etc. [B.S.1.29]

संध्ये सृष्टिराह ॥ १ ॥

Sandhye sṛṣṭirāha ॥ 1॥

In the intermediate stage (between waking and deep sleep there is a real) creation , because the sruti says so. [B.S.2.1]

मायामात्रं तु कात्स्न्येनानभिव्यक्तस्वरूपत्वात् ॥३ ॥

Māyāmātram tu kārtsnyenānabhivyaktasvarupatvāt ॥3॥

But (the dream world is) mere illusion on account of its nature not being manifest with the totality (attributes of the waking state). [B.S.2.3]

स एव तु कर्मानुस्मृतिशब्दविधिभ्यः ॥९ ॥

Sa eva tu karmānusmṛtiśabdavidhibhyaḥ ॥9॥

But the selfsame soul (returns from Brahman after susupti on account of work, memory , scriptural authority, and precept. [B.S.2.9]

2.2 SVAPNA (THE DREAM SLEEP)

स्वप्नस्थानोऽन्तःप्रज्ञः सप्ताङ्ग एकोनविंशतिमुखः

प्रबिबिक्त भुक्तैजसो द्वितीयः पादः ॥४ ॥

Svapnasthāno'ntahprajñāḥ saptāṅga ekonaviṁśatimukhaḥ

prabibikta bhuktaijaso dditīyaḥ pādaḥ ॥4॥

Taijasa is the second quarter, whose sphere (of activity) is the dream state, whose consciousness is internal who is possessed of seven limbs and nineteen mouths and enjoys subtle objects. [M.K.1.4]

विभुतिं प्रसवं त्वन्ये मन्यन्ते स्रुष्टिचिन्तकाः स्वप्नमायसरुपेति स्रुष्टिरन्यैर्विकल्पिता ॥ ७ ॥

Vibhutim prasavam tvanye manyante sruṣṭicintakāḥ svapnamāyasarupeati

sruṣṭiranyaieiroikalpitā ॥ 7॥

Some creationists believe it to be the projection of the glory of Gods own superhuman power, while others consider the world to be of the same nature as dream or illusion.

[M.K.1.7]

अन्यथा ग्रुहृतः सुप्नो निद्रा तत्वमजानतः ।

विपर्यसे तयोः क्षीणे तुरीयं पदमश्नुते ॥१५ ॥

Anythā gruhnataḥ suapnoe nidrā tatvamajānataḥ ।

viparyase tayoh kṣīṇe turīyam padamaśnute ॥15॥

Dream is the misapprehension of reality, sleep is the state in which one is in a state of non-apprehension of reality. When the erroneous knowledge in these two disappears, Thurya is realised. [M.K.1.15]

अदीर्घत्वाच्च कालस्य गत्वा देशान्नपश्यति ।

प्रतिबुद्धश्च वै सर्वस्तस्मिन्देशे न विद्यते ॥ २ ॥

Adīrghatvācha kālasya gatvā deśānnapaśyati ।

pratibuddhaśca vai sarvastasmіндеśe na vidyate ॥ 2॥

On account of the shortness of time, it is not possible for the dreamer to go and see the dream objects. Nor does the dreamer, when he wakes up, find himself in the places seen in his dream. [M.K.2.2]

अभवश्च रथादीनां स्रुयते न्ययपुर्वकम् ।

वैतथ्यं तेन वै प्राप्तं स्वप्न आहुः प्रकाशितम् ॥३ ॥

Abhavaśca rathādīnām sruyate nyayapurvakam ।

vaitathyam tena vai prāptam svapna āhuḥ prakāśitam ॥3॥

Strictly conforming to reason and logic. Sruthi also declares the nonexistence of the chariots, etc, perceived in his dream by the dreamer. Therefore it is said by the seers that sruthi herself declares the illusory nature of dream experiences, and establishes the same through logic and reason. [M.K.2.3]

अन्तःस्थानाच्च भेदानां तस्माज्जागरिते स्मृतम् ।

यथा तत्र तथा स्वप्ने संवृतत्वेन भिद्यते ॥४ ॥

Antaḥsthānāच्च bhedānām tasmājjāgarite smṛtam ।

yathā tatra tathā svapne saṁvṛtatvėna bhidyate ॥4॥

Different objects cognised in dream are illusory because they are being perceived to exist. For the same reason the objects seen in the waking state are also to be considered as

illusory. As in the waking state so in the dream the nature of objects remains the same. The only difference is the limitation of space in the case of dream objects they being seen within. [M.K.2.4]

स्वप्नजागरितस्थाने ह्येकमाहुर्मनीषिणः ।

भेदानां हि समत्वेन प्रसिद्धेनैव हेतुना ॥ ५ ॥

Svapnajāgaritasthāne hyekamāhurmanīṣiṇaḥ|

bhedānām hi samatvena prasiddhenaiṅva hetunā|| 5||

The thoughtful persons speak of the sameness of the waking and dreamstates on account of the similarity of the objects perceived in these two states and on the grounds already described. [M.K.2.5]

सप्रयोजनता तेषां स्वप्ने विप्रतिपद्यते ।

तस्माद्यन्तवत्त्वेन मिथ्यैव खलु ते स्मृताः ॥७ ॥

Saprayojanatā teṣām svapne vipratipadyate|

tasmādadyantavattoena mithyaiva khalu te smṛtāḥ||7||

That the objects of the waking state can serve our purpose in life is contradicted in the dream state experiences. Therefore they are undoubtedly illusory on account of their body waking and dream having a beginning and an end. [M.K.2.7]

अपुर्वं स्थनिधर्मे हि यथा स्वर्गनिवासिनाम् ।

तानयं प्रेक्षते गत्वा यथैवेह सुशिक्षितः ॥८ ॥

Apurvam sthanidharme hi yathā svarganivāsinām|

tānayaṁ prekṣate gatvā yathaiveha suśikṣitaḥ||8||

The objects perceived by the dreamer when they are of such nature as not easily met within the waking state, undoubtedly owe their existence to the practical condition in which the dreamer with his mind works for the time being as in the case of those residing in heaven. The dreamer associating himself with the dream condition s experiences those objects even as one when sent with full instructions goes from one place to another and sees the objects belonging to that place. [M.K.2.8]

स्वप्नवृत्तावपि त्वन्तश्चेतसा कल्पितं त्वसत् बहिश्चेतो गृहीतं स दृष्टं वैतथ्यमेतयोः ॥९॥

जाग्रदवृत्तावपि त्वन्तश्चेतसा कल्पितं त्वसत् बहिश्चेतो गृहीतं सद्युक्तं वैतथ्यमेतयोः ॥१०॥

*Svapnavṛttavapi tvantaścetasā kalpitam tvasat bahiśceto grhītam sa dr̥ṣṭm
vaitathyametayoḥ||9||*

*Jāgradaṅvṛttāvapi tvantaścetasā kalpitam tvasat bahiśceto grhītam sadyuktam
vaitathyametayoḥ||10||*

In the dream also what is imagined by the dreamer within his mind is illusory and what is cognised by him outside in the dream appears to be real . But in truth both these are known to be unreal, both belong to the dream . Similarly , in the waking state also what is imagined within by the mind is considered illusory and what is experienced outside by the mind appears to be real, but both these in fact , should be rationally held to be equally unreal. [M.K.2.10]

उभयरपि वैतथ्यं भेदानां स्थानयोर्द्यदि ।

क एतान्बुध्यते भेदान्के वै तेषां विकल्पकः ॥११॥

Ubhayarapi vaitathyam bhedanām sthānayoryadi ।

ka etānbudhyate bhedānkeṁ vai teṣām vikalpakāḥ||11||

If the objects cognised in both the condition of dream and of waking be illusory, who cognises all these illusory objects and who again imagines them. [M.K.2.11]

सुप्नमाये यथा दृष्टे गन्धर्वनगरं यथा ।

तथा विस्वमिदं दृषं वेदान्तेषु विचक्षणैः ॥३१॥

Suapnamāye yathā dr̥ṣṭe gandharvanagaraṁ yathā ।

tathā visvamidaṁ dr̥ṣam vedānteṣu vicakṣaṇaiḥ||31||

As the dream of the illusions or “ the palace city of the fairy Morgana” are seen in the sky , so is the universe viewed by the experienced *vedantins*. [M.K.2.31]

सप्रयोजनता तेषां स्वप्ने विप्रतिपद्यते ।

तस्मादाद्यन्तवत्त्वेन मिथ्यैव खलुतेस्मृताः ॥ ३२ ॥

Saprayojanatā teṣām svapne vipratipadyate ।

tasmādādyantavattvena mithyaiva khalutesmṛtāḥ|| 32 ||

The argument that they , the objects of the waking state , serve some purpose is contradicted in the dream . Therefore they are undoubtedly accepted to be illusory by the discriminate on account of their having a beginning and an end. [M.K.4.32]

सर्वे धर्मा मृषा स्वप्ने कयस्यान्तर्निदर्शनात् ।

संवृतेऽस्मिन्प्रदेशे वै भुतानां कुतः ॥ ३३ ॥

Sarve dharmā mruṣā svapne kayasyāntarnidarśanāt ।

saṁvṛte'asminpradeśe vai bhutanām kutaḥ ॥ 33 ॥

All objects cognised in the dreams are unreal because they are seen within the body. How is it possible to perceive those things that are perceived to exist there to be really within. [M.K.3.33]

न युक्तं दर्शनं गत्वा कलस्यनियमादगतौ ।

प्रतिबुधश्च वै सर्वस्तस्मिन्देसे न विद्यते ॥ ३४ ॥

Na yuktaṁ darśanaṁ gatvā kalasyaniyamādagatau ।

pratibudhaśca vai sarvastasmindeśe na vidyate ॥ 34 ॥

It is not possible for the dreamer to go to have the experiences of the dream objects on account of the limited time involved in such journeys. Again on waking up the dreamer does not find himself in the place where he dreamt himself to be. [M.K.4.34]

मित्रैः सह सम्मन्त्र्य सम्बुद्धो न प्रपद्यते ।

श्रुहितं चापि यत्किञ्चित् प्रतिबुद्धो न पश्यति ॥ ३५ ॥

Mitradyaiḥ saha sammantrya sambuddho na prapadyate ।

gṛhītaṁ cāpi yatkicīṭ pratibuddho na paśyati ॥ 35 ॥

The dreamer on being awakened realises his illusory part of the conversations he had with his companions ,etc, during his dream . Moreover he does not retain in the waking state anything which he had acquired or received in his dream. [M.K.4.35]

स्वप्ने चावस्तुकः कायः प्रिथगन्यस्य दर्शनात् ।

यथा कायस्तथा सर्वं चित्तदृश्यं वस्तुकम् ॥ ३६ ॥

*Svapne cāvastukaḥ kāyaḥ prithaganyasya darśanāt |
yathā kāyastathā sarvaṃ cittadṛśyaṃ vastukam || 36 ||*

The body which is actively participating in the dream life must necessarily be unreal since the other body of the dreamer is perceived as lying in the bed as distinctly different from his dream-body. Like the body everything cognised in the dream is certainly unreal. [M.K.4.36]

ग्रहणजागरितवत्तद्देतुः स्वप्न इष्यते ।

तद्देतुत्वात् तस्यैव सजागरितमिष्यते ॥ ३७ ॥

*Grahaṇajāgaritavattaddetuḥ svapna iṣyate |
taddetutoāttu tasyaiva sajjāgaritamīṣyate || 37 ||*

Since the experiences of objects in the dream are similar to the experience of objects in the waking state to the experience of objects in the waking state, it is thought that the waking experiences . On account of this reason , the waking experiences , which are supposed to be the cause for the dream , appear as real to the dreamer alone. [M.K.4.37]

असज्जागरिते द्रुष्ट्व स्वप्ने पश्यति तन्मयः ।

असत्स्वप्नेऽपि द्रुष्ट्व च प्रतिबुद्धो न पश्यति ॥३९ ॥

*Asajjagārite druṣṭva svapne paśyati tanmayaḥ |
asatṣvapne'api druṣṭva ca pratibuddho na paśyati ||39||*

Being deeply impressed with the unreal objects seen in the waking state, a man 'sees' these very things in his dreams as well. Moreover the unreal objects cognised in the dream are not seen again in the waking state. [Ch IV-39]

विपर्यसद्यथा जग्रदचिन्त्यन्भुतवत्स्पृशेत् ।

तथा स्वप्ने विपर्यसात् धर्मस्तत्र पश्यति ॥ ४१ ॥

*Viparyasadyathā jagradacintyanbhutavatspṛśet |
tathā svapne viparyasāt dharmastatraeva paśyati || 41 ||*

Just as one in the waking state considers as real , through false knowledge , the objects whose nature cannot be described , similarly in the dream also one perceives, through false knowledge, objects whose existence is possible only in that condition[M.K.4.41]

यथा स्वप्ने द्वयाभसं चितं चलति मायया ।

तथा जाग्रद्द्वयाभसं चितं चलति मायया ॥ ६१ ॥

Yathā swapne dvayābhasam citam calati māyayā ।

tathā jāgraddvayābhasam citam calati māyayā ॥ 61 ॥

As in dream the mind is seen to act through dillusion, producing the appearance of duality in itself, so also in the waking state the mind is seen to act through maya providing the pluralistic appearances. [M.K.4.61]

अद्वयं च द्वयाभसं चितं स्वप्ने न सम्शयः ।

अद्वयं च द्वयाभसं तथा जाग्रन्न सम्शयः ॥ ६२ ॥

Advayam ca dvayābhasam citam swapne na samśayaḥ ।

advayam ca dvayābhasam tathā jāgranna samśayaḥ ॥ 62 ॥

There is no doubt that the mind which is in fact non-dual, splits itself into many in dream . In this manner in the waking state too undoubtedly the nondual mind appears as though dual. [M.K.4.62]

स्वप्नदृक् प्रचरन् स्वप्ने दिक्षु वै दशसु स्थिताम् ।

अण्डजान् स्वेदजान्वाऽपि जीवान्पश्यति यान्सदा ॥ ६३ ॥

Svapnadṛk pracaran swapne dikṣu vai daśasu sthitām ।

aṇḍajān svedajānvā'pi jīvānpaśyati yānsadā ॥ 63 ॥

The whole variety of living beings born of eggs, moisture , etc.,alwaysseen by the dreamer when he lives his dream and goes about therein , in the ten directions , having no existence ever, apart from the mind of the dreamer. [M.K.4.63]

स्वप्नदृक्कित्तदृश्यास्ते न विद्यन्ते ततः पृथक् ।

तथातद्द्रुश्यमेवेदं स्वप्नदृक्कित्तमिष्यते ॥ ६४ ॥

*Svapnadṛkcittadr̥śyāste na vidyante tataḥ pṛthak ।
tathā tadadr̥śyamevedaṁ svapnadṛkcittamiṣyate ॥ 64 ॥*

These separative centers which are objects of the mind of the dreamer have no independent existence of their own apart from his mind . Similarly , this mind of the dreamer is admitted to be the object of perception of the dreamer only . There fore , the mind of the dreamer is not separate from the dreamer himself. [M.K.4.64]

य एष स्वप्ने महीयमानश्चरत्येष आत्मेति होवाचैतदमृतभयमेतद् ब्रह्मेति
स ह शान्तहृदयः प्रवव्राज स हाप्राप्यैव देवानेतद्भयं ददर्श तद्यद्यपीदं शरीरमन्धं
भवत्यनन्धः स भवति यदि स्नाममस्नामो नैवैषोऽस्य दोषेण दुष्यति ॥१॥

*Yaeṣa svapne mahīyamānaścaratyeṣa ātmeti
hovācaītadamṛtabhayametadbrahmeti sa ha śāntahradayaḥ pravavrāja sa
hāprāpyaīva devānetadbhayaṁ dadarśa tadyadyapīdaṁ śarīramandhaṁ
bhavatyānandhaḥ sa bhavati yadi sṁamamasnāmo nāvaiṣo'sya doṣeṇa duṣyati
॥1॥*

‘That person who goes around being worshipped in dreams is the Self. It is immortal and fearless. It is Brahman.’ Indra then left happy in mind. But even before he returned to the gods, a doubt arose in his mind: ‘A person may be blind, but when he is dreaming he is not blind. He may be lame, but when he is dreaming he is not lame. There may be some defects in his body, but his dream body is not affected by them. [K.U.8.1]

न वधेनास्य हन्यते नास्य स्नाम्येण स्नामो घ्नन्ति त्वेवैनं

विच्छादयन्तीवाप्रियवैत्तेव भवत्यपि रोदितीव नाहमत्र भोग्यं पश्यामीति ॥२॥

*Na vadhenāsyā hanyate nāsyā sṁamyēṇa sṁāmo ghnanti tvevāinaṁ
vicchādayantīvāpriyavetteva bhavatyapi roditīva nāhamatra
bhogyāṁ paśyāmīti ॥2॥*

‘The body may be killed but the other is not killed. Nor is the dream lame if the body is lame. Nevertheless, in dreams it may seem as if people are killing him; it may seem as if

people are chasing him; it may seem as if there is something unpleasant. He may even seem to be weeing. I see nothing good in this.’ [K.U.8.2]

स समिप्ताणिः पुनरेयाय तं ह प्रजापतिरुवाच मघवन्यच्छान्तहृदयः प्राब्राजीः किमिच्छन्पुनरा गम इति स
होवाच तद्यद्यपीदं भगवः शरीरमनघं भवत्यनन्धः स भवति यदि स्नाममस्त्रामो नैवैषोऽस्य दोषेण दुष्यति ॥३॥

*Sa samiptāṇiḥ punareyāya taṁ ha prajāpatiruvāca
maghavanyacchāntahṛdayaḥ prāvrajīḥ kimicchanpunarā gama iti sa hovāca
tadyadyapīdam*

*bhagavaḥ śarīramanadhaṁ bhavatyānandhaḥ sa bhavati yadi
srāmamasrāmo naivaiṣo’sya doṣeṇa duṣyati* ॥3॥

Indra returned with fuel in hand . Prajapati asked : ‘ Indra, you left happy in mind. What has made you come back?’ Indra replied : ‘Lord, a person may be blind , but when he is dreaming he is not blind . He may be lame . There may be some defects in his body , but his dream body is not affected by them.’ [K.U.8.3]

स यत्रैतत्स्वप्न्यया चरति ते हास्य लोकाः तदुतेव महाराजो भवति उतेव महाब्राह्मणः उतेवोच्चावचं निगच्छति
स यथा महाराजो जानपदान् गृह्णित्वा स्वे जनपदे यथाकामं परिवर्तेत एवमेवैष एतत्प्रणान्

गृह्णित्वा स्वे शरीरे यथाकामं परिवर्तते ॥ १८ ॥

*Sa yatraitatsvapnyayā carati te hāsya lokāḥ taduteva mahārājo bhavati uteva
mahābrāhmaṇaḥ utevoccāvacaṁ nigacchati sa yathā mahārājo jānapadān
gṛhitvā sve janapade yathākāmaṁ parivarteta evamevaiṣa etatpraṇān
gṛhitvā sve śarīre yathākāmaṁ paribartate* ॥ 18॥

“ When the self thus stays in the dream state, these are the results of its past work .It then becomes either a great king as it were or a woethy Brahmana as it were or reaches high and law states as it were. As a great king may take his citizens and go about at will in his own kingdom, so does this self thus take the organs and go about at will in its own body. [B.U.2.18]

तस्य वा एतस्य पुरुषस्य द्वे एव स्थाने भवतः इदं च परलोकस्थानं च
सन्ध्यं तृतीयं स्वप्नस्थानं तस्मिन् सन्ध्यं स्थाने तिष्ठत्रेते उभे स्थाने
पस्यति इदं च परलोकस्थानं च ।

अथ यथाक्रमोऽयं परलोकस्थाने भवति तमाक्रममाक्रम्यो
भयान्पाप्मन आनन्दांश्च पश्यति स यत्र प्रस्वपिति अस्य लोकस्य सर्वगतो
मात्रामपादाय स्वयं विहत्य स्वयं निर्माय स्वेन भासा स्वेन ज्योतिषा
प्रस्वपिति अत्रायं पुरुषः स्वयं ज्योतिर्भवति ॥ ९ ॥

*Tasya vā etasya puruṣasya dve eva sthāne bhavataḥ idaṁ ca paralokasthānaṁ ca
sandhyam tṛtīyam svapnasthanaṁ tasmin sandhyam sthāne
tiṣṭhatrete ubhe sthānepasyati idaṁ ca paralokasthānaṁ ca ।
atha yathākramo'yaṁ paralokasthāne bhavatatamākramamākramyo
bhayānpāpmana ānandāṁśca paśyati sa yatra prasvapitiasya lokasya
sarvavato mātrāmapādāya svayam vihatya svayam nirmāya svenabhāsā svena
jyotiṣā prasvapiti atrāyam puruṣaḥ svayam jyotirbhabati ॥ 9 ॥*

This entity (the individual self) mentioned above has only two places this life and the next life . The dream state which is the third is at the junction (of the two). Staying in that places at the junction it sees both places this life and the next. Now what ever support it may have for the next life It betakes itself to that and sees both miseries.and joys.When it dreams it takes away a little of this all sustaining body, itself makes (the body) insensible and itself creates (a dream body) and dreams through its own radiance (illumined) by its own light. In this state this entity (the self) itself becomes the light.
[B.U.3.9]

तदेते श्लोका भवन्ति स्वप्नेन शरिरमभिप्रहत्या सुप्तः सुप्तानभिचाकशिति ।

शुक्रमादाय पुनरैति स्थानं हिरण्मयः पुरुष एकहंसः ॥ ११ ॥

*Tadete ślokā bhavanti svapnena śariramabhiprahatyā
suptaḥ suptānabhicākaṣiti śukramādāya punaraiti sthānaṁ
hiraṇmayāḥ puruṣa ekahaṁsaḥ ॥ 11 ॥*

‘Regarding this there are the follow mantra verses. The effulgent, infinite entity that travels alone makes the body inertthrough dream and itself awake and taking a luminous bit of the organs it witnesses thinks that are dormant. Again it comes to the waking state.

[B.U.3.11]

स्वप्नान्त उच्चावचमियमानो रूपाणि देवः कुरुते बहूनि ।

उतेव स्त्रीभिः सह मोदमानो जक्षदुतेबापि भयानि पश्यन् ॥१३॥

*Svapnānta uccāvachamiyamāno rupāṇi devaḥ kurute bahuni |
uteva strībhiḥ saha modamāno jakṣadutebāpi bhayāni paśyan||13||*

In dream the effulgent entity attaining higher and lower states, creates manifold forms (as impressions) : It seems to rejoice in the company of women, or laugh or even see terrible objects. [B.U.3.13]

आराममस्य पश्यन्ति न तं पश्यति कश्चन इति ॥

तं नायतं बोधोयेदित्याहुः ।

दुर्भिषज्यं हास्मै भवति यमेष न प्रतिपद्यते ।

अथो खलाहुः जागरिते देश एवास्मैष इति यानि ह्येव जाग्रत्पश्यति तानि सुप्त इति

अत्रायं पुरुषः स्ययं ज्योतिर्भवति सोऽहं भगवते सहस्रम् ददामि अत उर्ध्वं विमोक्ष्याय ब्रूहि ॥१४॥

Arāmamasya paśyanti na taṁ paśyati kaścana iti||

Taṁ nāyataṁ bodhoyedityāhuḥ |

durbhiṣajyaṁ hāsmāi bhavati yameṣa napratipadyate |

*atho khalāhuḥ jāgarite deśa evāsmāiṣa iti yāni hyeva jāgratpaśyatitāni supta
iti*

atrāyaṁ puruṣaḥ syayaṁ jyotirbhavati so'haṁ bhagavate sahastram

dadāmi ata urdhvaṁ bimokṣyāya brūhiti||14||

“People see (only) its (fanciful) play but none sees it.” They say,” Do not rouse a man suddenly. (For) if it does not get back to the (proper) organ , the body is difficult to doctor.On the other hand others say that the waking state itself is its dream state,for one sees in dream only those object s that he sees in the waking state. (It is not so). In the

dream state this infinite entity itself becomes the lioght.” I give you a thousand (cows) , venerable sir. Plese tell me beyond this about liberation.[B.U.3.14]

स वा एष एतस्मिन्सम्प्रसादे रत्वा चरित्वा ह्यैव पुण्यं च पापं च पुनः
प्रतिन्यायं प्रतियोन्याद्रवति स्वप्नायैव स यत्तत्र
किञ्चित्पश्यत्यनन्वागतस्तेन भवति असङ्गो ह्ययं पुरुष इति
एवमेवैतद्याज्ञवल्क्य सोऽहं भगबते सहरत्रं ददामि अत उर्ध्वं
बिमोक्षायैव ब्रुहीति ॥१५॥

*Sa vā eṣa etasminsamprasāde ratvā caritvā ddaṣṭaiiva puṇyam ca pāpam ca
punaḥ
pratinyāyam pratiyonyādravati svapnāyaiva sa yattatra
kiñcitpaśyatyananvāgatastena bhavati asaṅgo hyayam puruṣa iti
evamevaitadyājñavalkya so'ham bhagabate sahartram dadāmi ata urdhvam
bimokṣāyaiva bruhīti||15||*

‘After rejoicing and wandering (in dream) and merely seeing (the result of) good and evil that entity (says) in the state of profound sleep, and hastens back in a reverse way just to its previous state, the dream. It is unaffected by whatever it sees in that state, for this infinite entity is unattached.’ ‘It is indeed so, venerable sir. I give you a thousand (cows) .Please tell me beyond this about libaration itself.’ [B.U.3.15]

तद्यथा महामत्स्य उभे कुलेऽनुसञ्चरति पुर्वं चपरं च एवमेवायं
पुरुषएताबुभावन्तावनुसञ्चरति स्वप्नन्तं च बुद्धान्तं च ॥ १८ ॥

*Tadyathā mahāmatsya ubhe kule'nusañcarati purvam caparam ca ebamevāyam
puruṣaetābubhāvantaṅvanusañcarati svapnantam ca budghāntam ca|| 18||*
‘As a large fish swims alternately to both the banks (of a river), eastern and western, even so does this infinite entity move alternately to both thesestates – those of dream and waking. [B.U.3.18]

ता वा अस्तैता हिता नाम नाडयो यथा केशः सहरत्रधा भिर्नास्तावताणिम्ना
 तिष्ठन्ति शुक्लस्य नीलस्य पिङ्गलस्य हरितस्य लोहितस्य पुर्णं अथ यत्रैनं
 घ्नन्तिव जिनन्तिव हस्तिव विच्छाययति गर्त्यमिवपतति यदेव
 जाग्रद्भयं पश्यति तदत्राविद्यया मन्यते अथ यत्र देव इव राजेव
 अहमेवेदं सर्वऽस्मिति मन्यते सोऽस्य परमो लोकः ॥२० ॥

*Tā vā astaitā hitā nāma nāḍayo yathā keśaḥ saharatradhā
 bhirnastāvātāṇimnā tiṣṭhanti śuklasya nīlasya piṅgalasya haritasya
 lohitasya purṇa atha yatrainam ghnantiva jinantiva hastiva vicchāyayati
 gartyamiva patati yadeva
 jāgradbhayaṁ paśyati tadatrāvidyayā manyate atha yatra deva iva rājeva
 ahamevedaṁ sarva'smiti manyate so'sya paramo lokaḥ ॥20॥*

In a man are those nerves called Hita, which are as fine as a hair split in to a thousand parts and full of white, blue brown, green and red serums. Now when he feels as if somebody was killing him, or overpowered him, or an elephant was cheating him, or he was falling into a pit- (in short) fancies at the time through ignorance what ever fears he has experienced in the waking state, (that is dream). So also when he is a god, as it were, or a king, as it were, or he thinks, 'I am this universe and comprise all' This last is his highest state. [B.U.3.20]

स वा एष एतास्मिन्स्वप्नान्ते रत्वा चरित्वा द्वैष्टैवा पुण्यं च पापं च पुनः
 प्रतिन्यायं प्रतियोन्याद्रवति बुद्धान्ता यैव ॥३४ ॥

*Sa vā eṣa etāsmiṁsvapnānte ratvā caritvā ddaṣṭaiivā puṇyaṁ ca pāpaṁ ca
 punaḥ pratinyāyaṁ pratiyonyādravati budghāntā yaiva ॥34॥*
 This same individual self after rejoicing and wandering and merely seeing (the results of) good and evil in the dream state, hastens back in a reverse way just to its previous state – that of waking. [B.U.3.34]

तदभावो नाडीषु तच्छु तेः आत्मनि च ॥७ ॥

Tadabhāvo nāḍīṣu tacchu teḥ ātmani ca ॥7॥

The absence of that (dreaming, i.e. dream less sleep takes place) in the nerves and in the self as it is known from the sruti [B.U.4.7]

In summary the state of dream स्वप्न(*svapna*) is very much axim to wakeful state. There are multiplicities of thoughts, experience of emotions, pain & pleasure, etc. in both these states. The scriptures bring out the differences in terms of grossness स्थूलof wakeful state and says that dream is subtle state of consciousness (सुक्ष्म); alsoजाग्रतhasexternalised consciousness(बहिष्प्रज्ञा) and dream is inernalised state of consciousness(अन्तःप्रज्ञा).

2.3 SUSUPTI (THE DEEP SLEEP)

यत्र सुप्तो न कञ्चन कामं कामयते न कञ्चन स्वप्नं पश्यति तत् शुषुप्तम् ।

शुषुप्तस्थान एकीभूतः प्रज्ञानधन एवा नन्दमयो ह्यानन्दभुक् चेतोमुखः प्रज्ञास्मृतीयः पादः ॥ ५ ॥

*Yatra supto na kañcana kāmam kāmayate na kañcana
svapnam paśyati tat śusuptam ।*

*śusuptasthāna ekībhuṭaḥ prajñānadhana ebā nandamayo
hyānandabhuk cetomukhaḥ prajñasmṛtīyaḥ pādaḥ ॥ 5 ॥*

That is the state of deep-sleep where in the sleeper does not desire any objects, nor does he see any problem . The third quarter (Pada) is the Prajnaya whose sphere is deep-sleep in whome all (experiences) become unified or undifferentiated, who is verily a homogenous mass of consciousness entire, and who is the very gateway for the projection of consciousness into the other two planes of consciousness the dream and the waking. [M.K.1.5]

निगृहितस्य मनसो निर्बिकल्पस्य धिमतः ।

प्रचारः स तु बिज्ञेयः सुषुप्तेऽन्यो न तत्समः ॥ ३४ ॥

*Nigr̥hitasya manaso nirbikalpasya dhimataḥ ।
pracāraḥ sa tu bijñeyaḥ suṣupte'nyo na tatsamaḥ ॥ 34 ॥*

The behavior that the mind has when it is under control, free from all ideation, and full of discrimination, should be particularly noted. The behavior of our mind in deep sleep is different and is not similar to that (of the control mind). [M.K.3.34]

तद्यत्रैतत्सुप्तः समस्तः सम्प्रसन्नः स्वप्नं न विजानात्यासु तदा नाडीषु
सूप्तो भवति तं न काश्चन पाप्मा स्पृशति तेजसा हि तदा सम्पन्नो भवति ॥३॥

*Tadyatraitatsuptaḥ samastaḥ samprasannaḥ svapnaṁ na vijānātyāsu tadā
nāḍīṣu srpto bhavati taṁ na kāścana pāpmā sprśati tejasā hi tadā sampanno
bhavati ॥3॥*

When a person is sound asleep, all his organs are inactive and quiet. He is free from all worries, and he does not have any dreams. The organs then disappear into the veins. No sin can affect him then, for the rays of the sun have surrounded him. [C.U.8.3]

Deep sleep quietens all organs and provides deep rest.

यदा तु मनसि क्लान्ते कर्मात्मानः क्लमान्विताः ।
विषयेभ्यो निवर्तन्ते तदा स्वपिति मनवः ।३५।

*Yadā tu manasi klānte karmātmānaḥ klamānvitāḥ ।
viṣayebhyo nivartante tadā svapiti manavaḥ ।35।*

When the mind including sensory and motor organs is exhausted and they dissociate themselves from their objects, then the individual sleeps. [C.S.10.35]

When the mind (as well as the soul) gets exhausted or become inactive and the sensory and motor organs become inactive then the individual gets sleep. Sleep is nothing but the location of the mind in a place unconnected with sensory or motor organs.

तद्यत्रैतसुप्तः सम्प्रसत्रः सम्प्रसन्नः स्वप्नं न विजानात्येष आत्मेति
 होवाचैतदमृतमभयमेतद् ब्रह्मेति स ह शान्तहृदयः प्रवब्राज स
 हाप्राप्यैव देवानेतद्भयं ददर्श नाह खल्वयमेवं सम्प्रत्यात्मानं
 जानात्ययमहमस्मीति नो एवेमानि भूतानि विनाशमेवापीतो भवति
 नाहमत्र भोग्यं पश्यामीति ॥१॥

*Tadyatraitasuptaḥ samprasatraḥ samprasannaḥ svapnaṁ na vijānātyeṣa
 ātmeti hovācaitadamṛtamabhayametad brahmeti sa ha śāntaḥṛdayaḥ
 pravavrāja sa hāprāpyaiva devānetadbhayaṁ dadarśa nāha khalvayamevaṁ
 sampratyātmānaṁ jānātyayamahamasmīti no evemāni bhūtāni
 vināśamevāpīto bhavati
 nāhamatra bhogyaṁ paśyāmīti ॥1॥*

Prajapati said : when the self is sleeping, with all its organs are inactive, it is free from worry and has no dreams. This is what the the self is like [i.e. it is spotless]. It is immortal and fearless. It is Brahman.’ Indra left happy in mind. But even before he got back to the gods, he was troubled by a doubt: when the self is in deep sleep, it is not able to recognize itself as “Iam so-and-so” as it does when it is awake. Not only that, it does not even recognize beings around it. It is as if the self has been obliterated. I donot see that anything good will come from this.’ [C.U.8.1]

स समित्पाणिः पुनरेयाय तं ह प्रजपतिरुवाच मघवन्यच्छान्तहृदयः
 प्राब्राजीः किमिच्छन्पुनरागम इति स होवाच नाह खल्वयं भगव एवं
 सम्प्रत्यात्मानं जानात्ययमहमस्मीति नो एवेमानि भुतानि विनाशमेवापीतो
 भवति नाहमत्र भोग्यं पश्यामीति ॥२॥

*Sa samitpāṇiḥ punareyāya taṁ ha prajapatiruvāca
 maghavanyacchāntaḥṛdayaḥ prāvrajīḥ kimicchanpunarāgama iti sa hovāca
 nāha khalvayaṁ bhagava evaṁ sampratyātmānaṁ jānātyayamahamasmīti no
 evemāni bhutāni vināśamevāpīto bhavati nāhamatra bhogyaṁ paśyāmīti ॥2॥*
 Indra returned with fuel in hand. Prajapati asked: ‘Indra, you left happy in mind. What has made you come back?’ Indra replied: ‘Lord, when the self is in deep sleep, it is not able to recognize itself as “I am so-and-so,” as it does when it is awake. Not only that, it

does not even recognize beings around it. It is as if the self has been obliterated. I donot see anything good coming from this.’ [C.U.8.2]

स होवाचाजातशत्रु यत्रैष एतत्सुप्तोऽभुद्य एष बि ज्ञान भयः पुरुषः
तदेषां प्राणानां विज्ञानेन विज्ञानमादाय य एषोऽन्तर्हृदय आकाशस्तस्मिञ्छेते
तानि यदा गृहात्यथ हैतत्पुरुसः स्वपिति नाम तदंगृहित एव प्राणो भवति
गृहीता वाक् गृहीतं चक्षुः गृहीतं श्रोत्रम् गृहीतं मनः ॥१७॥

*Sa hovācājātaśatru yatraiṣa etatsupto 'bhudya eṣa bi jñāna bhayaḥ puruṣaḥ
tadeṣāṃ prāṇānāṃ vijñānena vijñānamādāya ya eṣo 'ntahrudaya
ākāśastasmicchete tāni yadā gṛhātyatha haitapturusaḥ svapiti nāma
tadaṅgrhita eba prāṇo bhavati gṛhītā vāk gṛhītāṃ cakṣuḥ gṛhītāṃ śrotram
gṛhītāṃ manaḥ ॥17॥*

Ajatasatru said ‘ When this self that is associated with the intelect was thus asleep , it withdraws by its specialised knowledge the functions of the organs and lies in the supreme self that is within the heart. When it withdraws the organs it has the name of swapiti. Then verily the nose is withdrawn, the eye is withdrawn , the organ of speech is withdrawn, the eye is withdrawn, the ear is withdrawn, and the mind is withdrawn. [B.U.1.17]

अथ यदा सुषुप्तो भवति यदा न कस्यचन बेद हिता नाम नाड्यो दूससति
सहस्राणि हृदयासुरीततमभिप्रतिष्ठन्ते ताभिः प्रत्यवसृप्य पुरीतति शेते
स यथा कुमारो वा महाराजो वा महाब्राह्मणो
वातिघ्रीमानन्दस्य गत्वा शयीत एवमेवैष एतच्छेते ॥१९॥

*Atha yadā susupto bhavati yadā na kasyacana beda hitā nāma nādayo
dūāsaptati sahasrāṇi hrudayāpturitātamabhipratiṣṭhante tābhiḥ
pratyavasrupya purītati śete sa yathākumāro vā mahārājo vā mahābrāhmaṇo
vātighrīmānandasya gatvā śayīta ebamebaiṣa etacchete ॥19॥*

Again when the self becomes fast asleep when it is not aware of anything it returns to the body along the seventytwo thousand nerves called Hita, which brach off from the heart to

all parts of the body or a great king or a worthy Brahman lives having reached the very limit of bliss so does the self remain. [B.U.1.19]

In deep sleep there is rest and entry into *Pranamaya kosa*.

तद्यथास्मिन्नाकाशे श्येनो वा सुपर्णो वा विपरिपत्य श्रान्तः संहृत्य पक्ष्यौ
संलययैव ध्रियते एवमेवायं पुरुष एतस्मा अन्ताय धावति यत्र सुप्तो
न कञ्चन कामं कामयते नो कञ्चन स्वप्नं पश्यति । ॥ १९ ॥

*Tadyathāsmitrākāśe śyeno vā suparṇo vā viparipatya śrāntaḥ saṁhatya
pakṣyau saṁlayāyauva dhriyate evamevāyaṁ puruṣa etasmā antāya dhāvati
yatra supto na kañcana kāmam kāmayate no kañcana svapnam paśyati* ॥

19||

‘As a hawk or a falcon , flying variously in the sky , is exhausted , and the stretching its wings directs itself towards its nest only even so does this infinite entity hasten to the state where , falling asleep, it seeks no desire and sees no dream. [B.U.2.19]

When fatigued, the body goes to deep sleep.

सलिल एको द्रष्टाद्वैतो भवति एष ब्रह्मलोकः सम्रा एति हैनमनुशशास
यज्ञवल्क्यः एषास्य परमा गतिः एषास्य परमा सम्पत् एषोऽस्य परमो लोकः
एषोऽस्य परम आनन्दः एतस्यैवानन्दस्यान्यानि भुतानि मात्रामुप जिवन्ति ॥ ३२ ॥

*Salila eko draṣṭādvaito bhavati eṣa brahmalokaḥ samrā eti hainamanuśāśāsa
yajñavalkyaḥ eṣāsyā paramā gatiḥ eṣāsyā paramā sampat eṣo’syā paramo
lokaḥ eṣo’syā parama ānandaḥ etasyaivānandasyānyāni bhutāni mātrāmupa
jivanti* ॥ 32 ॥

It becomes (in deep sleep serene) like water, one, the seer and free from duality. This is the world that is Brahman , O Emperor’. Thus did Yajnavalkya teach Janaka;’ this is its highest goal, this is its highest glory, this is its highest world this is its highest bliss all other being live on a particle of this very bliss. [B.U.2.32]

It is a state of no multiplicities of thought.

भूमा संप्रसादादध्युपदेशात् ॥८॥

Bhūmāsamprasādādadyupadeśāt ॥8॥

The bhuman (is brahman) because it is taught after the state of deep-sleep (i.e. after prana or the vital force, which alone functions even in that state). [B.S.1.8]

This state, though unconscious is in the form of *Prana*.

सुषुप्त्युत्क्रान्त्योर्भेदेन ॥४२॥

Suṣuptyutkrāntyorbhedena ॥42॥

Because of the supreme self being shown as different (from the individual soul) in the states of deep-sleep and death. [B.S.1.42]

There are differences differences between individuals in *Susupti*.

स्वप्ययसंपत्योरन्यतरापेक्षम् आबिष्कृतं हि ॥ १६ ॥

Swapyayasampatyoranyatarāpekṣam ābiṣkṛtaṁ hi ॥ 16॥

(The declaration of absence of all cognition is made) having in view either of the two states viz deep-sleep and absolute union (with Brahman) for this is made clear (by the scriptures). [B.S.2.16]

अत्र पितापिता भवति मातामाता लोका अलोकाः देवा अदेवाः ।

अत्र स्तेनोऽस्तेनो भवति भ्रुणहाऽभ्रुणहा

चान्डालोऽचान्डालः पौलोकसोऽपौलोकसः श्रमणोऽश्रमणः तापसोऽतापसः

अनन्वागतं पुण्येनानन्वागतं

पपेन तीर्णो हि तदं सर्वाञ्छोकाहृदयस्य भवति ॥२२॥

Atrapitāpitābhavati mātāmātā lokā alokāḥ devā adevāḥ ।

atra steno'asteno bhavatibhruṇahā'bhruṇahā

cāṇḍālo'cāṇḍālah paūlokso'paūlokṣaḥ śramaṇo'śramaṇaḥ tāpaso'tāpasaḥ

ananvāgataṁ puṇyenānanvāgataṁ

papena tīrṇo hi tadaṁ sarvāñchokāhṛdayasya bhavati ॥22॥

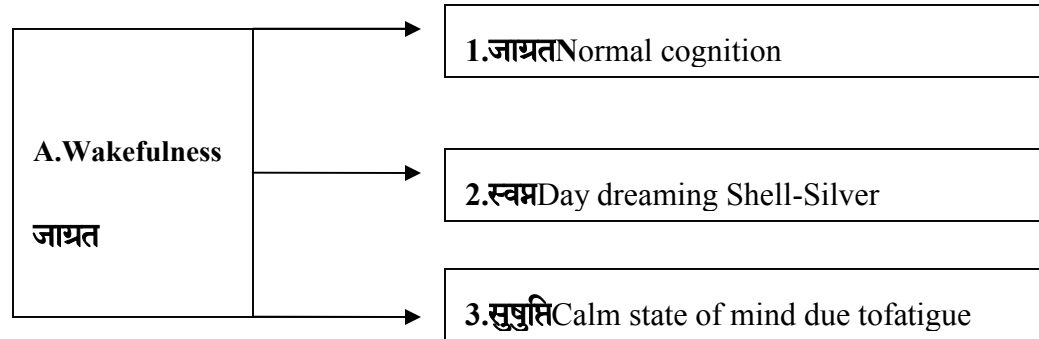
In this state a father is no father, a mother no mother, worlds no worlds, the gods no gods, the *Vedas* no *Vedas*. In this state a thief is no thief, the killer of a noble *Brahman* no

killer, a *Candala*, no *Candala*, a *Pulakasa*, no *Pulakasa*, a monk no monk, a hermit no hermit. (This form of his) is untouched by good work and untouched by evil work, for he is then beyond all the woes of his heart (intellect). [B.U.4.3.22]

This is a state in which all responsibilities, pain & pleasure of *Jagrata&Svapna* have been frozen to its seed form. It is called **कारण**, causal state designated as *Anandamaya Kosa*. Trifold process of cognition (ssee-seeing-seen tuple) is frozen. But still it is full of our personality traits in the form of *vasanas* and *samskaras* (inputs in the subconscious mind). It is called a state of unconsciousness.

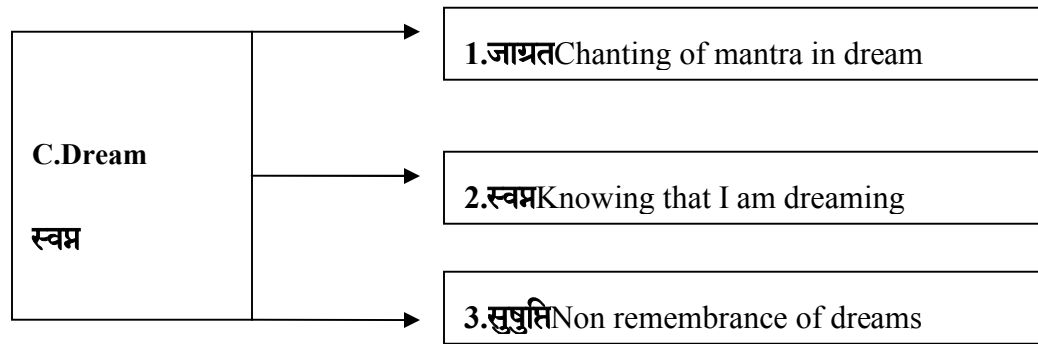
fatigue and the like is waking sleep. Similarly, the getting of a mantra in a dream is dream-waking the knowing ‘I am dreaming’ in the dream state is dream-dream; when the experience cannot be retold in the subsequent waking state it is dream sleep. In the same way, even in deep sleep the function of satva in the form of joy is waking-sleep; after that there is memory ‘I slept happily’. In the same condition, the function of the rajās is sleep-dream. After that only there is memory, “I sleep painfully”. In the same state in the function of tamas is sleep-sleep. After that the memory is of the form “I slept in deep non-knowing”. All this is clearly explained in the (yoga) Vasistha and the nectar-like Vartika. [S.B.8]

In summary three types of जाग्रत, स्वप्न, and सुषुप्ति (*susupti*) are distinguished in the scriptures mentioned below. Let us discuss three types of *Jagrat*.

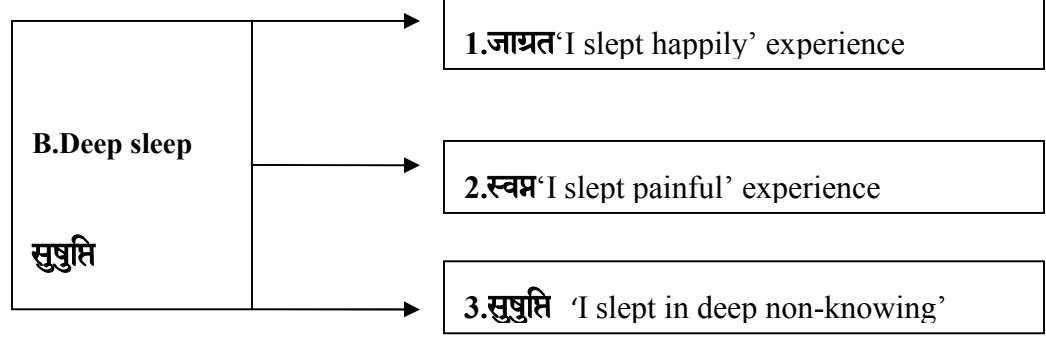


There are three types of dreams according to *Yoga vasista* as the the spectrum of dream is limitless. It encompasses all the conscious, subconscious, unconscious, and super conscious experiences and their timeless assimilation in the eternal flow of life. The three types of dreams as mentioned in *Yoga Vasista* are of three types and they are

1. Subconscious stage of the dream: The dreams experienced in this stage mostly pertain to the subconscious effects and activities, imaginations, and expressions of suppressed desires and emotions.
2. Unconscious stage of dream: The dreams of this stage are expressions of the unconscious mind with a possible linkage with the hidden intellect. The dreams that lead to the flashes of creative ideas and scientific discoveries, etc are experienced in this stage.
3. Conscious stage of dream: In this stage, the individual consciousness enters the subtlest, the innermost, and the divine core of life. Realization of the soul and its absolute linkage with the cosmic consciousness is attained in this stage. Divine messages are received in such dreams that inspire sublime transmutation of the individual self.



The deep sleep with enslaved *tamas* while second is *rajas* predominant सुषुप्ति and third is *satvic susupti*.



2.3.2 CLASSIFICATION OF SLEEP ACCORDING TO AYURVEDA

तमोभवा श्लेष्मसमुद्भवा च मनःशरीरश्रमसंभवा च ।

आगन्तुकी व्याध्यनुवर्तिनी च रात्रिस्वभावप्रभवा च निद्रा ॥ ५८ ॥

Tamobhavā śleṣmasamudbhavā ca manaḥśarīraśramasambhavā ca | āgantukī vyādhynuvartinī ca rātrisvabhāvoprabhavā ca nidrā || 58||

Sleep is the following types:-

1. Caused by *tamas*;
2. Caused by (vitiated) *kapha*;
3. Caused by mental exhaustion;
4. Caused by physical exhaustion;
5. *Agantuka* or indicative of bad prognosis leading to imminent death;
6. Caused as complication of other diseases like *samnipata jvara*, etc.; and
7. Caused by the very nature of the night (physiological sleep). [C.S.10.58]

2.4 OTHER ASPECTS OF SLEEP

2.4.1 EFFECT OF SLEEP

निद्रायत्तं सुखं दुःखं पुष्टिः काश्यं बलाबलाम् ।

बुधता क्लीवता ज्ञानमज्ञानं जीवितं न च ॥३६॥

आकालेऽतिप्रसङ्गच्च न च निद्रा निषेविता ।

सुखायुषी पराकुर्यात् कालरात्रिरिवापरा ॥३७॥

सैव युक्ता पुनर्युक्ते निद्रा देहं सुखायुषा ।

पुरुषं योगिनं सिद्ध्या सत्या बुद्धिरिवागता ॥३८॥

Nidrāyattam sukham duḥkham puṣṭiḥ kāśyaṁ balābalām |

vrūṣatā klīvātā jñānamajñānam jīvitam na ca ||36||

Akāle'tiprasaṅgacca na ca nidrā niṣevitā |

sukhāyuṣī parākuryāt kālarātririvāparā ||37||

Sāva yuktā punaryuṅke nidrā deham sukhāyuṣā |

puruṣam yoginam siddhyā satyā buddhirivāgatā ||38||

Happiness, misery, nourishment, emaciation, strength, weakness, virility, knowledge, ignorance, life and death – all these occur depending on the proper or improper sleep.[C.S. 10.36-38]

Like the night of destructions, untimely and excessive sleep and prolonged vigil take away both happiness and longevity. The same sleep, if properly enjoyed brings about happiness and longevity in human beings as the real knowledge brings about *Siddhi* (spiritual power) in a *yogin*.

2.4.2 INDICATIONS OF DAY SLEEP

गीताध्ययनमद्यस्त्रीकर्मभाराध्वकर्षिताः ।

आजीर्णिनः क्षताः क्षीणा वृद्धा बालास्तथाऽबलाः ॥३९॥

त्रुष्णातीसारशूलार्ताः श्वासिनो हिक्किनः क्रुशाः ।

पतिताभिहतोन्मत्ताः क्लान्ता यानप्रजागरैः ॥४०॥

क्रोधशोकभयक्लान्ता दिवास्वप्नोचितास्च ये ।

सर्व अते दिवास्वप्नं सेवेरन् सार्वकालिकम् ॥४१॥

धातुसाम्यं तथा ह्येषं बलं चाप्युपजायते ।

श्लेष्मा पुष्णाति चाङ्गानि स्थैर्यं भवति चायुषः ॥४२॥

ग्रीष्मे त्वादानरुक्षाणां वर्धमाने च मारुते ।

रात्रीणां चातिसंक्षेपाहिवास्वप्नः प्रशस्यते ॥४३॥

*Gītādhyayanamadyastrīkarmabhārādhvakarśitāḥ |
ājīrṇinaḥ kṣatāḥ kṣīṇā vruddhā bālāstathā'balāḥ ॥39॥*

*Truṣṇātīsārasūlārtāḥ śvāsino hikkinaḥ kruśāḥ |
patitābhihatonmattāḥ klāntā yānaprajāgaraīḥ ॥40॥*

*Krodhaśokabhayaklāntā divāsvapnocitāscā ye |
sarva ate divāsvapnaṁ severan sārva-kālikam ॥41॥*

*Dhātusāmyam tathā hyeṣaṁ balaṁ cāpyupajāyate |
śleṣmā puṣṇāti cāṅgāni sthātryaṁ bhavati cāyusaḥ ॥42॥*

*Grīṣme tvādānarukṣāṇāṁ vardhamāne ca mārute |
rātrīṇāṁ cātisaṅkṣepāhivāsvapnaḥ praśasyate ॥43॥*

Sleeping during day time in all seasons is prescribed for those who are exhausted by singing, study, alcoholic drinks, sexual acts, elimination therapy, carrying heavy eight, walking long distance; those suffering from phthisis, wasting thirst, diarrhoea, colic pain, dysonea, hiccup, insanity, those wh are too old, too young, weak and emaciated; those injured by fall and assault, those exhausted by journey by a vehicle, vigil, anger, grief and fear, and those who are accustomed to day sleep. By this the equilibrium of *dhatu*s and strength are maintained and the *kapha* nourishes the organs and ensures longevity.

In summer season nights become shorter and vata gets aggravated in the body due to the absorption of fluid (*adana*). Therefore, during this season, sleep during day time is prescribed for all. [C.S.10.39-43]

2.4.3 CONTRA-INDICATIONS OF DAY SLEEP

ग्रीष्मवर्ज्येषु कालेषु दिव्वस्वप्नात् प्रकुप्यतः ।

श्लेष्मपित्ते दिवास्वप्नस्तस्मात्तेषु न शस्यते ॥४४ ॥

मेदस्विनः स्नेहनित्याः श्लेष्मलाः श्लेष्मरोगिणः ।

दूषीविषातार्ताश्च दिवा न शयीरन् कदाचन ॥४५ ॥

हलीमकः शिरःशूलं स्तैमित्यं गुरुगात्रता ।

अङ्गमर्दोऽग्निनाशश्च प्रलेपो हृदयस्य च ॥४६ ॥

शोफारोचकहृल्लासपीनसार्धावभेदकाः ।

कोठारुः पिडकाः कण्डूस्तन्द्रा कासो गलामयाः ॥४७ ॥

स्मृतिबुद्धिप्रमोहश्च संरोधः स्रोतसां ज्वरः ।

इन्द्रियाणामसामर्थ्यं विषवेगप्रवर्तर्धनम् ॥४८ ॥

भवेन्नृणां दिवास्वप्नस्याहितस्य निषेवणात् ।

तस्माद्धिताहितं स्वप्नं बुद्धवा स्वप्यात् सुखं बुधः ॥४९ ॥

*Grīṣmavarjyeṣu kāleṣu divvasvapnāt prakupyataḥ |
śleṣmapitte divāsvapnastasmātteṣu na śasyate ॥44॥*

*Medasvinaḥ snehanityāḥ śleṣmlāḥ śleṣmarogīṇaḥ |
dūṣīviṣārtāśca divā na śayīran kadācana ॥45॥*

*Halīmakāḥ śiraḥśūlāṁ stāimityaṁ gurugātrataḥ |
aṅgamardo'gnināśaśca pralepo hradayasya ca ॥46॥*

*Sophārocakahrallāsapīnasārdhāvabhedakāḥ |
koṭhāruḥ piḍakāḥ kaṇḍūstandrā kāso galāmayāḥ ॥47॥*

*Smrutibuddhipramohaśca saṁrodhaḥ strotasāṁ jvaraḥ |
indriyāṅāmasāmarthyāṁ viṣavegapravartardhanam ॥48॥*

Bhavenṅṅāṁ divāsvapnasyāhitasya niṣevaṅāt |

tasmāddhitāhitaṁ svapnaṁ bud dhavā svapyāt sukhaṁ budhaḥ ॥49॥

Sleeping during the day time in the seasons other than summer is not advisable as it causes vitiation of *kapha* and *pitta*. Persons with excessive fat, those who addicted to

taking unctuous substance, those with *slaismika* constitution, those suffering from diseases, due to the vitiation of *kapha* and those suffering from dusivias (artificial poisoning) should never sleep during day time. If one violates the prescriptions regarding sleep during the day time, he would subject himself to *halimaka* (serious type of jaundice), headache, timidness, heaviness of the body, malaise, loss of digestive power, hridayopalepa (a feeling as if phlegm adhered to the heart), oedema, anorexia, nausea, rhinitis, hemicrania, urticaria, eruption, abscess, pruitus, drowsiness, coughing, disease of the throat, impairment of the memory and intelligence, obstruction of the circulating channels of the body, fever, weakness of sensory and motor organs and enhancement of the toxic effects of the artificial poisons. So one should keep in view the merits and demerits of sleep in various seasons and situations in order that it may bring happiness to him.[C.S.10.44-49]

2.4.4 EFFECT OF NIGHT AWAKENING

रात्रौ जागरणं रुक्षं स्निग्धं प्रस्वपनं दिवा ।

अरुक्षमनभिष्यन्दि त्वासीनप्रचलायितम् ॥५० ॥

Rātrau jāgaraṇaṁ rukṣaṁ snigdhaṁ prasvapanaṁ divā

arukṣamanabhiṣyandi tvāsīnapracalāyitam ॥50॥

Vigil during night causes roughness in the body; sleep during day time causes unctuousness and dosing in sitting posture does neither cause roughness nor unctuousness. [C.S.10.50]

2.4.5 THE ROLE OF SLEEP IN OBESITY

देहवृत्तौ यथाऽऽहारस्तथा स्वप्नः सुखो मतः ।

स्वप्नाहारसमुत्थे च स्थौल्यकार्श्ये विशेषतः ॥५५॥

*Dehavṛtau yathā'āhārastathā svapnaḥ sukho mataḥ |
svapnāhārasamutthe ca sthauilyakārsye viśeṣataḥ ||51||*

Like proper diet, proper sleep is also essential for maintaining of the body. Corpulence and emaciation are specially conditioned by proper or improper sleep and diet.

[C.S.10.51]

2.4.6 CAUSES OF INSOMNIA

कायस्य शिरसश्चैव विरेकश्छर्दनं भयम् ।

चिन्ता क्रोधस्तथा धूमो व्यायामो रक्तमोक्षणम् ॥५५॥

उपवासोऽसुखा शय्या सत्त्वौदार्यं तमोजयः ।

निद्राप्रसङ्गमहितं वारयन्ति समुत्थितम् ॥५६॥

एत एव च विज्ञेया निद्रानाशस्य हेतवः ।

कार्यं कलो विकारश्च प्रकृतिर्वायुरेव च ॥५७॥

*Kāyasya śirasaścaiva virekaśchardanam bhayam |
cintā krodhastathā dhūmo vyāyāmo raktamokṣaṇam ||55||*

*Upavāso'sukhā śayyā sattvaudāryam tamojayah |
nidrāprasaṅgamahitam vārayanti samutthitam ||56||*

*Eta eva ca vijñeyā nidrānāśasya hetavaḥ |
kāryam kalo vikāraśca prakṛtiroāyureva ca ||57||*

Elimination of dosas from the body and head through purgation and emesis, fear, anxiety, anger, smoke, physical exercise, blood letting, fast, uncomfortable bed, predominance of sattva and suppression of tamas go a long way towards overcoming the sleep in excess.

The above mentioned factors along with overwork, oldage, disease, specially these due to the vitiation of vatta like colic pain, etc. are known to cause sleeplessness even in normal individuals. Some are insomniac even by nature. [C.S.10.55-57]

2.4.7 METHODS AND MEASURES TO INDUCE GOOD SLEEP

अभ्यङ्गोत्सादनं स्नानं ग्राम्यानुपौदका रसाः ।
 शाल्यत्रं सदधि क्षीरं स्नेहो मद्यं मनः सुखम् ॥५२ ॥
 मनसोऽनुगुणा गन्धाः शब्दाः संवाहनानि च ।
 चक्षुषोस्तर्पणं लेपः शिरसो वदनस्य च ॥५३ ॥
 स्वास्तीर्णं शयनं वेश्म सुखं कालस्तथोचितः ।
 आनयन्त्यचिरान्निद्रां प्रनष्टा या निमित्ततः ॥५४ ॥

*Abhyaṅgotsādanam strānam grāmyānūpaudakā rasāḥ |
 śālyatram sadadhi kṣīram sneho madyaṁ manaḥ sukham ||52||
 Manaso'nugunā gandhāḥ śabdāḥ saṁvāhanāni ca |
 cakṣuṣostarpaṇam lepaḥ śiraso vadanasya ca ||53||
 Svāstīrṇam śayanam veśma sukham kālastathocitaḥ |
 ānayanīyācīrānnidrām pranaṣṭā yā nimittataḥ ||54||*

If for some reason or other, one is subjected to sleeplessness, he can be instantaneously cured by massage, unction, bath, intake of soup of domestic marshy and aquatic animals, Sali rice with curd, milk, unctuous substance and alcohol, psychic pleasure, smell of scents and hearing of sounds of one's own taste, samvahana (rubbing the body by hand), application of soothing ointment to the eyes, head and face, comfortable bed and home and proper time. [C.S.10.52-54]

2.4.8 GOOD AND BAD SLEEP

रात्रिस्वभावप्रभवा मता या तां भूतधात्रीं प्रवदन्ति तज्ज्ञाः ।
 तमोभवामाहुरधस्य मुलं शेषाः पुनर्व्याधिषु निर्दिशन्ति ॥५९ ॥

*Rātrisvabhāvaprabhavā matā yā tāṁ bhūtadhātrīṁ pravadanti tajjñāḥ |
 tamobhavāmāhuradhasya mulaṁ śeṣāḥ punarvyādhiṣu nirdiśānti ||59||*

The sleep caused by the nature of the night is the sleep per excellence; this is known as “*bhutadhatri*” (that nurses all living beings). The one caused by *tamas* is the root cause of all sinful acts. The remaining types are to be treated as diseases. [C.S.10.59]

2.4.9 OVERCOMING EXCESS SLEEP

क्षौद्राश्वलालासंघृष्टैर्मरिचैनेत्रमञ्जयेत् ।

अतिनिद्रा शमं याति तमः सुर्योदयादिव ॥१० ॥

Kṣaudrāśvalālāsandhṛṣṭeīrmaricainetramañjayet

atinidrā śamaṁ yāti tamaḥ suryodayādiva ॥10॥

Black-pepper is grounded with honey and saliva of the horse and applied as *Anjana* in the eye which destroys excessive sleep as the sun-rise destroys darkness. [S.S.13.10]

जातिपुष्पं प्रवालं च मरिचं कटकीवचा ।

सैन्धवं बस्तमुत्रेण पिष्ट तन्द्राध्नमञ्जनम् ॥११ ॥

शिरीषबीजगोमूत्राणामरिच सैन्धवचैः ।

अञ्जनं स्यात्प्रबोधाय सरसोनशिलावचैः ॥१२ ॥

Jātipuṣpaṁ pravālaṁ ca maricaṁ kaṭakīvacā

saīndhavaṁ bastamutreṇa piṣṭa tandrādhnamañjanam ॥11॥

Sirīṣabījagomūtraṣṇāmarica saīndhavacaiḥ

añjanaṁ syātprobodhāya sarasonaśilāvacaiḥ ॥12॥

Jatipuspa (Jasmine flowers), *Pravala* (coral), *Marica* (Black pepper), *Katuki* (Picrorrhiza Kurrooa), *Vaca* (Acorus Calamus), and *Siandhava* (Rock salt) are grounded along with goat's urine and applied as *Anjana* to get ridd of sleep. The seeds of *Sirisa* (Albezzia lebbek), Cow's urine, *Krsna* (long pepper), *Marica* (Black pepper) and *Sajnadhava* (Rock salt) are grounded thoroughly and used as *Anjana* along with *Rosana* (garlic), *Silva* (Realgar) and *Vaca* (Acorus Calamus) to wake up from sleep. [S.S.13.11,12]

2.4.10SUMMARY

निन्दिताः पुरुषास्तेषां यौ विशेषेण निन्दितौ ।
 निन्दिते कारणं दोषास्तयोर्निन्दितभेषजम् ॥६० ॥
 येभ्यौ यदा हिता निद्रा येभ्यश्चाप्यहिता यदा ।
 अतिनिद्रायानिद्राय भेषजं यद्भवा च सा ॥६१ ॥
 या या यथाप्रभावा च निद्रा तत् सर्वमत्रिजः ।
 अष्टौनिन्दितसंख्याते व्याजहार पुनर्वसुः ॥६२ ॥

*Ninditāḥ puruṣāsteṣāṃ yau viśeṣeṇa ninditau |
 nindite kāraṇaṃ doṣāstayorninditabheṣajam ||60||
 Yebhyau yadā hitā nidrā yebhyaścāpyahitā yadā |
 atinidrāyānidrāya bheṣajam yadbhavā ca sā ||61||
 Yā yā yathāprabhāvā ca nidrā tat sarvamatrijah |
 aṣṭauninditasankhyāte vyājahāra punarvasuḥ ||62||*

To sum up:

Lord *Punarvasu* on the chapter on “Eight Types of Undesirable Constitutions” has explained the following.

1. Enumeration of undesirable constitutions;
2. The two most undesirable types of persons;
3. Cause of undesirability;
4. Demerits of undesirable persons;
5. Their treatment;
6. Indications and contra-indications of sleep depending upon the nature of the individual and time;
7. Treatment of excessive sleep and sleeplessness;
8. Factors that are responsible for causation of sleep; and
9. Types and effects of sleep. [C.S.10.60-62]

The review of literature in this chapter has been divided into three parts.

1. Polysomnography Variables and Sleep Index
2. Autonomic & Respiratory variables and
3. Heart rate variability (HRV) studies.

3.1 POLYSOMNOGRAPHY VARIABLES AND SLEEP INDEX

3.1.1 TRANSCENDENTAL MEDITATION (TM)

Around 1960, *Maharishi* Mahesh yogi introduced Transcendental Meditation to the world. This technique is neither a religion nor a way of life. It is a natural, effortless technique, which aims at improving all aspects of life. Adapted from ancient Indian techniques, it gained popularity and now has spread globally. The practice involves a daily 20-minutes session during which the individual repeats a '*mantram*'. The systematic and standardized form in which *Maharishi* had put forward the TM technique greatly encouraged scientific research (Mahesh Yogi, 1963).

When sleep research was being evolved, R.K. Wallace in 1968 made the first serious investigation of the physiological effects of TM, which was published in his Ph.D. thesis, entitled “The physiological effects of TM: A proposed fourth major state of consciousness” (Wallace, 1970). In this, 27 subjects were studied. Each subject acted as his own control. There was a pre control period; 10-min eyes open and 10-20 min with eyes closed. This was followed by 20-40 min of meditation, after which the subjects sat with eyes closed and then eyes open, each for 10 minutes. In this study there was no repetition of meditation sessions, neither were there non-meditation sessions for further

comparison. Oxygen consumption in 5 subjects by the closed circuit system showed a significant decrease in oxygen consumption during meditation in all the subjects. The mean decrease in oxygen consumption was about 40 cc/min or 17% compared to the pre-control period. The mean decrease in carbon dioxide elimination was about 30cc/min. The cardiac output was studied in 5 subjects by the dye dilution method, and was found to be significantly decreased in all the 5 subjects. Arterial blood gas analysis in ten subjects revealed a slight decrease in pH and no significant changes in pO₂ and pCO₂ levels. Blood lactate levels decreased at the onset and remained low during meditation. EEG was recorded in 26 subjects. In 5 subjects EOG recording was also made. The most notable change in EEG pattern was an increase in intensity of 8-9 cps waves (slow alpha) in the central and frontal regions. Depending on the subject, there was an increase /decrease/ no change in the intensity of 10-11 cps alpha. They had reported a feeling of drowsiness at the onset of meditation and their EEG record showed a flattening of alpha activity to low voltage mixed frequency waves, especially in the 2-7 cps range. EOG showed no apparent change. Younger, Adriance & Berger in 1975 conducted an experiment in which Electroencephalograms (EEGs) and Electroculograms (EOGs) were recorded during Transcendental Meditation periods on 8 experienced subjects. It was observed that two subjects out of eight spent considerable portions of their meditation periods in unambiguous physiological sleep. Tebecis in 1976 reported that there were some characteristic changes in eye movements during meditation with closed eyes in subjects with experience in TM. The common changes that were seen were an increase in

slow, large-amplitude, 'rolling' eye movements and a continuous decrease in rapid, low-amplitude, 'jerky' eye movements. It was also reported that the main changes in eye movements during TM were similar to those during passive hypnosis. In another study five experienced practitioners of transcendental meditation spent considerable parts of meditation sessions in sleep stages 2, 3, and 4 (Pagano, et al., 1976). A comparison was made with the Electroencephalogram records during meditation with those who took naps at the same time. The range of states observed during meditation did not support the view that meditation produces a single, unique state of consciousness.

In a survey, the EEG characteristics of persons practicing the Transcendental Meditation technique, out of 78 subjects, 21 people demonstrated intermittent prominent bursts of frontally dominant theta activity (Herbert & Lehmann, 1977). It was also reported that theta bursts were followed by the alpha rhythms. Subjects reports elicited during theta bursts indicated pleasant states and there were no subjective experiences noticed related to sleep. Remaining subjects who were put in control did not show theta bursts during relaxation and sleep onset. It was predicted that theta burst may be the manifestation of a state adjustment mechanism which comes into play during prolonged low-arousal states, and which may be related to EEG patterns of relaxation in certain behavioral conditions. A polygraphic recording (EEG, EOG, heart rate) was done in subjects during and after transcendental meditation (TM) as well as during night sleep (Wachsmuth & Dolce, 1980). During TM the amplitude of the alpha-waves was higher as before TM and appeared continuously. Also the same EEG changes were noticed

during relaxation with closed eyes. There were differences observed between the flat EEGs recorded during TM or during sleep. It was also observed that subjects showed slower heart rate with alpha rhythm. These findings suggested that that the subjects were able to maintain themselves for unusually long time in a state of decreased alertness. In an EEG study 13 experienced practitioners of transcendental meditation (TM) were recorded for 5 min before TM, during 20 min of TM and 5 min after, as well as during closed-eyed wakefulness, drowsiness, sleep onset and sleep (Stigsby, Rodenberg & Moth, 1981). Thirty volunteers were matched for age and gender and recruited to the control group. The EEG frequency showed an increasing theta and delta activity and decreasing alpha activity as the participants tended to fall asleep. The frequency spectrum noticed during TM was like the spectrum observed between wakefulness and drowsiness and it remained unchanged during the 20 min of meditation. Intra- or interhemispheric differences between quantities of EEG activity did not remain stable during TM, nor any theta burst was observed during the meditation. In a polygraphic study (Gallois, 1984), of 40 minutes duration, subjects were divided into three groups viz., autogenic training (n =10) [TA], among 10 subjects transcendental meditation (n =10) [TM], compared to 10 controls. The TM group showed significantly less number of sleeping episodes during relaxation and a decreased cardiac rhythm compared to the control. Subsequently standard ambulatory night sleep electroencephalograph (EEG) of 11 long-term practitioners of the Transcendental Meditation (TM) program reported "higher states of consciousness" during sleep (the experimental group) as compared to that of nine short-

term practitioners and 11 non-practitioners (Mason, et al., 1997). EEG tracings during stages 3 and 4 sleep showed that the experimental group had theta-alpha activity simultaneously with delta activity and decreased chin electromyography (EMG) during deep sleep compared to short-term practitioners. Also experimental long term practitioner had an increase in rapid eye movement (REM) density during REM periods compared to short-term practitioners. It was predicted that the interspersing of alpha and delta are uncommon in other recordings. The maintenance of transcendental consciousness along with deep sleep was one of the distinct criteria which were assumed to be the higher state of consciousness. Long-term meditators subjects report that transcendental experiences (TE), which first occurred during their Transcendental Meditation (TM) practice co-existed with waking and sleeping states (Travis, et al., 2002). To investigate neurophysiological correlates of this integrated state EEG was recorded in these subjects. A comparison was made between the groups during simple and choice contingent negative variation (CNV) tasks. Individuals reported the integration of the transcendent with waking and sleeping, CNV was higher in simple but lower in choice trials, and 6-12 Hz EEG amplitude and broadband frontal EEG coherence were higher during choice trials. So it was concluded that TM has an increasing integration of the transcendent with waking and sleeping.

To investigate the autonomic variables along with the electrophysiological variables, two experiments were conducted to measure the oxygen uptake (Experiment II) and the carbon dioxide production (Experiment I) during transcendental meditation

(Fenwick, et al., 1977). A control group of non-meditators and few meditators listening to music was used for both experiments. In Experiment I, there was a drop in oxygen consumption and carbon dioxide production following the practice of TM. EEG recordings were taken during Experiment II in the meditating group. The EEG results showed that transcendental meditation is a method of holding the level of consciousness at stage 'onset' sleep in meditators. No evidence was noticed that the EEG findings during sleep have similarities with the onset of sleep. Also there was no evidence that meditation is a hypo metabolic state. In this study there was no support that TM is a fourth stage of consciousness described in ancient scripture of India. The effect of transcendental meditation (TM) on breathing was studied in 16 experienced meditators and 16 control subjects (Wolkove, et al., 1984). In meditators, minute ventilation decreased significantly during quiet breathing and during meditation. The change in minute ventilation during meditation was due to a decrease in tidal volume resulting from a shortened inspiratory time. Meditation was associated with a decreased response to progressive hypercapnea quiet breathing and during meditation trials. During meditation tidal volume was smaller at a given alveolar PCO₂ than during quiet breathing studies because of a decrease in mean inspiratory flow rate. Based on these observations it was suggested that an alteration in wakefulness, more subtle than sleep or the unconscious state, could significantly affect the chemical and neural regulation of breathing.

Biochemical variables were used as objective variables along with the electrophysiological measures viz., electrooculogram, electroencephalogram, and

electromyogram during the practice of meditation. The concentration of 13 neutral and acidic plasma amino acids was measured before, during and after either 40 min of control relaxation or 40 min during the process of transcendental meditation (TM) (Jevning, Pirkle & Wilson, 1977). Increased phenylalanine concentration was noted during TM practice whereas there was no change during control relaxation. Also no difference between the groups of total time slept or sleep stage percent was observed. A lack of correlation was observed with increased phenylalanine with sleep in the long-term practitioners. The findings of the study suggested that there is a relationship between the increased phenylalanine and TM practice. Although meditation has been practiced worldwide for centuries, there are no reports that it causes epilepsy (Orme-Johnson, 2007). Medical care statistics and clinical studies indicate that individuals who regularly practice the Transcendental Meditation technique had fewer problems of the nervous system and specifically show decreased symptoms of epilepsy. Also there was no evidence available that the Transcendental Meditation technique increases glutamate, which has been associated with epilepsy and causes epilepsy.

Summary

The summary of the findings using transcendental meditation has been categorized into three sections viz., electrophysiological, biochemical, autonomic & respiratory and metabolic studies.

1. The electrophysiological studies suggested that during TM, few subjects spent considerable portion of their meditation in physiological sleep. Subsequently in a

study subjects demonstrated theta bursts followed by alpha rhythm indicating pleasant state of mind. Similar study reported that TM practitioners spent appreciable parts of their meditation sessions in sleep stages 2, 3 and 4 suggestive of the onset of sleep during meditation. In one of the polygraphic study, slower alpha rhythm was reported with slow heart rate which suggested that meditators experienced the state of decreased alertness during meditation. To evaluate the intra and inter hemispheric EEG activity, a study was done which suggested that the EEG activity in intra and interhemisphere remained stable. No conclusion could be drawn from this study. Other study which was conducted using standard ambulatory EEG demonstrated a higher state of consciousness during sleep. It was observed that experimental group had theta and alpha activity simultaneously with delta activity apart from other findings of EEG variables which was considered as the 'higher state of consciousness' or the fourth state of consciousness as quoted in ancient Indian scriptures. A polygraphic study on TM showed a rarity in the number of sleeping episodes during relaxation, a significant decrease in cardiac rhythm and a decreased respiratory rate. Respiratory suspensions were frequent in this group, reaching a maximal duration of 50 seconds.

2. Biochemical studies revealed that there was increased concentration of phenylalanine during TM practice suggestive of a deeper state of mind. This may indicate a mood elevation like the effect of dopamine.

3. Metabolic studies suggested that there was a drop in oxygen consumption and carbon dioxide production during the practice of TM. This study concluded that meditation is not a hypometabolic state.
4. Studies on respiratory variables during meditation concluded that the tidal volume was lower at a given PCO₂ than during eyes open and awake. A decrease in respiratory flow during meditation suggested that meditation alters the state of wakefulness to a more subtle state than sleep.

3.1.2 MINDFULNESS BASED MEDITATION

Mindfulness meditation is a Buddhist meditation becoming popular globally for its benefits. In 1993 a study was done to evaluate the effectiveness of a meditation-based stress reduction program on fibromyalgia (Kaplan, Goldenberg & Galvin-Nadeau, 1993). Seventy-seven patients with fibromyalgia took part in a 10-week group outpatient program. Patients were evaluated before and after the program. Outcome measures included visual analog scales to measure global well-being, pain, sleep, fatigue, and feeling refreshed in the morning. Meditators were also evaluated with Symptom Check List Revised (SCL-90-R), Coping Strategies Questionnaire, Fibromyalgia Impact Questionnaire, and the Fibromyalgia Attitude Index. The mean scores of 51% of the patients showed moderate to marked improvement and only they were counted as "responders." These preliminary findings suggest that a meditation-based stress reduction program is effective for patients with fibromyalgia. Solid-organ transplant surgery patients are often compromised for their quality of life. Anxiety, depression, and

insomnia frequently occur despite excellent function of the transplanted organ (Kreitzer, et al., 2005). Use of complementary and alternative medicine has been one of the preferred treatment modality for chronic illnesses. In a clinical trial twenty solid-organ transplant recipients were enrolled in a mindfulness-based stress reduction program. During the 8-week course, subjects learned various forms of meditation and gentle *Hatha* yoga practices. Participants were given audiotapes for individual practice and maintained practice diaries. Significant improvements in the quality and duration of sleep were observed even after 6 months of completion of the mindfulness-based stress reduction course. It was concluded that mindfulness-based stress reduction program is an effective treatment in improving the quality and duration of sleep. Sleep disturbance is a very common problem in cancer patients (Carlson & Garland, 2005). The effects of an 8-week Mindfulness-Based Stress Reduction (MBSR) program on the sleep quality of a heterogeneous sample of 63 cancer patients was examined. Overall sleep disturbance was significantly reduced and participants reported that their sleep quality had improved. There was also a significant reduction seen in stress, mood disturbance, and fatigue. To assess changes in quality of life and sense of coherence (SOC), a questionnaire study was planned using mind body medicine as an intervention, (Fernros, Furhoff & Wändell, 2008). A health-related quality of life (HRQOL) inventory, SOC-13 scale, healthcare utilization and medication were used as variables for eligible participants (n = 83). These variables were studied before and 6 months after a one week course. Assessments were also made on control group (CG) who had previously attended the course (n = 69).

Subjects in both the groups were matched for age and gender. Changes in HRQOL and SOC of the 13 HRQOL subscales, eight showed clinically significant improvement in the study group. Men and women of this group improved with their HRQOL and SOC after the course intervention. Insomnia has become an associated problem for many physical and psychological ailments. Another study assessed thirty adults with psychophysiological insomnia (Ong, Shapiro & Manber, 2008) who underwent a six week intervention using mindfulness meditation for sleep restriction, stimulus control, sleep education, and sleep hygiene. Sleep diaries and self-reported pre-sleep arousal questionnaires were assessed weekly while secondary measures of insomnia severity, arousal, mindfulness skills, and daytime functioning were assessed before and after the treatment. It was observed that there were significant improvements in several night time symptoms of insomnia as well as statistically significant reductions in pre-sleep arousal, sleep effort, and dysfunctional sleep-related cognitions. In addition, a significant correlation was found between the number of meditation sessions arranged and arousal. In general the findings indicate that mindfulness meditation can be combined with cognitive behavioral therapy can become helpful in minimizing both sleep and sleep-related arousal. In another study the objective was to examine the usefulness of a mindfulness-based cognitive therapy (MBCT) for treating insomnia symptoms in patients with anxiety disorder (Yook, et al., 2008). Nineteen patients with anxiety disorder were assigned to an eight week MBCT clinical trial. Participants showed significant improvement in Pittsburgh Sleep Quality Index, Penn State Worry Questionnaire,

Ruminative Response Scale, Hamilton Anxiety Rating Scale, and Hamilton Depression Rating Scale scores at the end of the eight week program as compared with baseline. These findings suggested that MBCT can be effective in relieving insomnia symptoms by reducing worry associated sleep disturbances in patients with anxiety disorder.

A quantitative study was conducted based on grounded theory and used content analysis of diary entries from older adults who had participated in a clinical trial of an eight week mindfulness meditation program (Morone, et al., 2008). Twenty seven adults with chronic low back pain with an average age of 65 years and a moderate severity of at least 3 months duration participated in the study. Various techniques were used for pain alleviation. Community-dwelling older adults with chronic low back pain experienced numerous benefits from mindfulness meditation including less pain, improved attention, better sleep, enhanced well-being, and improved quality of life. A number of participants reported improved sleep latency as well as quality of sleep.

In a study the biochemical and immunological variables were investigated. Forty-nine patients with breast cancer and 10 with prostate cancer participated in an eight week MBSR program which included relaxation, meditation, gentle yoga (Carlson, et al., 2003). Variables viz., quality of life, mood, stress, and various immunological assays were assessed before and after the intervention. Significant improvements were seen in overall quality of life, symptoms of stress, and sleep quality. Although there were no significant changes observed in biochemical and immunological variables, the overall number of lymphocytes or cell subsets, T cell production of Interleukin-4 (IL-4)

increased and Interferon-gamma (IFN-gamma) decreased, whereas Natural Killer (NK) cell production of IL-10 decreased. MBSR participation was associated with enhanced quality of life and decreased stress symptoms in breast and prostate cancer patients. This study was first of its kind to show changes in cancer-related cytokine production associated with program participation. A year later a study was conducted on fifty-nine patients with breast cancer and 10 with prostate cancer who had enrolled for an eight-week Mindfulness-Based Stress Reduction (MBSR) program which incorporated relaxation, meditation, gentle yoga, and daily home practice. Demographic and health behavior variables, quality of life, mood, stress, and the hormone measures of salivary cortisol (assessed three times/day), plasma Dehydroepiandrosterone (DHEAS), and salivary melatonin were assessed pre- and post-intervention (Carlson, et al., 2004). Significant improvements were seen in overall quality of life; symptoms of stress, and sleep quality. Improvements in quality of life were associated with decreases in afternoon cortisol levels, but not with morning or evening levels. No overall changes in DHEAS or melatonin were found. So, it was concluded that MBSR program was associated with enhanced quality of life and decreased stress symptoms in breast and prostate cancer patients, and resulted in possibly beneficial changes in hypothalamo-pituitary-adrenal (HPA) axis functioning.

An article provided a description of a clinical study that used combined Tai Chi and mindfulness-based stress reduction as an educational program (Wall, 2005). This program was of five weeks for middle aged-school boys and girls. These boys and girls

participated in this five week program and experienced well-being, calmness, relaxation, improved sleep, less reactivity, increased self-care, self-awareness, and a sense of interconnection with nature. It was concluded that Tai Chi and mindfulness-based stress reduction may be a transformational tool that can be used in educational programs appropriate for middle aged-school children. Another article reported a systematic review of the evidence of the effectiveness of Mindfulness-Based Stress Reduction for cancer supportive care (Smith, et al., 2006). Cancer can leave a negative impact on both psychological and physical health thereby affecting the quality of life. Using the main biomedical and complementary medicine databases three randomized controlled clinical trials and seven uncontrolled clinical trials were traced out. Studies reported positive results, including improvements in mood, sleep quality and reductions in stress. Another study systematically evaluated the evidence that sleep can be improved by mindfulness-based stress reduction (MBSR), a formalized psycho-educational intervention that helps individuals to self-manage and reframe the thoughts (Winbush, Gross, & Kreitzer, 2007). Evidence suggest that increased practice of mindfulness techniques is associated with improved sleep and that MBSR participants experience a decrease in sleep-interfering cognitive processes (e.g., worry).

Summary

Studies on fibromyalgia with the intervention of mindfulness based meditation benefited many variables including quality of sleep. These findings suggested that meditation is an effective treatment and can be used to alleviate the problem of fibromyalgia. Significant

improvements were seen in overall quality of life, symptoms of stress, and sleep quality. The overall number of lymphocytes or cell subsets, T cell production of Interleukin-4 (IL-4) increased and Interferon-gamma (IFN-gamma) decreased, whereas Natural Killer (NK) cell production of IL-10 decreased in a study conducted on patients with breast and prostate cancer.

Subsequently another study was done on cancer patients with different biochemical variables, mood, stress and quality of life index. It was found that the cortisol amount decreased in the afternoon and there was an association between the quality of life and afternoon cortisol levels. This showed that following the practice of MBSR, there was an enhanced quality of life.

Another eight week course of MBSR benefited solid organ transplant surgery patients in terms of improving their quality and duration of sleep. A questionnaire study revealed that both men and women improved their quality of life after six months of a one week MBSR program. A five week program of MBSR with Tai chi benefited the school students with well-being, calmness, relaxation, less reactivity, increased self care, self awareness, sense of interconnection with nature and sleep. In another study on patients with psychophysiological insomnia there was a significant reduction in pre sleep arousals, sleep effort, and dysfunctional sleep-related cognition.

In a qualitative study on MBSR an improvement was seen in their sleep latency, quality of sleep and an improvement in chronic back pain experienced by the participants in that study.

3.1.3 TANTRA YOGA MEDITATION

Tantra is an ancient path of meditation with roots in both Hindu and Tibetan Buddhist spirituality. It is called the "Royal Path" because, in ancient times, Tantra was the spiritual path taken only by those who had mastered all other paths. Tantric writings dating back up to 5,000 years are still used in many modern meditation teachings today (Venkata Reddy, 1979).

Autonomic and electroencephalographic (EEG) correlates of Tantra Yoga meditation were studied in three groups with three varied levels of meditation proficiency (Corby, et al., 1978). Measures of skin resistance, heart rate, respiration, autonomic orienting responses, resting EEG, EEG alpha and theta frequencies, sleep-scored EEG, averaged evoked responses, and subjective experiences were recorded. Proficient meditators demonstrated increased autonomic activation during meditation while inexperienced meditators demonstrated autonomic relaxation. Also an increase in alpha and theta power, minimal evidence of EEG-defined sleep, and decreased autonomic response orienting to external stimulation was seen. These findings challenged the current "relaxation" model of meditative states.

Summary

Proficient Tantra yoga meditators showed increased alpha and theta power and minimum evidence of EEG defined sleep with increased autonomic activation during meditation whereas inexperienced meditators showed autonomic relaxation suggestive of the ecstatic state of intense concentration.

3.1.4 KUNDALINI YOGA MEDITATION

According to Hindu tradition Kundalini yoga is a pure spiritual science that leads to enlightenment and God-Realization under the guidance of a Spiritual Master. In Hindu tradition, the techniques are only communicated from Master to disciple once the disciple is deemed ready.

Very less scientific literature is available on the practice of Kundalini yoga. This technique was found to be specific in treating obsessive-compulsive disorder (Khalsa, 2004).

Summary

Kundalini yoga an ancient yogic technique was found to be beneficial in treating Obsessive compulsive disorder and related psychiatric disorders.

3.1.5 GENERAL SUMMARY OF MEDITATION TECHNIQUES AND THEIR BENEFITS

Evolution of sleep-wake cycles focused on phylogenetic and ontogenetic appearances of REM cycles (active sleep). A correlation has been made with EEG studies during states of concentration (Yoga, Transcendental meditation, Zen meditation, Mindfulness meditation). These states have been found to have specific brain activities but are different from deep sleep, in spite of certain similarities in the EEG. Several hypotheses are set forth to explain brain activities underlying sites of concentration. The possibilities of developing a conscious mastery over dreams are also under research, and special attention is given to the works of Saint Denys (1867), and Hindu tradition.

The state effects of meditation appear to include decreased electrocortical arousal. There is also evidence that meditators more readily demonstrate alpha and theta activity than non meditators, even when not meditating. Meditators appear to show both stronger orienting and recovery responses to stressors while meditating. Meditation practice may begin with left hemisphere type activity, which thereby gives more opportunity for functioning of the right hemisphere – the spatial functioning of the brain. However, it appears that during advanced meditation ("no thought") both left and right hemisphere are actively inhibited or suspended. Depending on the individual, inexperienced meditators may report sleep, hypnogogic reverie, trance or abreaction during practice. The current evidence does not support the notion of unique state effects associated with the practice of meditation.

Present day neurophysiology is attributed to think that thought processes are the highest level of brain function. It has been common knowledge to oriental thinkers for many centuries, that there are many further states of the human mind, culminating in the state of thoughtless awareness; the fourth state of consciousness. This state must have a physiological basis. The complicated structure of the brain, the extravagant abundance of neural and glial elements in the brain, the infinite possibilities of synaptic junctions and synaptic transmission, and the multitude of neurotransmitters and neuromodulators; all these point to the definite possibility of a much greater level of performance and achievement for the human brain than has been apparent so far. Not only the theories but also the experience of Eastern seers has shown that the brain can transcend the

boundaries of logic and reason, and experience states of awareness, commonly unrecognized. In the past few decades, knowledge about the functioning of the human brain has been growing exponentially and scientists of diverse disciplines are concentrating on unraveling its mysteries. It is necessary for scientists to investigate this state with all available tools and find the neurophysiological basis of this state. A study analyzed the correlation between contemplation and psychosis from three cases of patients presenting psychotic symptoms subsequent to practicing meditation. Sleep loss following a wrong doing in meditation was found to be the main cause in the first two cases, and drug withdrawal was found to be the principal factor in causing a psychotic eruption in the third case. In this last case, sleep deprivation subsequent to meditation was only a minor influence.

Consciousness remains an elusive concept due to the difficulty to define what has been regarded for many years as a subjective experience, therefore irrelevant for scientific study. Recent research and development in the field of yoga has provided some insight in defining consciousness. The extensive literature available on this domain suggests following perspectives of consciousness. (1) Consciousness and attention may not reflect the same process. (2) Consciousness during wake and sleep may not involve the same mechanisms. (3) Besides physiological states of consciousness, human beings can experience modified states of consciousness either by self-training (transcendental meditation, hypnosis, etc.) or by drug intake (hallucinogens, anesthetics, etc.).

Meditation, a wakeful hypometabolic state of parasympathetic dominance, is compared with other hypometabolic conditions, such as sleep, hypnosis, and the torpor of hibernation. It is concluded that there are many analogies between the physiology of long-term meditators and hibernators across the phylogenetic scale. These analogies further reinforce the idea that plasticity of consciousness remains a key factor in successful biological adaptation.

3.2 AUTONOMIC & RESPIRATORY CHANGES

3.2.1 TRANSCENDENTAL MEDITATION [TM]

The Transcendental Meditation (TM) technique is a simple, natural, effortless procedure whereby the mind easily and naturally arrives at the source of thought, the settled state of the mind -- Transcendental Consciousness -- pure consciousness, self-referral consciousness, which is the source of all creative processes. Transcendental meditation is practiced for 15–20 minutes in the morning and evening, while sitting comfortably with the eyes closed. During this technique, the individual's awareness settles down and the meditator experiences a unique state of restful alertness. As the body becomes deeply relaxed, the mind transcends all mental activity to experience the simplest form of awareness, Transcendental Consciousness, where consciousness is open to itself. This is the self-referral state of consciousness.

In a study, Wallace, Benson and Wilson (1971), described their observations on 36 subjects. The self as control design was implemented for this study. The pre-control period consisted of 10-30 min with eyes closed and eyes open for a similar period. After

20-30 min of meditation they were asked to stop meditating and sit with eyes closed for 10 min, followed by eyes open for the same time. They reported a decrease in oxygen consumption of an average decrease of 17%. Minute ventilation decreased by about 1 liter/min and respiratory rate decreased by about 3 breaths / min during meditation. Mean lactate concentration decreased from a pre-control level of 11.4 mg, to 8.0 mg/100 ml. The average heart rate during meditation decreased by 3 beats per minute. Rectal temperature remained fairly constant during meditation. The skin resistance increased markedly at the onset of meditation with a mean increase of about 140 K Ω . After meditation, skin resistance decreased but remained higher than before meditation.

Rieckert (1977) reported a significant increase in forearm blood flow during meditation, while the finger circulation showed a slight decrease. These changes were contrasted with those in a group practicing autogenic training i.e., this group showed a significant increase in a finger circulation and a slight increase in forearm circulation. A study by Levander and others (1972) reported changes in the forearm blood flow measured with a water plethysmograph in 5 TM subjects. There was a small but significant increase in mean forearm blood flow during TM. There was a decrease on non- TM days during the test and post-test periods.

Orme-Johnson (1973), reported a study on 16 subjects [8 meditators and 8 controls]. The meditators had a mean experience of 15 months. The GSR habituation and spontaneous GSR fluctuations were studied. In a second experiment, 6 meditators (with experience of meditation ranging from 2-54 months) and 8-non meditators were studied.

Though habituation was initially similar for the two groups, the meditators habituated in significantly fewer trials than non-meditators. A study by Travis (2001) compared EEG and autonomic patterns during transcending to "other" experiences during Transcendental Meditation (TM) practice. To correlate specific meditation experiences with physiological measures, the experimenter rang a bell three times during the TM session. Subjects categorized their experiences around each bell ring. Transcending, in comparison to "other" experiences during TM practice, was marked by: (1) significantly lower breath rates; (2) higher respiratory sinus arrhythmia amplitudes; (3) higher EEG alpha amplitude; and (4) higher alpha coherence. In addition, skin conductance responses to the experimenter-initiated bell rings were larger during transcending. These findings suggested that monitoring patterns of physiological variables may lead to dynamically changing inner experiences during meditation practice. This could allow a more precise investigation into the nature of meditation experiences and a more accurate comparison of meditation states with other eyes-closed conditions.

Summary

To summarize, TM had following effects, (1) the minute ventilation decreased by 1 lit/min with the decrease in heart rate and rectal temperature, (2) there was an increase in the mean forearm blood flow during TM. (3) meditators could habituate better than the non-meditators.(4) there were marked changes in higher respiratory sinus arrhythmia, higher alpha waves amplitude and higher alpha coherence. With these above findings TM practice appeared to be associated with reduced sympathetic activity.

3.2.2 TIBETAN BUDDHIST MEDITATION

Spontaneous realization on the basis of transmission is possible but rare. Normally an intermediate step is needed in the form of analytic meditation, i.e., thinking about what one has heard. As part of this process, entertaining doubts and engaging in internal debate over them is encouraged in some traditions. Analytic meditation is just one of two general methods of meditation. When analytic meditation achieves the quality of realization, one is encouraged to switch to "focused" or "fixation" meditation.

A study conducted by Cohen and others (2004) examined the effects of the Tibetan yoga practices, which incorporated controlled breathing, visualization, mindfulness techniques and low impact postures in patients with lymphoma. The yoga groups were given 7 weekly yoga sessions. Patients in the yoga group reported significantly lower sleep disturbance scores compared with the wait-list control group, in terms of better subjective sleep quality; faster sleep latency, longer sleep duration and less use of sleep medications.

G- Tum - mo meditation literally means 'heat'. This is an advanced Tibetan Buddhist meditation practice. The belief is that during this practice, dissolution of the *Prana* (subtle energy) occurs and the internal heat is ignited. Benson, et al., in 1982, reported changes in the temperature of the digits in three senior meditators. There was an increase in the digital temperature by 8.3°C during meditation. In this study the number of recording sessions is not mentioned. Also, separate non-meditation control sessions were not carried out.

Summary

The self-rated sleep studies suggested that Tibetan Buddhist meditation reduced mental arousal and it was associated with extraordinary autonomic voluntary control.

3.2.3 ZEN MEDITATION

Zen meditation allows an aspirant to keenly attune to his environment—the idea is to tap those vast resources of energy and enlightenment inherent in all of us. To effortlessly find within, what we had been unsuccessfully trying to discover without. That, in essence, is both the art and the science of meditation.

Hirai (1960) found changes in the breathing during Zen meditation. The breath rate decreased to 4-5 breaths per minute. The amplitude of both abdominal and thoracic breathing increased during meditation. However, the amplitude of abdominal breathing was greater than that of thoracic. The same study reported an acceleration of the pulse rate during meditation to between 80 and 100 beats/minute.

In a study on experienced Zazen meditators, Akishige (1968) reported a decrease in spontaneous skin conductance responses during Zazen. The same study also showed that there was a decrease in oxygen consumption and rate of respiration, associated with Zen meditation. Sugi and Akutsu (1968) observed a 20% decrease in oxygen consumption associated with meditation in ten experienced Zen monks.

Goyeche and others (1972) compared Zen meditation with relaxation. In their design the order of treatment (i.e., quiet relaxation or meditation) was randomly assigned to each of the eight subjects. It was found that the breath and heart rate decreased during

Zen meditation (cited from Woolfolk, 1975). A study, which recorded EKG and EEG simultaneously, correlated the frontal midline theta rhythm with cardiac autonomic activities during Zen meditation (Kubota, et al., 2001). Sustained attention and breath control was employed (A standard procedure of Zen meditation) as the task to provoke frontal midline theta rhythm (Fm theta). For the subjects in which Fm theta activities were provoked (six men, six women, 48% of the total subjects), peripheral autonomic activities were evaluated during the appearance of Fm theta as well as during control periods. Successive inter-beat intervals were measured from the ECG, and a recently developed method of analysis by Taichi based on heart rate variability was used to assess cardiac sympathetic and parasympathetic functions separately. Both sympathetic and parasympathetic indices were increased during the appearance of Fm theta compared to control periods. Theta band activities in the frontal area were correlated negatively with sympathetic activation suggesting a relationship between cardiac autonomic function and activity of medial frontal neural circuitry.

Another study by Murata (2004) and others on EEG coherence and autonomic nervous activity using heart rate variability (HRV) during Zen meditation showed EEG coherence in the frontal region, an increase in high-frequency (HF) power (as a parasympathetic index of HRV), and a decrease in the ratio of low-frequency to HF power (as a sympathetic index of HRV). There was a negative correlation between the percent change (with the control condition as the baseline) in slow alpha inter-

hemispheric coherence (reflecting internalized attention) and in HF (reflecting relaxation).

More recently, a study (Cysarz & Bussing, 2005) reported the high degree of cardio-respiratory synchronization during meditation in inexperienced meditators suggesting that the physiological implication of meditation does not require prior experience in meditation.

Summary

Zen meditation showed

1. both thoracic and abdominal breathing increased but the amplitude of abdominal breathing was higher suggestive of a deeper level of meditation practice,
2. a decrease in heart rate and breath rate during the practice,
3. there was an increase in autonomic activity with frontal midline brain activity
4. there was a decrease in spontaneous skin conductance decrease in oxygen consumption and rate.

These findings suggested that Zen meditation was a state of alertful rest.

3.2.4 BRAHMAKUMARIS RAJA YOGA MEDITATION

Brahmakumaris Raja Yoga Meditation is a method of relaxing, refreshing and clearing the mind and heart. This particular meditation helps a subject to disconnect from damaging habits of thought, feeling and reaction.

Autonomic and respiratory variables were studied in 18 experienced (5-25 years of experience). Each meditator was studied in three test and three control sessions (Telles

& Desiraju, 1993). Group analysis showed a significant increase in the heart rate during meditation compared to the pre period of meditation and non-meditation sessions. There were no changes in palmar GSR, finger plethysmogram amplitude and respiratory rate. Individual analysis revealed that changes in autonomic variables suggestive of both activation and relaxation occurred simultaneously in different subdivisions of the autonomic nervous system. To summarize, this study highlighted two points, (i) meditation is best described as a physiological state of ‘alertful rest’, and (ii) considerable physiological variation is seen within intra- and inter-individual comparisons.

Summary

During the practice of Brahmakumari Raja Yoga meditation there was an increase in heart rate corresponding to ‘alertful state’ and no change in the other variables of autonomic and respiratory variables suggested the ‘relaxation state’ of meditation. Thus Brahmakumari Raja Yoga meditation is supposed to be the practice of ‘alertful rest’ practice.

3.2.5 RAJA YOGA MEDITATION

This technique involves the eight stages given by *Patanjali* in his treatise of aphorisms. The meditators focus on an internal or external image. As described in *Patanjali’s Yoga Sutra*, the ultimate stage is called *Samādhi* (fulfillment).

Bagchi and Wenger (1957) studied 14 subjects during *Raja* yoga meditation and during rest, which was supposed to be the control period of the experiment. They did not show changes in EEG patterns, heart rate or BP. However, there was an increase in skin

resistance and a decrease in respiratory rate during *Raja* yoga meditation. In a later report (1961), Wenger and Bagchi assessed various physiological changes occurring during *Raja* yoga meditation in 4 yoga students (2 to 7 years experience) and 4 subjects with longer experience. In both the more and less experienced subjects, heart rate increased by 1 or 2 beats per minutes during meditation. This was clearer in the later studies of finger pulse volume, showed slightly higher values after meditation began in the yoga students, which returned to the pre-meditation level at the middle and late stages of meditation. In the seniors, the mid-meditation pulse volume was almost 20% higher than the pre-meditation values and on the whole, the basal levels were higher and changes more pronounced, when compared to the yoga students. In both groups systolic and diastolic BP readings were slightly more than the pre meditation period. All average BP readings were greater for the older yogis than the yoga students in meditation. As far as the respiratory system response is concerned, the yoga students showed a drop in breath rate from about 14 to 6 or 7 breaths per minute which remained approximately constant during the remainder of the meditative period. The study also reported that palmar conductance was decreased in both groups during meditation. The decrease in palmar conductance in yoga students was more than that seen during a period of relaxation. It was observed from the findings that subjects, who had many years of experience, their ambient breath rate was lower than those whose practice was of shorter duration and hence the changes in their breath rates would be less marked than that of yoga students. Gharote (1984) measured the changes in the metabolic rate during *Raja* Yoga meditation

in a single subject. The mean metabolic rate during meditation was lower than the pre-meditation value though this was not statistically significant. The metabolic rate tested soon after meditation showed a statistically significant increase compared to the mean value during meditation. From these findings, it was observed that the subject go into a profound meditative state in which there was non-responsiveness to external stimuli and a diminution of EEG and EKG voltages.

Summary

To sum up, Raja yoga meditation showed

1. an increase in skin resistance and decrease in respiratory during Raja yoga meditation practice,
2. the lowering of the ambient body temperature in the subjects having many years of experience of yoga,
3. metabolic rate was more after meditation than during the practice.

3.2.5 OTHER MEDITATION TECHNIQUES

Peng et al. (2004) analyzed beat-to-beat heart rate and continuous breathing signals from 10 experienced meditators (4 females and 6 males with ages ranging between 29 and 55 years) during three traditional interventions: relaxation response, breath of fire, and segmented breathing. Heart rate and respiratory dynamics were generally similar during the relaxation response and segmented breathing. High amplitude, low frequency oscillations due to respiratory sinus arrhythmia during both the relaxation response and

segmented breathing, along with a significantly increased coherence between heart rate and breathing compared to baseline was observed. The third technique, breath of fire marked by a significant increase in mean heart rate with respect to baseline, and a significant decrease in coherence between heart rate and breathing. These findings suggested that different meditative/breathing protocols might have evoked common heart rate effects, as well as specific responses. These results supported the concept of a "meditation paradox," since a variety of relaxation and meditative techniques may produce active rather than quiescent cardiac dynamics, associated with prominent low frequency heart rate oscillations or increases in mean resting heart rate.

The practice of yoga regulates body physiology through control of posture, breathing, and meditation (Sathyaprabha, et al., 2008). Effects of yoga on autonomic functions of patients with refractory epilepsy, as quantified by standardized autonomic function tests (AFTs), were determined. The yoga group received supervised training in yoga, and the exercise group practiced simple routine exercises. AFTs were repeated after 10 weeks of daily sessions. Data were compared with those of healthy volunteers. The yoga group showed significant improvement in parasympathetic parameters and a decrease in seizure frequency scores. There was no improvement in blood pressure parameters in either group. Two patients in the yoga group achieved normal autonomic functions at the end of 10 weeks of therapy, whereas there were no changes in the exercise group. These findings suggested that yoga may have a role as an adjuvant therapy in the management of autonomic dysfunction in patients with refractory epilepsy.

Summary

Different meditative/breathing protocols may evoke common heart rate and specific responses of autonomic variables and also meditation can be used as a therapy in the management of autonomic dysfunction in patients with epilepsy.

3.2.7 MEDITATION ON 'OM'

Yoga teachings consider the syllable 'OM' to be the force behind all thoughts. Either chanting or thinking about 'OM' is supposed to cause a quiet mental state. In 'OM' meditation aspirant repeats the syllable 'OM' mentally and effortlessly.

The autonomic and respiratory variables were studied (Telles, Nagarathna & Nagendra, 1995) in seven experienced OM meditators (with experience ranging from 5 to 20 years). Each subject was studied in two types of sessions-meditation (with a period of mental chanting of OM) and control (with a period of non-targeted thinking). The meditators showed a statistically significant reduction in heart rate during meditation compared to the control period. During both types of sessions, there was a comparable increase in the cutaneous peripheral vascular resistance. This was interpreted as a sign of increased mental alertness even while being physiologically relaxed (as shown by the reduced heart rate). When repetition of 'OM' was compared with the repetition of 'ONE' in 12 meditators, there was a difference in the autonomic and respiratory responses (Telles, Nagarathna & Nagendra, 1998). Both types of sessions resulted in a decrease in the heart and breath rates, but repetition of OM alone reduced the skin resistance, suggesting a subtle change in the mental state, related to the significance of

the syllable. Finally, it was interesting to note in a single case study that an accomplished meditator was able to switch between ‘single thought’ and ‘no thought’ states at will, with significant differences in the breath rate and pattern between the states (Telles & Desiraju, 1992).

Summary

‘OM’ repetition reduced the skin resistance and heart rate, attaining the state of mental alertness with relaxation.

3.3 CHANGES IN HEART RATE VARIABILITY

3.3.1 CYCLIC MEDITATION

Heart rate variability (HRV) was studied in cyclic meditation (CM) and supine rest (SR) (Sarang & Telles, 2006). CM included yoga postures followed by guided relaxation. Forty two male volunteers were assessed in CM and SR sessions of 35 minutes, where CM or SR practice was preceded and followed by 5 minutes of SR. During the yoga postures of CM and after CM, low frequency power and the low frequency to high frequency power ratio decreased, whereas high frequency power increased. Heart rate increased during the yoga postures and decreased in guided relaxation and after CM. There was no change in SR. Hence, it appeared that predominantly sympathetic activation occurred in the yoga posture phases of CM while parasympathetic dominance increased after CM.

Summary

During the practice of CM, there was sympathetic activation whereas parasympathetic dominance improved following the practice of CM.

3.3.2 INTEGRATED APPROACH OF YOGA

The integrated yoga practice and guided yogic relaxation on both perceived stress and autonomic responses in healthy pregnant women were measured (Satyapriya, et al., 2009). The 122 healthy women were recruited in the study between 18 and 20 weeks of pregnancy. Subjects were randomized to practicing yoga and deep relaxation or standard prenatal exercises 1-hour daily. Perceived stress decreased in the yoga group and increased in the control group. During a guided relaxation period in the yoga group, compared to baseline, the high-frequency band of the heart rate variability spectrum (parasympathetic) increased in the 20th week and in the 36th week, and both the low-frequency band (sympathetic), and the low-frequency to high-frequency ratio were continuously reduced. Moreover, the low-frequency band remained decreased after deep relaxation in the 36th week in the yoga group. The findings of the study suggested that yoga reduced perceived stress and improves adaptive autonomic response to stress in healthy pregnant women.

Summary

Yoga practice increased the high frequency bands of HRV and reduced low-frequency to high frequency ratio suggestive of adaptive autonomic response to stress in healthy pregnant women.

3.3.3 IYENGAR YOGA

A study investigated the vagal modulation during yoga practice in cardiac patients (Khattab, et al., 2007). Eleven healthy yoga practitioners (7 women and 4 men, ages ranging between 26 and 58 years) were examined. Each individual was subjected to training units of 90 min once a week for five weeks. During session two, they practiced a yoga program developed for cardiac patients by B.K.S. Iyengar. On session three, they practiced a placebo program of relaxation. On each training day they underwent ambulatory 24 hour Holter monitoring. Mean RR interval (interval between two R-waves of the ECG) was significantly higher during the time of yoga intervention compared to placebo and to control. The increase in HRV parameters was significantly higher during yoga exercise than during placebo and control especially for the parameters associated with vagal tone, i.e. mean standard deviation of NN (Normal Beat to Normal Beat of the ECG) intervals for all 5-min intervals (SDNNI) and root mean square successive difference (RMSSD). These above findings suggested that relaxation by yoga training is associated with a significant increase of cardiac vagal modulation. This specific yoga module could be a suitable intervention in cardiac rehabilitation programs. In another study, twenty-seven women and 10 men were enrolled for the study (Shapiro, et al., 2007). The intervention consisted of 20 classes led by senior Iyengar yoga teachers, in three courses of 20 yoga classes each. All participants were diagnosed with unipolar major depression in partial remission. Psychological and biological characteristics were assessed pre- and post-intervention, and participants rated their mood states before and

after each class. Significant reductions were shown for depression, anger, anxiety, neurotic symptoms and low frequency heart rate variability. Moods improved from before to after the yoga classes. So, yoga appears to be a promising intervention for depression.

Summary

Yoga practice showed significant reductions in anxiety, depression, anger, neurotic symptoms and low frequency of heart rate variability. These above findings produced many beneficial emotional, psychological and biological effects.

3.3.4 OTHER TECHNIQUES OF YOGA

Cardiovascular and respiratory changes during yogic breathing exercise *kapalabhati* (KB) was studied in 17 advanced yoga practitioners (Stancak, et al., 1991). Blood pressure, ECG and respiration were recorded continuously for 5 min periods of KB during pre- and post-KB resting periods. The beat-to-beat series of systolic blood pressure (SBP) and diastolic blood pressure (DBP), R-R intervals and respiration were analyzed by spectral analysis of time series. The mean modulus calculated between SBP and R-R intervals was used as a parameter of baroreceptor-cardiac reflex sensitivity (BRS) with increase in SBP and DBP. All frequency bands of R-R interval variability were reduced in KB. Also the BRS parameter was reduced in KB. The amplitude of the high-frequency oscillations in SBP and DBP increased during KB. The low-frequency blood pressure oscillations were increased after KB. It was observed that decreased

cardiac vagal tone during KB which was due to changes in respiratory pattern and due to decreased sensitivity of arterial baroreflex.

Another study was conducted to study the HRV in two yoga practices. Twelve male volunteers (age range, 21 to 33 years) were assessed before and after each practice on separate days (Raghuraj, et al., 1998). Heart rate variability measures were recorded in these subjects. The results showed a significant increase in low frequency (LF) power and LF/HF ratio while high frequency (HF) power was significantly lower following kapalabhati. There were no significant changes following nadishuddhi. The results suggested that kapalabhati modified the autonomic status by increasing sympathetic activity with reduced vagal activity. Nineteen human subjects were studied to assess the influence of different breathing patterns on autonomic cardiovascular modulation during acute exposure to altitude-induced hypoxia (Bernardi, et al., 2001). Nine controls and 10 Western yoga trainees of similar age, while breathing spontaneously, at 15 breaths/min (controlled breathing) and during 'complete yogic breathing' (slow diaphragmatic + thoracic breathing, approximately 5 breaths/min) in yoga trainees, or simple slow breathing in controls were studied. Simulated altitude increased VE in controls but not in yoga trainees; % SaO₂ decreased in all subjects, but more in controls than in yoga trainees. Simulated altitude decreased RR interval and increased indices deduced from spectral analysis of heart rate variability (low frequency/high frequency (LF/HF) ratio and systolic blood pressure in controls, indicating sympathetic activation; these changes

were blunted in yoga trainees, and in both groups during slow or yogic breathing. No effect of altitude was seen on stimulation of carotid baroreceptors in both groups.

In an another study, thirty five male volunteers whose ages ranged from 20 to 46 years were studied in two sessions of yoga-based guided relaxation and supine rest (Vempati & Telles, 2002). Assessments of autonomic variables were made for 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 subjects before and after both types of relaxation. A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation. During guided relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high frequency component increased, suggesting reduced sympathetic activity. Also, subjects with a baseline ratio of LF/HF showed a significant decrease in the ratio after guided relaxation. The results suggest that sympathetic activity decreased after guided relaxation based on yoga, depending on the baseline levels. In another study, HRV was measured using head stand as intervention (Manjunath & Telles, 2003). To assess heart rate variability (HRV) along with non-specific autonomic measures (used in earlier studies), before and after two minutes of the head stand, to compare changes in two categories of subjects, i.e., those who practiced the headstand in a traditional way (without any support) and those who used the support of the wall (a present day adaptation) were the aims of the present study. Forty male volunteers with twenty subjects under each category. The results showed that both categories had an increase in the power of the low

frequency component (LF) and a decrease in the high frequency component (HF) of the HRV spectrum, increased LF/HF ratio, and decreased heart rate. Subjects who practiced the head stand with the support of a wall showed reduced finger plethysmogram amplitude suggesting increased sympathetic vasomotor tone and practicing the headstand without support was associated with an increase in the skin conductance level, suggestive of increased sympathetic sudomotor tone. Hence, both categories showed similar changes in the HRV components though changes in sympathetic vasomotor and sudomotor activity were different. These changes suggest sympathetic activation, irrespective of the method of practice.

Summary

Kapalabhati was found to decrease the systolic blood pressure and low frequency oscillations after its practice. These findings suggested that there was a differentiated pattern of vegetative activation and inhibition associated with KB.

Kapalabhati modified the autonomic status by increasing sympathetic activity with reduced vagal activity. In subjects exposed to high altitude induced hypoxia, slow yogic breathing was found to maintain better blood oxygenation without increasing minute ventilation and reduced sympathetic activation during altitude induced hypoxia.

Other study based on guided relaxation technique, there was a decrease in sympathetic activity following the practice of guided relaxation technique. Heart rate variability was studied on head stand posture in another study suggested that there is sympathetic

activation irrespective of the practice of headstand posture either with support or without support.

Table 3.4.1. Summary table of literature review on Polysomnography and sleep index (Transcendental meditation)

Authors & year of publication	N (sample size)	Experimental Design	Variables studied	Findings
Younger, Adriance & Berger (1975)	Eight subjects [n = 8]	<i>Single group with onetime assessment</i> Recording was made during the practice of TM	EEG & EOG	Two subjects spent considerable portions of their meditation periods in uncertain physiological sleep
Tebecis (1976)	Eight subjects [n = 28] Experimental-14 Control-14	<i>Single group with onetime assessment</i> Recording was made during the practice of TM	EOG	Slow large amplitude, rolling, eye movement increased and a decrease in rapid, low amplitude, jerky eye movement.
Pagano, et al., (1976)	Five subjects [n = 5]	<i>Two groups with onetime assessment</i> Recording was made during the practice of TM and during naps	EEG	Practitioners of transcendental meditation spent considerable parts of meditation sessions in sleep stages 2, 3 & 4.
Herbert & Lehmann (1977)	One hundred and thirty two subjects [n = 132] Experimental-78 Control-54	<i>Two groups with onetime assessment</i> Recording was made during the practice of TM and relaxation	EEG	Twenty one subjects reported frontally dominated theta bursts and no subjective experience of sleep. Fifty-four non-meditating showed no burst during relaxation and sleep onset.

Wachsmuth & Dolce (1980)	Five subjects [n = 5]	<i>Single group with three time assessments</i> Recording was made during & after TM and during sleep	EEG, EOG and heart rate	Amplitude of alpha waves and bilateral theta bursts were observed during TM and during relaxation. The heart rate was slower during meditation as well as light sleep.
Stigsby, et al., (1981)	Twenty six subjects [n = 26] Experimental-13 Control-13	<i>Two groups with three times assessments</i> Recording was made five minutes before, during twenty minutes and after five minutes of TM	EEG	The EEG mean frequency of the TM group was about 1 c/sec slower than that of the control group. Intra or inter hemisphere differences between quantities of EEG activity remained stable during TM.
Travis, et al., (2002)	Fifty one subjects [n=51] Rare TE-17 Occasional TE-17 Cont TE-17	<i>Three groups and one time assessment</i> Recording was made in two comparison groups during choice and simple contingent negative variation tasks	EEG	CNV was higher in simple but lower in choice trials and 6-12 Hz. EEG amplitude and broad band frontal EEG coherence were higher during choice trials.
Fenwick, et al., (1997)	Fifteen subjects [n=15]	<i>Two groups with one time assessment</i> Recording was made between the meditators and non-meditators using EEG and other variables	Oxygen uptake & carbondioxide production and EEG	Drop of O2 consumption have small EEG results showed that TM meditation could hold the level of consciousness at stage onset sleep.

Warrenburg, et al., (1980)	Thirty one subjects [n=31]	<i>Three groups with one time assessment</i> Recording was made by using three different interventions viz., PRT & meditation, sitting with eyes closed and reading from a travel book	EEG & measure of somatic relaxation	Long term progressive relaxation group lower levels of somatic activity across all condition composed to both novice PR and long term TM groups
Jevning, Pirkle & Wilson (1977)	Thirteen subjects [n=13]	<i>One group with two times assessments</i> Recording was made before and after the practice of TM	Plasma amino acid EOG, EEG & EMG	Increased phenylalanine was noted during TM practice and no difference between the groups of total time slept or sleep stage percent was observed.
Wolkove, et al., (1984)	Thirty two subjects [n=32] Experimental-16 Control-16	<i>Two groups with one time assessments</i> Recording was made between experienced meditators vs. Control	Minutes ventilation and respiratory patterns	In meditation minute ventilation decreased significantly during quick breathing while eyes are open awake. Meditation was also associated with decreased response to progressive hypercapnia. During meditation VT was smaller at a given alveolar PCO ₂ than during MA studies because of a decrease in mean inspiratory flow rate (VT/TI).
Wachsmuth , 1980	Five subjects [n=5]	<i>One group with three time assessments</i> Recording was made before, during, after TM	EEG, EOG & heart rate	During TM the amplitude of the alpha wave was higher as before TM and appeared continuously bilateral theta – bursts have also observed. The heart rate was significantly slower during meditation light sleep.

<p>Gallois (1984)</p>	<p>Twenty eight subjects [n=30] TM-10 Autogenic-10 Control-10</p>	<p><i>Three groups with two-times assessment</i></p> <p>Recording was made between TM, autogenic training & control subjects</p>	<p>Polygraph</p>	<p>The number of sleeping episodes during relaxation, cardiac rhythm, significantly decreased in the TM group, increased stability of the E.D.G. during and after relaxation, respiratory rate decreased to a value of 33% of the initial rate, respiratory suspensions were frequent in the TM group, reaching a maximal duration of 50 seconds.</p>
<p>Mason, et al., (1997)</p>	<p>Thirty one subjects [n=31] Long term-11 Short term-9 Non-practitioners-11</p>	<p><i>Three groups with onetime assessment</i></p> <p>Recording was made between long term vs. short term vs. non-practitioners</p>	<p>EEG</p>	<p>There is a graded difference across groups during stages 3 & 4 in theta 2 – alpha 1 power with experimental having greater power than non practitioner, long term practitioner also had increased rapid eye movement (REM) density during REM periods compared to short term practitioner.</p>

Table 3.4.2. Summary table of literature review on Polysomnography and sleep index (Mindfulness based meditation techniques)

Author & year of publication	N (sample size)	Experimental Design	Variable studied	Findings
Kapla, Goldenberg & Galvin-Nadeau (1993)	Seventy seven subjects [n=77]	<p><i>One group with two times assessments</i></p> <p>Recording was made before and after the practice of Mindfulness based Meditation</p>	<p>Analog scales of Global wellbeing, Pain, Sleep, Fatigue, Feeling refreshed in the morning, SCL-90 R, Coping strategies questionnaire, Fibromyalgia impact questionnaire and Fibromyalgia attitude index.</p>	<p>Fifty one percent showed moderate to marked improvement and only they were counted as "responders."</p>
Carlson, et al., (2003)	<p>One hundred and one subjects [n=101]</p> <p>Experimental-59 Control-42</p>	<p><i>Two groups with two times assessments</i></p> <p>Recording was made before and after the practice of Mindfulness based meditation in breast</p>	<p>Demographic & health behavior variables quality of life, mood, stress and counts of NK, NKT, B, T total, T helper</p>	<p>Significant improvements were seen in overall quality of life, symptoms of stress, and sleep quality. But, there were no significant changes in the overall number of lymphocytes or cell subsets, T cell production of IL-4 increased and IFN-gamma decreased, whereas NK cell production of IL-10 decreased.</p>

		cancer and prostate cancer patients	and T cytotoxic cells as well as NK and T cell production of TNE, IFM – gamma, IL-4 and IL-10	
Carlson, et al., (2004)	One hundred subjects [n=100] Experimental-58 Control-42	<i>Two groups with two times assessments</i> Recording was made before and after the practice of Mindfulness based meditation in breast cancer and prostate cancer patients	Qualities of life, mood stress and the hormones measure of alivary cortisol, Plasma HEAS, and salivary melatonin	Improvements were seen in overall quality of life, symptoms of stress, and sleep quality. No significant improvements were seen in mood disturbance. Approximately 40% of the sample demonstrated abnormal cortisol secretion patterns in both pre- and post-intervention. No other changes were observed in other variables.
Carlson & Garland (2005)	Sixty three subjects [n=63]	<i>One group with two times assessments</i> Recording was made before and after the practice of Mindfulness meditation to evaluate the sleep quality of cancer patients	Scales for Stress, Mood disturbance and Fatigue	There was significant reduction in stress mood disturbance and fatigue
Kreitzer, et.al., (2005)	Twenty subjects [n=20]	<i>One group with two times assessments</i>	Quality of life anxiety depression	Significant improvements in the quality and duration of sleep continued for 6 months after completion of the

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		Recording was made before and after the practice of Mindfulness based stress reduction Program in solid organ transplant recipients	insomnia	mindfulness-based stress reduction course.
Yook, et al., (2008)	Nineteen subjects [n=19]	<p><i>One group with two times assessments</i></p> <p>Recording was made before and after the practice of Mindfulness based cognitive therapy in patients with anxiety disorders</p>	Penn state worry questioner ruminative response scale, Hamilton anxiety rating scale, Hamilton depression rating scale score.	Participants showed significant improvement in Pittsburgh Sleep Quality Index, Penn State Worry Questionnaire, Ruminative Response Scale, Hamilton Anxiety Rating Scale, and Hamilton Depression Rating Scale scores at the end of the 8-week program as compared with baseline.
Morone, et al., (2008)	Twenty seven subjects [n=89]	<p><i>One group with two times assessments</i></p> <p>Recording was made before and after the practice of Mindfulness meditation program of 8 Months' in two groups of chronic low back pain patients</p>	Diary entries	A number of participants reported improved sleep latency as well as quality of sleep. Participants described achieving well-being during and after a meditation session that had immediate effects on mood elevation but also long-term global effects on improved quality of life.

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<p>Fernros, Furhoff & Wandell (2008)</p>	<p>One hundred and fifty two subjects [n=152] Experimental-83 Control-69</p>	<p><i>Two groups with two times assessments</i> Recording was made before and six months after a 1- week course of Mind body medicine</p>	<p>Health related quality of life (HRQOL) having 30 subscales.</p>	<p>Men and women improved their health related quality of life and sense of coherence.</p>
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Table 3.4.3. Summary table of literature review on Polysomnography and sleep index (Tantra yoga meditation)

Authors & Year of publication	N (sample size)	Experimental Design	Variables studied	Findings
Corby, et al., (1978)	Thirty six subjects [n=36]	<p><i>Three groups with one time assessment</i></p> <p>Recording was made during the meditation of three groups as they were divided based on the level of meditation proficiency</p>	Skin resistance , heart rate, respiration, autonomic orienting responses and subjective experience	Proficient meditators demonstrated increased alpha and theta power minimal evidence of EEG defined sleep and decreased autonomic orienting to external situation.

Table 3.4.4. Summary table of literature review on Polysomnography and sleep index (Music therapy)

Authors & Year of publication	N (sample size)	Experimental Design	Variables studied	Findings
Tsai (2004)	One hundred subjects [n=100] Experimental-41 Control-59	<i>Two groups with two times assessments</i> Recording was made before and after the audiovisual training	Scales that measures anxiety, sleep, relaxation	Audio-visual relaxation training significantly improved anxiety, sleep, and relaxation in the treatment group as compared to the control group
Lai (2005)	Sixty subjects [n=60]	<i>Two groups with repeated assessments</i> Recording was made before and after three weeks of music listening	Pittsburgh sleep quality index (PSQ) and Epworth sleepiness scale	Music resulted in significantly better sleep quality in the experimental group, as well as significantly better components of sleep quality: better perceived sleep quality, longer sleep duration, greater sleep efficiency, shorter sleep latency, less sleep disturbance and less daytime dysfunction.
Khalsa, et al., (2009)	Forty five subjects [n=45] Life style-15 Yoga & meditation-15 Control-15	<i>Three groups with two times assessments</i> Recording was made before and after the interventions in three groups	Self-report questionnaires that evaluated music performance anxiety, mood, PRMDs, perceived stress, and sleep quality	Both yoga groups showed a trend towards less music performance anxiety and significantly less general anxiety/tension, depression, and anger at end-program relative to controls, but showed no changes in PRMDs, stress, or sleep.

Table 3.4.5. Summary table of literature review on Polysomnography and sleep index (Other yoga techniques)

Author & year of publication	N (sample size)	Experimental Design	Variables studied	Findings
Chen, et al., (2009)	One twenty eight subjects [n=128] Experimental-62 Control-66	<i>Two groups with two times assessments</i> Recording was made before and after the intervention of yoga and control groups	Sleep quality, depression, and self-perception of health status	Most of the mental health indicators of the participants in the experimental group had significantly improved after the silver yoga interventions, and many of the indicators improved after 3 months of intervention and were maintained throughout the 6 months study.
Vera, et al., (2009)	Twenty six subjects [n=26] Experimental-16 Control-10	<i>Two groups with two times assessments</i> Recording was made before and after the intervention of yoga and control groups	Subjective Sleep Quality (SSQ), Adrenocorticotropic hormone (ACTH), cortisol and dehydroepiandrosterone sulphate (DHEA-S)	The yoga group had lower PSQI scores and higher blood cortisol levels than control subjects.

Table 3.4.6. Summary table of literature review on autonomic and respiratory variables (Zen meditation)

Authors & Year of Publication	N (Sample size)	Design of the study	Variables studied	Findings
Kubota et al., (2001)	Twelve subjects [n=12]	<i>One group with one time assessment</i> Simultaneous recording was made during the practice of <i>zen</i> meditation in both men and women	EEG, ECG	Increased sympathetic and parasympathetic indices during the appearance of Fm theta; Negative correlation -Theta band activities [frontal] & sympathetic activation

Table 3.4.7. Summary table of literature review on autonomic and respiratory variables (Brahma kumari raja yoga meditation)

Authors & Year of Publication	N (Sample size)	Design of the study	Variables studied	Findings
Telles & Desiraju, (1993)	Eighteen males [n=18]	<i>One group with repeated assessments</i> Recording was made during the practice session of meditation and three control sessions	Autonomic & respiratory variables	Increased heart rate in meditation; Changes in autonomic variables -both activation and relaxation - simultaneously in different subdivisions of the autonomic nervous system.

Table 3.4.8. Summary table of literature review on autonomic and respiratory variables (Raja yoga meditation)

Authors & Year of Publication	N (Sample size)	Design of the study	Variables studied	Findings
Bagchi & Wenger (1957)	Fourteen subjects [n=14] Experimental-7 Control-7	<i>Two groups with two times assessments</i> Recording was made before and after the practice of intervention in both experimental and control groups	Autonomic & respiratory variables	Increase in skin resistance & decrease in respiratory rate
Wenger & Bagchi (1961)	Eighteen subjects [n=8] Experimental-9 Control-8	<i>Two groups with two times assessments</i> Recording was made before and after the practice of intervention in both experienced and novices practitioners	Autonomic & respiratory variables	Increased heart beat-both groups; Decreases respiratory rate & palmar conductance-both groups; 20% reduction in pulse volume in experienced meditators

Table 3.4.9. Summary table of literature review on autonomic and respiratory variables (Other meditation techniques)

Authors & Year of Publication	N (Sample size)	Design of the study	Variables studied	Findings
Peng, et al., (2004)	Eleven subjects [n=11]	<i>One group with repeated assessments</i> Recording was made during the practice of three protocols viz., relaxation response, breath of fire & segmented breathing.	Beat-to-beat heart rate and continuous breathing signals	An increase in mean heart rate during the intervention of ‘breath of fire’ and also change in other intervention were observed.
Satyaprabha, et al., (2008)	One seventy two subjects [n=176] Yoga-18 Exercise-16 Healthy controls-142	<i>Three groups with two times assessments</i> Recording was made before and after the intervention of ten weeks in yoga group, exercise group and healthy volunteers	Autonomic function tests (AFTs)	The yoga group showed significant improvement in parasympathetic parameters and a decrease in seizure frequency scores. There was no improvement in blood pressure in either of the group was observed.

Table 3.4.10. Summary table of literature review on autonomic and respiratory variables (Kundalini meditation)

Authors & Year of Publication	(N) Sample size	Experimental Design	Variables studied	Findings
Arambula, et al., (2001)	Single subject [n=1]	<i>Single subject with three times assessments</i> Recording was made before, during and after the intervention	EEG, Heart rate [HR], Skin Conductance level [SCL], Blood Volume Pulse [BVP] & Respiration	Decreased breath rate; increased alpha power in parietal and occipital electrodes and a shift in breathing patterns with the increase in alpha frequencies.

Table 3. 4.11. Summary table of literature review on autonomic and respiratory variables (Meditation on ‘OM’)

Authors & Year of Publication	(N) Sample size	Experimental Design	Variables studied	Findings
Telles & Desiraju (1992)	Single subject [n=1]	<i>Single subject with two times assessments</i> Recording was made during single thought state and no thought state of the mind	Autonomic & respiratory variables	Distinct breath rate & pattern in the two states
Telles, Nagarathna & Nagendra (1995)	Seven subjects [n=7]	<i>One group with two times</i>	Autonomic & respiratory	Decrease in breath rate; Increase in the skin resistance in both conditions

		<i>assessments</i> Recording was made during mental chanting of 'OM' and non-targeted thinking	variables	
Telles, Nagarathna & Nagendra (1998)	Twelve subjects [n=12]	<i>One group with three times assessments</i> Recording was made before, during and after each practice for three interventions	Autonomic & respiratory variables	The two sessions viz., mental repetition of 'one' and 'non-targeted thinking' decreased heart rate & breath rate whereas in meditation session skin resistance was reduced

Table 3.4.12. Summary table of literature review on the measures of heart rate variability (Cyclic meditation)

Authors & Year of Publication	(N) Sample size	Experimental Design	Variables studied	Findings
Sarang & Telles (2006)	Forty two subjects [n=42] Experimental-42 Control-42	<i>Two groups with two times assessments</i> Recording was made before, during and after the practice of two independent interventions	Frequency domain measures of heart rate variability	During cyclic meditation (CM) and after CM, low frequency power and the low frequency to high frequency power ratio decreased, whereas high frequency power increased. Heart rate increased during the yoga postures and decreased in guided relaxation and after CM.

Table 3. 4.13. Summary table of literature review on the measures of heart rate variability (Integrated approach of yoga)

Authors & Year of Publication	(N) Sample size	Experimental Design	Variables studied	Findings
Satyapriya, et al., (2009)	Ninety subjects [n=90] Experimental-45 Control-45	<i>Two groups with repeated assessments</i> Recording was made before, 20 th week and 36 th week of pregnancy in both yoga and control groups	Frequency domain measures of heart rate variability	The high-frequency band of the heart rate variability spectrum increased by 64% in the 20th week and by 150% in the 36th week, and both the low-frequency band and the low-frequency to high-frequency ratio were reduced continuously.

Table 3.4.14. Summary table of literature review on the measures of heart rate variability (Other techniques of yoga)

Authors & Year of Publication	(N) Sample size	Experimental Design	Variables studied	Findings
Raghuraj, et al., (1998)	Twelve subjects [n=12]	<i>One group with two times assessments</i> Recording was made before and after the practice of Kapalbhathi and Nadisuddhi as two separate interventions	Frequency domain measures of HRV	An increase in low frequency (LF) power and LF/HF ratio while high frequency (HF) power was lower following <i>kapalabhati</i> was observed. There were no significant changes following <i>nadisuddhi</i> .

Summary Table of Literature Review | 2011

Vempati & Telles (2002)	Thirty five subjects [n=35] Yoga based guided relaxation-15 Guided relaxation- 25	<i>Two groups with three times assessments</i> Recording was made before, during and after the practice of Guided relaxation technique	Autonomic variables and frequency domain measures of HRV	The power of the high frequency component increased following the practice of guided relaxation technique and also, subjects after the recording showed a significant decrease in the ratio of LF/HF < or = 0.5.
Manjunath & Telles (2003)	Forty subjects [n=40] With support-20 Without support-20	<i>Two groups with two times assessments</i> Recording was made before and two minutes after the practice of the interventions viz., head stand posture without support and with support	Frequency domain measures of HRV	Both categories of subjects had an increase in the power of the low frequency component (LF) and a decrease in the high frequency component (HF) of the HRV spectrum, increased LF/HF ratio, and decreased heart rate.

4.1 AIM OF THE STUDY

The present study was aimed to study the effect of cyclic meditation on sleep architecture using polysomnography measures and measuring the indicators of polysomnography measures, subjective rating of sleep and heart rate variability.

4.2 OBJECTIVES OF THE STUDY

Following are the objectives of the study

- i. Comparing Polysomnography measures viz., EEG, EMG and EOG following the practice of cyclic meditation (CM) with respect to supine rest (SR) using a Polysomnography equipment.
- ii. Comparing the subjective rating of sleep following the practice of CM with SR using a self rated sleep scale.
- iii. Comparing the frequency and time domain variables of heart rate variability in CM with SR through a polygraph.

4.3 RATIONALE OF THE STUDY

In several previous studies meditation practice has been shown to reduce physiological arousal (in terms of metabolism, sympathetic activity and levels of attention). However, the results varied across meditation practitioners and techniques. In spite of this inter and intra meditation variability, there remains a view that meditation is a state of hypo-arousal. Hypo-arousal may suggest that mental alertness is reduced. Meditation also has been shown to reduce stress and increase feelings of peace and calm. An assumption may be made based on the facts that real-world stress influenced cardio-respiratory functions

during sleep, hence influencing the restorative function of sleep. The present study was planned to measure the sleep architecture (based on Polysomnography variables and self rated sleep scale) and heart rate variability (both frequency domain and time domain measures) during sleep following the practice of cyclic meditation. This was considered important to get a comprehensive model of the meditation technique, in this case cyclic meditation.

Cyclic meditation has been found to be an effective technique in altering the autonomic status and establishes an equilibrium state in autonomic nervous system. Hence the practice of cyclic meditation might induce the slow wave sleep and establish the autonomic balance.

4.4 HYPOTHESIS

Cyclic meditation combines ‘stimulating’ and ‘calming’ practices, based on a statement in a yoga text, *Karika* (commentary) on *Mandukya Upanisad*, which suggests that this combination will be most helpful to reach mental equilibrium. The underlying idea is that for most persons the mental state is routinely somewhere between the extremes of being ‘inactive’ or of being ‘agitated’. Stimulations are necessary to activate the inactive and calming process leads an agitated mind to balance.

The hypothesis of this study was that the practice of cyclic meditation would induce positive impact in sleep architecture along with heart rate variability during sleep characterized by producing more calmness and serenity and reducing the amount of stress.

4.5 NULL HYPOTHESIS

Null hypothesis postulates that

1. CM has no beneficial effects on Rapid eye movement sleep (REM) and NREM (Non rapid eye movement) states of sleep.
2. CM does not bring about autonomic balance, and
3. Subjective rating of sleep shows no benefits of CM as an intervention.

5.0 METHODOLOGY

In this thesis the changes in (i) polysomnography measures, (ii) autonomic & respiratory variables and heart rate variability, (iii) a questionnaire to self-rate the sleep during previous night, were studied in normal volunteers following the practice of two yoga relaxation techniques viz., cyclic meditation and supine rest.

5.1 SUBJECTS

5.1.1 SAMPLE SIZE

Thirty subjects were studied in two separate sessions i.e., cyclic meditation and supine rest. The sample size was calculated based on an effect size obtained from the previous study of changes in cyclic meditation (Sarang and Telles, 2006c). It was calculated using G*Power software, Version 3.0.10 (Faul, et al., 2007), where the ' α ' was 0.05, power = 0.95 and the effect size was calculated as 0.7 and 0.65 respectively (Cohen's effect size = 0.7 and 0.65). Hence, the recommended sample size was thirty for Polysomnography recording and forty for Heart rate Variability measures. The number of subjects varied across the variables studied. The details are as follows:

Sl. No.	Variables studied	No. of Subjects	No. of recording sessions
1.	Polysomnography measures	30	30 x 2 = 60
2.	Autonomic & respiratory variables and heart rate variability	40	40 x 2 = 80
3.	Self rated sleep during previous night	30	30 x 2 = 60

5.1.2 AGE AND SOURCE OF SUBJECTS

The subjects were 30 male volunteers with age range: 20–33 years (mean \pm SD: 26.3 \pm 4.6 years).

The subjects with minimum one year experience of cyclic meditation and supine rest were selected for the study. The subjects were residential graduate and postgraduate students of Swami Vivekananda Yoga Anusandhana Samsthana, a Deemed University, Prashanti Kutiram, Bangalore, India.

The details about the subjects and their experience are presented in **Table 5.1.2**.

Table 5.1.2: Explains about the subjects and their experience in Cyclic Meditation

Sl. No.	Name	Gender	Age	Experience in months	No. minutes/day	Number of days/month
1.	DDD	M	19	3	30	25
2.	APM	M	26	2	45	24
3.	BKT	M	27	6	60	21
4.	HRS	M	24	6	30	24
5.	JSC	M	39	5	45	24
6.	OPS	M	26	6	60	27
7.	VRD	M	29	4	45	27
8.	VTS	M	24	5	60	27
9.	KKG	M	30	4	30	24
10.	SPS	M	26	4	45	24
11.	SMG	M	26	3	60	24
12.	MKP	M	28	3	30	28
13.	SKK	M	33	3	30	28
14.	BRS	M	26	4	30	28
15.	JPP	M	30	6	30	28
16.	DND	M	24	6	45	27
17.	RKS	M	26	6	45	24
18.	MHM	M	28	6	45	24
19.	RKR	M	28	6	30	24
20.	SHM	M	23	6	30	24
21.	DVR	M	20	6	30	24
22.	VKG	M	20	6	30	24
23.	JMS	M	25	3	30	21
24.	AKS	M	20	3	30	21
25.	SMS	M	20	3	45	21
26.	JKS	M	34	3	45	21
27.	TSG	M	30	3	45	24
28.	SKG	M	25	3	30	24
29.	BPS	M	21	4	30	24
30.	RRV	M	31	2	45	24
31.	SHV	M	25	2	30	21
32.	RPS	M	26	3	45	24
33.	AKT	M	24	3	60	24
34.	MKJ	M	25	4	30	21
35.	PKR	M	25	2	45	18
36.	DBS	M	26	3	30	24
37.	RSK	M	25	3	40	27
38.	ABT	M	26	3	30	24
39.	MKS	M	27	4	30	24
40.	DKH	M	24	2	30	30
		Mean	26.03	3.98	38.88	24.28
		SD	4.02	1.44	10.59	2.49

5.1.3 INCLUSION CRITERIA

The subjects who fulfilled following conditions were included in the study: (i) healthy volunteers based on a routine clinical examination with age range between 18 and 33 years, (ii) male subjects [as polysomnography (Baker & Driver, 2004) and autonomic & respiratory variables (Yildirim, et al., 2002) have been shown to vary with the phases of the menstrual cycles in females] (iii) sleep and wakeful cycles of all the subjects were taken into consideration to include them in the trial (iv) subjects with a minimum one year experience practicing CM and SR.

5.1.4 EXCLUSION CRITERIA

The following criteria were used to exclude the volunteers: (i) the presence of cognitive and/or neurological and/or metabolic disorders based on a medical history and routine clinical examination, (ii) volunteers who showed extra systoles during ECG recording, (iii) intake of medications which are known to influence cognitive, autonomic and metabolic functions and sleep (e.g. tranquilizers, anti histaminics), (iv) smoking or alcoholism which may have influenced the respiratory and autonomic variables and (v) any sleep disorders.

5.1.5 ETHICAL CONSIDERATIONS

A signed informed consent was obtained from all the subjects following a detailed explanation of the study. The study was approved by the Institutional Ethics Committee.

5.1.6 RANDOMIZATION

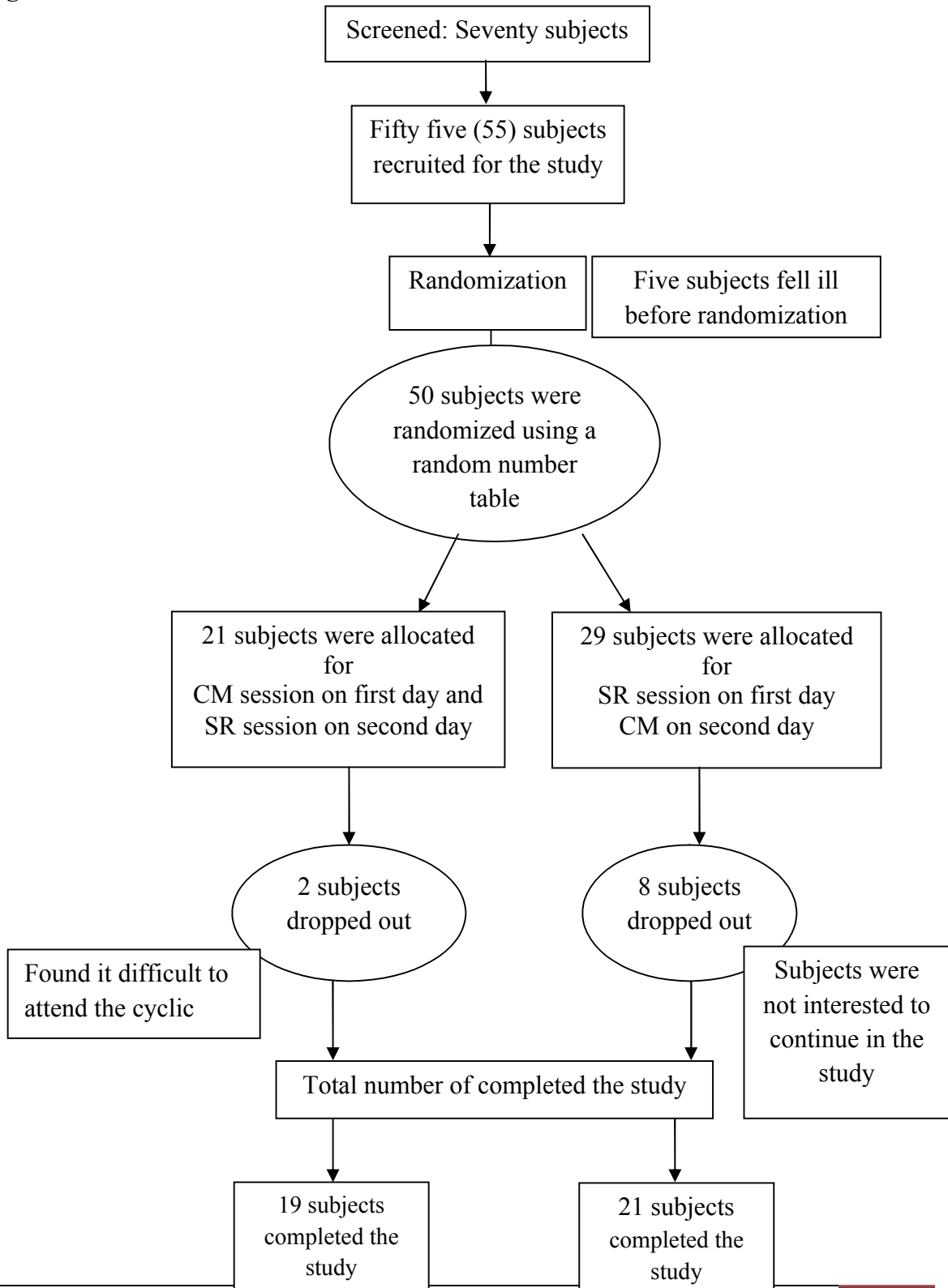
The cyclic meditation and supine rest sessions were randomly allocated using a random number table. This was to prevent the influence of being exposed to the laboratory for the first time ('order effect') from influencing the results. The recordings were made on different nights, not necessarily on consecutive nights but at the same time during night.

5.2 DESIGN OF THE STUDY

The pilot trials were conducted on ten subjects for polysomnography measures, autonomic & respiratory variables, and self rated sleep of the previous night in order to find out the effectiveness of the study design and duration of meditation experience, appropriateness of study variables, and to observe the trends following the practice of cyclic meditation.

The details about the trial profile is presented in **Fig. 5.2**

Fig.5.2: TRIALPROFILE



5.2.1: REASONS FOR DROP OUT

1. Participants fell ill after the recruitment.
2. Found it difficult to attend the meditation class.
3. Participants were not interested to continue the study further.

5.2.2 STRUCTURE OF SESSIONS

Subjects were assessed on three separate nights in the sleep laboratory. The first night was for acclimatization to the laboratory environment. The electrodes were connected as for a standard recording but no recording was taken. The other two recording sessions were three days apart. On one day participants were asked to practice cyclic meditation two times a day, i.e., at 6 a.m. and 6:45 p.m. After that they were asked to report to the sleep laboratory at 9:00 p.m. and a whole night recording was made. On the other day of recording participants were asked to practice unguided supine rest in *shavasana* (SR), as a control for cyclic meditation, twice in the day, and at the same time and for the same duration as the cyclic meditation sessions. Similarly participants reported to the sleep laboratory at 9:00 p.m. and a whole night polysomnography record was taken. The order of the sessions was randomized using a random number table. On both recording days [i.e., cyclic meditation (CM) and supine rest (SR)], participants were asked to avoid all other physical activity (e.g., walking, jogging, or other yoga practices). However they continued with the rest of their routine (e.g., listening to lectures on yoga). Since all of them were residing in the same yoga center, the rest of their routine was relatively comparable. The design of the study is presented in **Figure 5.2.1.A** and **Figure 5.2.1.B**.

Figure 5.2.1.A: Design of the study of polysomnography variables and self rated sleep

<p>PRACTICE TIMINGS: 6:00 AM</p> <p>DURATION OF PRACTICE: 23 minutes</p>	<p>PRACTICE TIME: 6:45 PM</p> <p>DURATION OF PRACTICE: 23 MINUTES</p>	<p>WHOLE NIGHT PSG RECORDING VARIABLES:</p> <ol style="list-style-type: none"> 1. EEG 2. EMG 3. EOG 4. ECG 5. RESPIRATION 	<p>RECORDING AFTER SLEEP:</p> <p>SELF RATED SLEEP</p> <ol style="list-style-type: none"> 1. RESPONSES ARE EITHER IN TIMES OR MINUTES 2. VAS
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Figure 5.2.1.B: Design of the study of heart rate variability

<p>PRACTICE TIME: 6:00 AM</p> <p>DURATION OF PRACTICE: 23 MINUTES</p>	<p>PRACTICE TIME: 6:45 PM</p> <p>DURATION OF PRACTICE: 23 MINUTES</p>	<p>WHOLE NIGHT HEART RATE VARIABILITY MEASURES:</p> <ol style="list-style-type: none"> 1. FREQUENCY DOMAIN MEASURES 2. TIME DOMAIN MEASURES
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5.2.3 ORDER OF SESSIONS

The cyclic meditation and supine rest sessions were randomized using a random number table.

Table 5.2.2.A: Subjects assigned to CM session after randomization

SL. NO.	SUBJECT CODE	SESSION
1.	JSC	CM
2.	DND	CM
3.	VRD	CM
4.	KKG	CM
5.	APM	CM
6.	JMS	CM
7.	AKS	CM
8.	RKS	CM
9.	BKT	CM
10.	SMS	CM
11.	JKS	CM
12.	BKS	CM
13.	RRV	CM
14.	SHM	CM
15.	RPS	CM
16.	AKT	CM
17.	MKJ	CM
18.	PKR	CM
19.	DBS	CM

Table 5.2.2.B: Subjects assigned to SR session after randomization

SL. NO.	SUBJECT CODE	SESSION
1.	VDD	SR
2.	TSG	SR
3.	SHM	SR
4.	SMG	SR
5.	SKG	SR
6.	SKK	SR
7.	MHM	SR
8.	HRS	SR
9.	BPS	SR
10.	RKR	SR
11.	DVR	SR
12.	VKG	SR
13.	VTG	SR
14.	SPS	SR
15.	MKP	SR
16.	OPS	SR
17.	JPP	SR
18.	RSK	SR
19.	ABT	SR
20.	MKS	SR
21.	DKH	SR

5.3 VARIABLES STUDIED

The following variables were studied:-

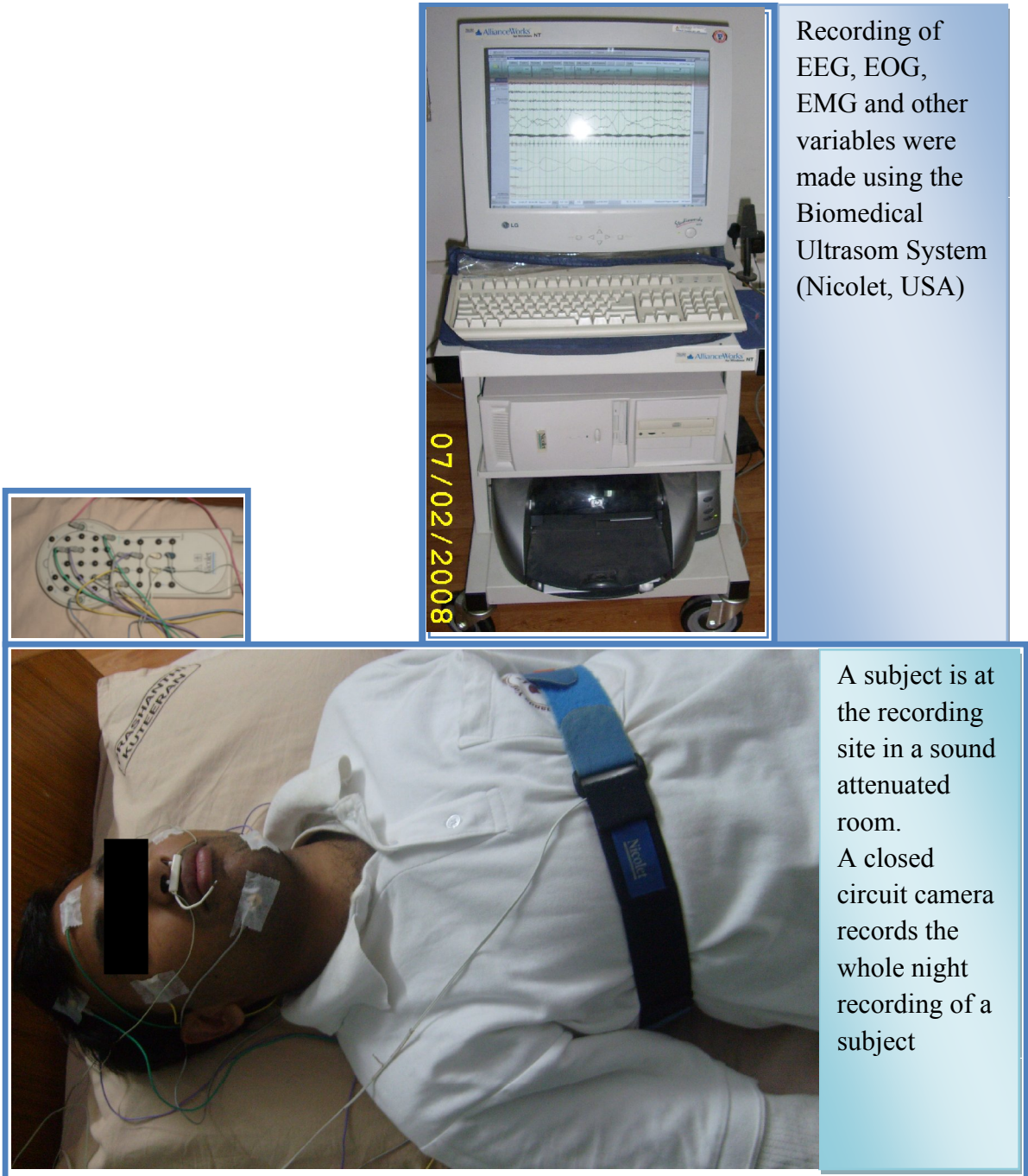
5.3.1 POLYSOMNOGRAPHY VARIABLES

Polysomnography variables viz., EEG, EMG and EOG were measured to score the different stages of sleep and in order to assess the changes following the nights of cyclic meditation and supine rest (Nicolet, Model No.OEM-S2122D00NM, Alliance Biomedica for Windows NT, USA). A subject connected with electrodes and sensors is presented in

Plate 5.3.1.A

Recordings of electroencephalogram (EEG), Electro-oculogram (EOG), and electromyogram (EMG) were carried out using the same machine. The system has 32 amplifiers so that the EEG could be recorded in 32 channels with 128 possible montages.

Plate 5.3.1.A: A subjects hooked with electrodes and sensors at sleep laboratory



Recording of EEG, EOG, EMG and other variables were made using the Biomedical Ultrasom System (Nicolet, USA)

A subject is at the recording site in a sound attenuated room. A closed circuit camera records the whole night recording of a subject

5.3.1. A Electroencephalogram (EEG)

EEG activity was the core variable of polysomnographic monitoring. Indeed while it was not possible to score part of sleep without using EMG or EOG (Looris, Harvey & Hobort, 1937).

5.3.1. A1 Electrode placement

The standard 10-20 system terminology developed by Jasper (Jasper, 1958) was followed for the recording of EEG. This system involved measuring electrode placements using four landmarks: the nasion, inion and left and right pre auricular points. The distances between nasion-inion and left and right pre auricular points were measured accurately as they were specific to each individual. The electrodes were placed at intervals of 10 or 20 percent of total distance between landmarks. A picture depicting the International 10-20 system is shown in **Plate 5.3.1.A1a**.

Once the measurements were taken and the precise location of the electrodes marked, the hair follicles were separated to cleanse the scalp with spirit. Electrode cups were then attached to the scalp. A conducting paste (Ten20 conductive paste) was added through a small hole at the top of the electrode cup. A 10-20 conductive paste was applied to the inside of the electrode cups before attaching them. Silver chloride electrodes were used as the mixture of some metals in electrodes might cause artifacts.

5.3.1. A2 Derivations

The manual published by Rechtschaffen and Kales (Rechtschaffen & Kales, 1968) recommends referential recording with single EEG lead, either C3 or C4, referenced to indifferent electrode placed on the ear lobe or contralateral mastoid (A1 or A2). The derivations used were C3-A2 or C4-A1. But according to the American Academy of Sleep Medicine (AASM) the recommended derivations were F4-A1, C4-A1 and O1-A2. Those proposed derivations were recommended not because of focalized EEG activity but for reasons of safety. Moreover in the present study the indifferent electrodes on the mastoid rather than ear lobes were used. There were many advantages in using C4-A1 derivation. On one hand the relatively large inter electrodes optimizes EEG signal amplitudes for sleep analysis, and on the other most sleep graph-elements, sleep staging criteria (vertex sharp waves, K complexes and spindles) are well visualized in these regions. F4-A1 derivation were used for high voltage NREM slow waves seen maximally in frontal regions whereas O1-A2 derivation was used for alpha rhythm of relaxed wakefulness which is maximal over the occipital poles. These derivations were also useful in recognizing sleep onset, particularly in subjects with complex onsets, particularly in subjects with few slow eye movements.

5.3.1. A3 EEG channel setting

5.3.1.A3a Gain

The recommended calibration gives a wave deflection of 7.5 to 10 mm for 50 microvolt signal. It was necessary to use 5 mm amplification for a 50 microvolt signal and in

subjects with very low voltage EEG signals, 14 mm amplification for a 50 microvolt signal.

5.3.1. A3b Time constant

The time constant was 0.3 seconds. It comprised a high pass 35 Hz filter. The time constant was not changed or shortened in any way (0.1) even if there was interference from slow potentials due to sweat as this would have an effect on the EEG signal such as inhibiting the slow waves in deep NREM sleep.

5.3.1. A3c Filters

These were indeed to provide the maximal visualization of sleep frequency bands, the delta band, spindles as well as the beta band (15 to 35 cps), and minimize high frequency interference, particularly that produced by EMG. Filters of 0.1 to 35 Hz were used in the present study.

5.3.1. B Electrooculogram (EOG)

To assess sleep accurately it is essential to recognize eye movement activity during sleep. It is essential to easily figure out differences in eye movements corresponding to different sleep stages.

An electrooculogram records the corneo-retinal potential difference which is reflected in form of in phase and out of phase deflections.

5.3.1. B1 Electrode placement (EOG)

The electrodes were placed as recommended by Rechtschaffen and Kales (Rechtschaffen & Kales, 1968) i. e., the right and left outer canthus (right and left eye movements). To detect horizontal and vertical eye movements, electrodes were offset from the horizontal, at approximately 1 cm above and 1 cm below the horizontal plane.

The skin surface to which the electrodes were applied was cleansed with spirit. This is particularly true for extended recordings. Like the EEG electrodes, the electrodes were placed on the places mentioned above with Ten20 paste. To stick on to the surface of the skin and to have uninterrupted recording, electrodes were held tight with micro pore tapes.

5.3.1. B2 Derivation

It was recommended that the two ocular electrodes be referenced to the same A1 or A2 electrode, either ROC/A2, or LOC/A1, or the contrary. The same reference was recommended as that for the EEG signal. This had the advantage of registering eye movements as out-of-phase per deflection while EEG activity (K complexes and slow waves, for example) could be seen as in-phase deflections. This eliminates certain artifacts, while having the capacity to distinguish eye movements in certain difficult cases.

These derivations were adequate to analyze human sleep satisfactory.

5.3.1. B3 EOG channel settings

EOG channel settings were the same as for EEG although some changes were made notable for the low-pass filter which must be limited to 0.5 Hz as there is no rapid component in eye movements and even a nystagmus can be detected with this filter. On the contrary, high frequency interference (EMG) was particularly problematic in observing certain low amplitude eye movements which should thus be completely eliminated. Some laboratories use shorter time constant (0.15) to minimize contamination from the slow wave in deep NREM sleep on EOG lines. The danger of this type of calibration a part from the fact that it does not completely eliminate contamination from slow sleep waves, is that it makes it impossible to actually distinguish the slow eye movements which are so useful in determining sleep onset.

5.3.1. C Electromyogram (EMG)

The electrodes were placed on muscles beneath the chin (mentalis and submentalis) to evaluate muscular activity during sleep.

5.3.1. C1 Electrode placement

The electrodes were placed beneath the chin, overlying the chin muscles. It was advisable to fix at least three electrodes to allow for a back-up electrode during the night but in the present study two electrodes were used. The chin was thoroughly cleansed before fixing the electrodes and to make sure that they were securely fixed, particularly in case of patients with a beard.

5.3.1. C2 Derivations

Any combination of the two placements was used. When calibrating at patient's bedside, the derivation producing the best quality was used.

5.3.1. C3 EMG channel setting

5.3.1. C3a Gain

Gain was as high as possible. Fourteen to fifteen mm amplification for a 50 microvolt signal was used. Muscle activity during sleep was essentially used to differentiate REM sleep from the other stages. As the EMG signal may be very weak, particularly at the end of the night, it was essential to use high amplification.

5.3.1. C3b Time constant

As EMG signal was the high frequency recorded in polysomnography and it was necessary to use a short time constant. The reference manual (Rechtschaffen & Kales, 1968) recommends using a time constant of 0.1 second, i.e., a 1 KHz high-pass filter. So in the present study the high filter was made higher to 1 KHz.

5.3.1. C3c Filters

The filter was at 0.5 Hz to monitor the maximum frequencies used in indicating muscular signals.

5.3.1. D calibrating of bio-signals while subject is in the bed

Preparation was meticulously checked when the subject was in bed. Each laboratory has its own checking procedure so only essential steps have been listed here, to ensure that

the system operates during the night. It was also ensured that subject was comfortable at the bed before starting the calibration process described below.

5.3.1. D1 EEG

Subject was asked to relax, with eyes closed for 30 seconds. It was also ensured that the alpha rhythm was adjusted correctly, modifying the amplitude if necessary. Disconnecting the 50Hz rejecter filter and checking that tracing continues normally, correcting any faults. Reconnecting the 50 Hz rejecter filters and proceed with the other calibrations.

5.3.1. D2 EOG

Subjects were asked to look up, down, right and left. The EOG tracings were marked for the respective calibration for standardized scoring.

5.3.1. D3 EMG

Subject was also asked to clench the teeth, chew, etc.; the amplification gains were adjusted at this stage

5.3.1. E Autonomic variables; Electrocardiogram (ECG)

In the present study, polysomnography recording involved large number of autonomic variables. One of them is ECG.

Electrodes were cupped, fixed with cotton used for sleep recordings, but in the interests of patient comfort, self-adhesive electrodes which stick easily to skin and which could be cleansed easily with spirit.

5.3.1. E1 Placing electrodes

Several electrode positions exist. One of the most common is recording with Limb lead-I electrodes.

5.3.1. E2 ECG channel setting

ECG sensitivity varies according to the position of the electrodes, which was adjusted when recording started and during calibration. A constant of 0.1 sec, i.e. a 0.5 Hz low-pass filter with a 10 Hz high-pass filter was set during the recording.

5.3.1. E3 Calibrating the subject

When monitoring started, the gain was set according to the position of the electrodes. It was important to note that the speed during sleep recording (10 or 15 mm/sec) and the subject's movements modified inter electrode distances. The ECG's carried out in polysomnography could only provide partial elements. It was however necessary to make sure that the P and QRS waves were detectable.

5.3.1. F Respiratory variables

There were two types of measurements for respiratory variables: qualitative measurement and self-qualitative measurements.

5.3.1. F1 Thoracic and abdominal straps

Mercury capillary length gauges consist of sealed, electric tube, containing an electric conductor (mercury). The gauze stretched and reduced by the respiratory movements which modified its length and section, and thus increased its resistance. This resistance variation was transformed into an electrical variation through the intermediary of a wheat

stone link operated by a high electric battery. As the current fluctuation is inversely proportional to the length of the gauze, two relatively long gauzes (circumference gauzes) gives an approximate measurement of volume (Loveridge, Perez-padilla & West, 1984).

Graphite straps comprised of a small rubber cylinder made in graphite. Variation in volume created by the movement of the rib cage for the abdomen cause the strap, stretches and modifies the section provoking a change in the resistance. The resistance variation was transformed into an electrical variation through a wheat stone link operated by a high capacity electric battery. It was more difficult to obtain a quantitative measure of the volume with this type of gauze. The amplitude observed is proportionate to stretching. The advantage with this type of monitor is its great stability and high sensitivity.

5.3.1. F1a Placing the straps

It was essential to use two straps, one to measure variation in the volume of ribcage and the other to the abdomen. The thorax and abdomen normally expands in synchronization. This mechanism appears on the trace as phased respiratory movement recorded for each strap. In the case of particular respiratory events involving either a reduction of diaphragm tone or respiratory muscle tone or the partial or total obstruction of the upper airways, respiration of paradoxical type may appear. This deviation is characterized on the recording by de-phasing and amplitude changes of the two tracks monitoring the thoracic movements and abdominal movements.

5.3.1. F2 Oronasal sensors

The use of single strap was insufficient to detect apneas during sleep, which are characterized by a blockage of the air passage. A quantitative assessment of the blockage of the air passage could be carried out effortlessly by detecting the variations in the temperature of the exhaled air. By using sensors which were sensitive to temperature variations (Berendes, Kipp & Hanioya, 1982) thermocouples and thermistors, the passage or non-passage of air could be detected.

The thermocouple consists of a closed circuit composed of two different metallic conductors. A current circulates when the two junctions were kept at different temperatures (Peltier effect). A variation in temperature in electric potential proportionate to the temperature variation is directly monitored by the polygraph.

The thermistor, an electric component in the form of a glass droplet is a resistor whose value fluctuates in function of temperature variations. The thermistors used are of the NTC type (negative temperature coefficient) as their value diminishes when the temperature rises. The warmer exhaled air modifies the ohm resistance which is transformed into an electric variation through a Wheatstone bridge operated by a high capacity electric battery. This montage ensured high sensitivity and good reliability. A number of precautions were taken. The thermistors were placed under an air conditioning outlet as the cool air could modify thermistor sensitivity; it was also important to check thermistor sensitivity; it was also important that the temperature of the room was not too

high; finally at body temperature (the temperature to which it is sensitive) and would no longer be able to record changes in temperature.

5.3.1. F2a Placing the sensors

The airway was monitored at mouth and nostril level. Thermistors can be mounted in series on the same track with two thermistors for the nostrils and one for the mouth.

Unlike straps, thermocouples and thermistors give no indication of volume, as they are sensitive to thermal variations only, and exhaled air, even in small quantities, will not show sufficient thermal variation to proportionately modify the amplitude of the signal.

So in the present study, the sensor was fixed above the upper lip directing two sensors towards nostrils and one towards the mouth.

5.3.1. F3 Respiratory airway setting

Whether the upper airways or thoracoabdominal movements, the setting was more or less the same apart from amplitudes.

Gain depends on a large number of factors (position stretching of the straps etc.) and can only be properly established when calibration was carried out on the subject in bed. As respiratory movements are very slow, a time constant of 1 sec i.e. a 0.15 high pass filter associated with a 15 Hz low pass filter was set during recording.

5.3.1. F4 Calibrating the bio-signals acquired during recording

Respiratory air way amplification was set at this stage.

The straps: subject was asked to breathe normally, inhaling and exhaling deeply. Checking that the amplitude was not saturated (plateau signal on the polygraph). It was important to check that the two thoracic and abdominal airways were in phase. It was also important to note the movements of inhalation and exhalation air.

Naso-buccal sensors; it was checked in the same way as for the abdominal and thoracic straps, asking the subject for opening his mouth.

The static charge –sensitive mattress measures variations in the electrostatic field setup by the subject's movement or from the dilation and contraction movements of the heart in the ribcage (balisto cardiography). This system not only discriminated between different types of apneas but will also indicate respiratory effort and objectify certain events such as partial obstruction or an increase in respiratory resistance which is difficult to isolate without using more invasive quantitative methods.

This device was operated at a low speed (≤ 15 mm/s) to be read on the computer screen, which was compatible with sleep recordings.

5.3.1. F5 Measurement of tracheal sounds

Tracheal sounds were measured by small microphone placed on the neck overlying the trachea, or on the upper thorax. They provided an indication of snoring and breathing uptake after unspecified respiratory events. They also provided quantitative indications when combined with computerized techniques (Meslier & Racineux, 1987).

5.3.1. F6 Oximetry (SaO₂ measurement)

A probe was placed on the patient's middle finger to assess arterial blood oxygen saturation by beaming red and infrared lights into the skin and measuring the ratio of the reemitted pulsing light intensities. Pulse oximetry provides estimates of SaO₂.

5.3.2 SELF RATED SLEEP

This is a questionnaire having four item questions and four visual analog scales. This was tested with its' reliability and validity. The detail of the questionnaire is presented in **Appendix-2.**

5.3.3 HEART RATE VARIABILITY (HRV)

Heart rate variability (HRV) describes the variations between consecutive heartbeats. The regulation mechanisms of HRV originate from the sympathetic and parasympathetic nervous systems in addition to other controls and hence, HRV is used as a quantitative marker of the autonomic control over the heart (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996). The ECG for HRV spectrum was acquired using a four channel polygraph (Medicaid, Chandigarh, India). The EKG was recorded using Ag/AgCl electrodes with conducting gel (Electrode Gel, Recorders and Medicare Systems, Chandigarh, India) and recording was made using standard Limb lead II configuration. Data were acquired at the sampling rate of 1024 Hz and were analyzed offline.

5.3.3. A Recording conditions

The subjects were studied in an air conditioned, sound attenuated room with dim lighting and the temperature was maintained between 20 and 25⁰ Celsius.

5.3.3. B Specifications of Medicaid system

Analog Inputs:

No. of channels	16 Channels (5 –DC)
Input Voltage Range	+/-5V
Input Impedance	1000G, i.e. 1T
A/D resolution	14 Bits Bipolar
Max. Input Voltage	+/-5V
Input Coupling	DC or 0.1 Hz (AC Mode)
Low-Pass Frequency (Hz)	DC, 0.1, 0.3, 0.5, 1, 3, 5, 7, 10
High-Pass Frequency (Hz)	0.1, 0.3, 0.5, 2, 10, 15, 35, 70, 99
Sensitivity (μV)	1, 2, 3, 5, 7, 5, 10, 15, 20, 30, 50, 75, 100, 200, 300, 500, 750, 1000, 1500
Sampling Rate	1024Hz
<u>Digital Input/Output:-</u>	
Voltage Levels	RS – 232
Output Drive Current	+/-20mA (Max)

5.3.3. C Testing procedure

The EKG was recorded using Ag/AgCl electrodes with conducting gel (Electrode Gel, Medicaid Systems, Chandigarh, India) and recording was made using standard limb lead II configuration. Data were acquired at the sampling rate of 256 Hz and were analyzed offline. Noise free data were included for analysis. Records of six participants had artifact and these recordings were excluded but repeat recordings were taken on the same participants and included for analysis. The R waves were detected to obtain a point event series of successive response-response intervals, from which the beat-to-beat heart series was computed. The data were analyzed with an HRV analysis program developed by the Biomedical Signal Analysis Group, University of Kuopio, Finland (Niskanen et al., 2004). The respiration was recorded using a stethograph connected to an AC amplifier and fixed around the trunk approximately 8 cm below the lower costal margin when the participants stood erect. Schematic representation of EKG and Heart rate (HRV) are presented in Figure 4.5.2.

5.3.3. D Variables measured

The following variables were measured (i) LF: Low frequency power of HRV spectrum is known to correspond to sympathetic modulation when expressed in normalized units. Low frequency band ranges between 0.05-0.15 Hz. (ii) HF: High frequency power (normalized units) of HRV spectrum between 0.15-0.4 Hz. The efferent vagal activity is a major contributor to the HF component. (iii) Ratio of low and high frequency powers (LF/HF ratio) is correlated with the sympatho-vagal balance. (iv) HR: Heart rate in

number of beats per minute (b/min). Normally, heart rate ranges between 70 and 80 beats per minute (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996).

5.4 INTERVENTIONS

5.4.1 CYCLIC MEDITATION

Throughout the practice of cyclic meditation subjects kept their eyes closed, and followed taped instructions with ear phones. The instructions emphasized carrying out the practice slowly, with awareness and relaxation. The practice began by repeating a verse from the yoga text, the *Mandukya Upanisad* (40 seconds); followed by isometric contraction of the muscles of the body ending with supine rest (1 minute): standing at ease (called *tadasana*) and ‘balancing’ the weight on both feet (2 minutes): then the first actual posture, bending to the right (*ardhakatichakrasana*, 1 minute 20 seconds); a gap of 1 minute 10 seconds with instructions about relaxation and awareness; bending to the left (1 minute 20 seconds); a gap as before (1 minute 10 seconds); forward bending (*padahastasana*, 1 minute 20 seconds); another gap (1 minute 10 seconds); backward bending (*ardhachakrasana*, 1 minute 20 seconds); supine rest with instructions to relax different parts of the body in sequence (10 minutes). The pictorial description of these postures in CM is given in Plate RL1. The postures were practiced slowly, with awareness of all the sensations that are felt. The total duration of the practice was 23 minutes (Nagendra, & Nagarathna, 2003). The basis of CM and its practical details are elaborated in **Appendix-3**.

5.4.2 SUPINE REST

During supine rest session, the subjects were lying supine with legs apart and arms away from the sides of the body and eyes closed. The subjects were left for 23 minutes without any specific guided instruction. This is considered as control session for the trial.

Table 5.4.2.A:- Time allocation during CM session

←-----Cyclic meditation (22:30 minutes: eyes closed)-----→			
Phase -I 5 minutes	Phase-II 5 minutes	Phase-III 5 minutes	Phase-IV 7:30 minutes
Prayer IRT Linear awareness Standing up <i>Täoäsana</i> Centering Observation of changes <i>Ardhakaöicakräsana</i> (Right side)	Observation of changes <i>Ardhakaöicakräsana</i> (Left side) Observation of changes Balance <i>Pädahastäsana</i>	Observation of changes <i>Ardhacakräsana</i> Observation of changes Lying down Linear awareness Surface awareness Part by part relaxation	DRT 'A' chanting 'U' chanting 'M' chanting AUM chanting Coming out of body Merging with sky <i>Sukhäsana</i> Prayer

Table 5.4.2.B: Time allocation during SR session

←-----Supine rest (22:30 minutes: eyes closed)-----→			
Phase -I 5 minutes	Phase-II 5 minutes	Phase-III 5 minutes	Phase-IV 7:30 minutes
Supine rest No guided instruction	Supine rest No guided instruction	Supine rest No guided instruction	Supine rest No guided instruction

6.1 DATA EXTRACTION

6.1.1 POLYSOMNOGRAPHY RECORDING

The 60 polysomnography (i.e., 2 sessions in 30 participants) records were subdivided into 30-second epochs and sleep stages were scored according to the standard criteria of Rechtschaffen and Kales (Rechtschaffen & Kales, 1968). The data files were coded to mask their identity from the scorer. All stages of sleep were visually inspected the actual tracing of each stage of sleep is presented in **Figure 6.1.1.A**, **Figure 6.1.1.B**, **Figure 6.1.1.C**, **Figure 6.1.1.D**, **Figure 6.1.1.E** and **Figure 6.1.1.F**.

The following variables were evaluated: (i) time in bed, (ii) sleep period time, i.e., the time from sleep onset to sleep end, (iii) total sleep time, i.e., the time from sleep onset to the end of the final sleep epoch minus time awake, (iv) sleep onset latency, i.e., the time from lights out to sleep onset. Where sleep onset is defined as the first of two consecutive epochs of sleep stage 1 or one epoch of any other stage, (v) REM latency, i.e., the time from sleep onset to the first REM sleep epoch, (vi) number of awakenings/hour, (vii) sleep efficiency, i.e., the percentage ratio between total sleep time and time in bed ($TST/TIB*100$), (viii) percentage of sleep period time in wakefulness after sleep onset (WASO percentage), and (ix) to (xi) percentage of SPT spent in sleep stages 1 (S1 percent), 2 (S2 percent), SWS percent, and REM sleep percent.

Tables 6.1.1. A: Sleep Scoring Criteria according to the Rechtschaffen & Kales, 1968 manual

Stages	Scoring Criteria		
	EEG	EOG	EMG
AWAKE	> 50% of alpha activity and low voltage mixed frequency	Rapid Eye movements	Normal muscle tone
NREM 1	< 50% of alpha activity	Slow rolling eye movements	Normal muscle tone
NREM 2	Presence of sleep spindles or K complexes	No eye movements	Relatively low muscle tone
NREM 3	Presence of 20 to 50 % of waves less than 2cps and greater than 75 uV	No eye movements	Relatively low muscle tone
NREM 4	> 50 % of waves less than 2cps and greater than 75 uV	No eye movements	Low muscle tone
REM	Low voltage mixed frequency	Rapid eye movements	Atonia

6.1.2 SELF RATING OF SLEEP

The four item questionnaire consisted of questions, the responses to which were either the ‘number of times’ or ‘time in minutes’ and hence did not require further data extraction.

The four VAS were scored by measuring the distance from the ‘0’ end of the scale to the mark made by the participant. All values were in cm.

6.1.3 AUTONOMIC AND RESPIRATORY VARIABLES

The heart rate in beats per minute (bpm) was obtained by continuously counting QRS complexes in successive 60s periods. The breath rate (in cycles per minute) was calculated by counting the breath cycles in 60s epochs, continuously.

Heart rate and heart rate variability spectrum (HR V) as well as breath rate were recorded for six hours during sleep and the first five minutes and the last five minutes of each hour was included for analysis. Hence in each six-hour sleep recording there were

twelve epochs each of five minutes, for analysis. For the pre-sleep recording the first five minutes out of a ten minute period was used.

Following the European Guidelines of the Task Force of the European Society of Cardiology, the following components of time domain HRV were analyzed viz., the number of pairs of Normal to Normal RR intervals differing by more than 50 ms (NN50), NN50 divided by total number of all NN intervals (pNN50), the square root of the mean squared differences of successive NN intervals (RMSSD), the standard deviation of NN intervals per seconds (STD/sec) and total index of NN intervals (TINN). In addition, the HRV power spectrum was obtained using Fast Fourier Transform analysis (FFT). The energy in the HRV series in the following specific frequency bands was studied viz., the very low frequency band (0.0-0.05 Hz), low frequency band (0.5-0.15 Hz), and high frequency band (0.15-0.50 Hz). The low frequency and high frequency band values were expressed as normalized units (Task Force of the European Society of Cardiology, 1996). Hence the HRV data were analyzed to obtain both time domain and frequency domain measures.

6.2 DATA ANALYSIS

Since the data were normally distributed, an independent samples 't' test was done to compare the nights following CM practice with the nights following SR practice for polysomnography variables.

Repeated measures analysis of variance (ANOVA), post-hoc tests with Bonferroni adjustment, comparing During-sleep (CM) with During-sleep (SR) for autonomic & respiratory variables and heart rate variability measures.

For self-rated sleep, data were not normally distributed. So, a non-parametric test 'Mann-Whitney U test' to compare CM data sets with SR.

Plate 6.1.1. A: Tracing indicating the Stage -Wakefulness

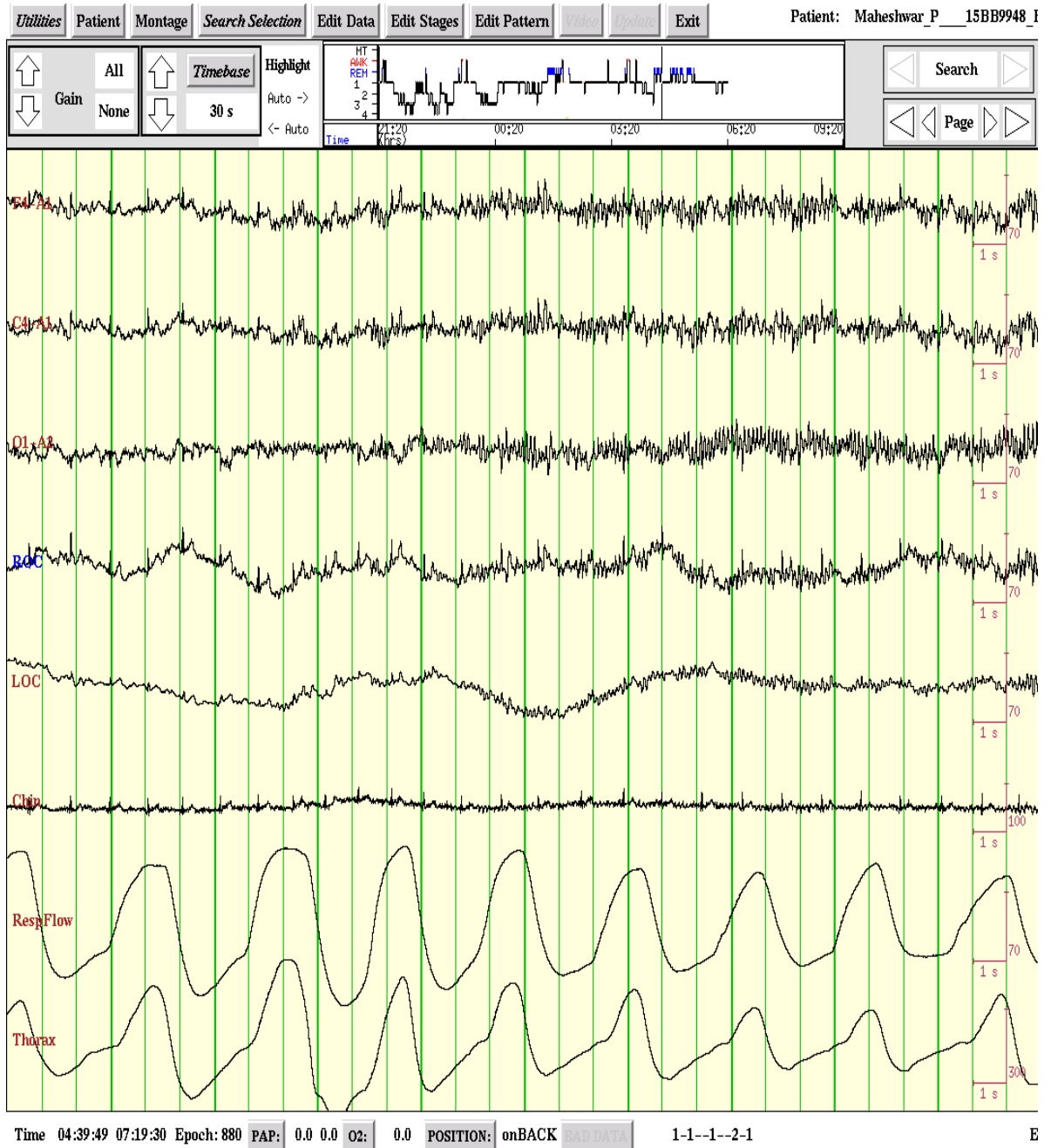


Plate 6.1.1. B: Tracing indicating the Stage –NREM-1

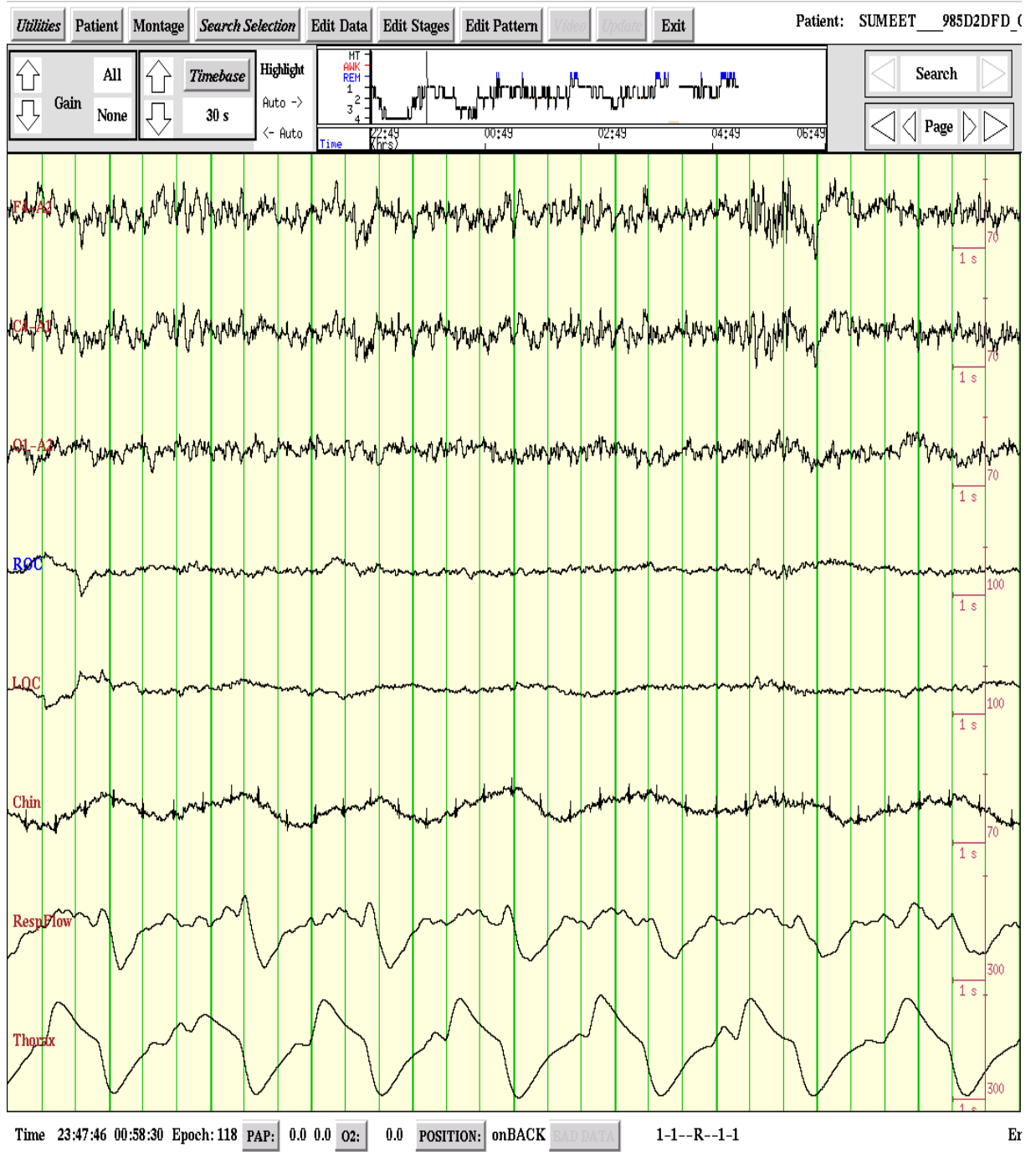


Plate 6.1.1. C: Tracing indicating the Stage –NREM-2:

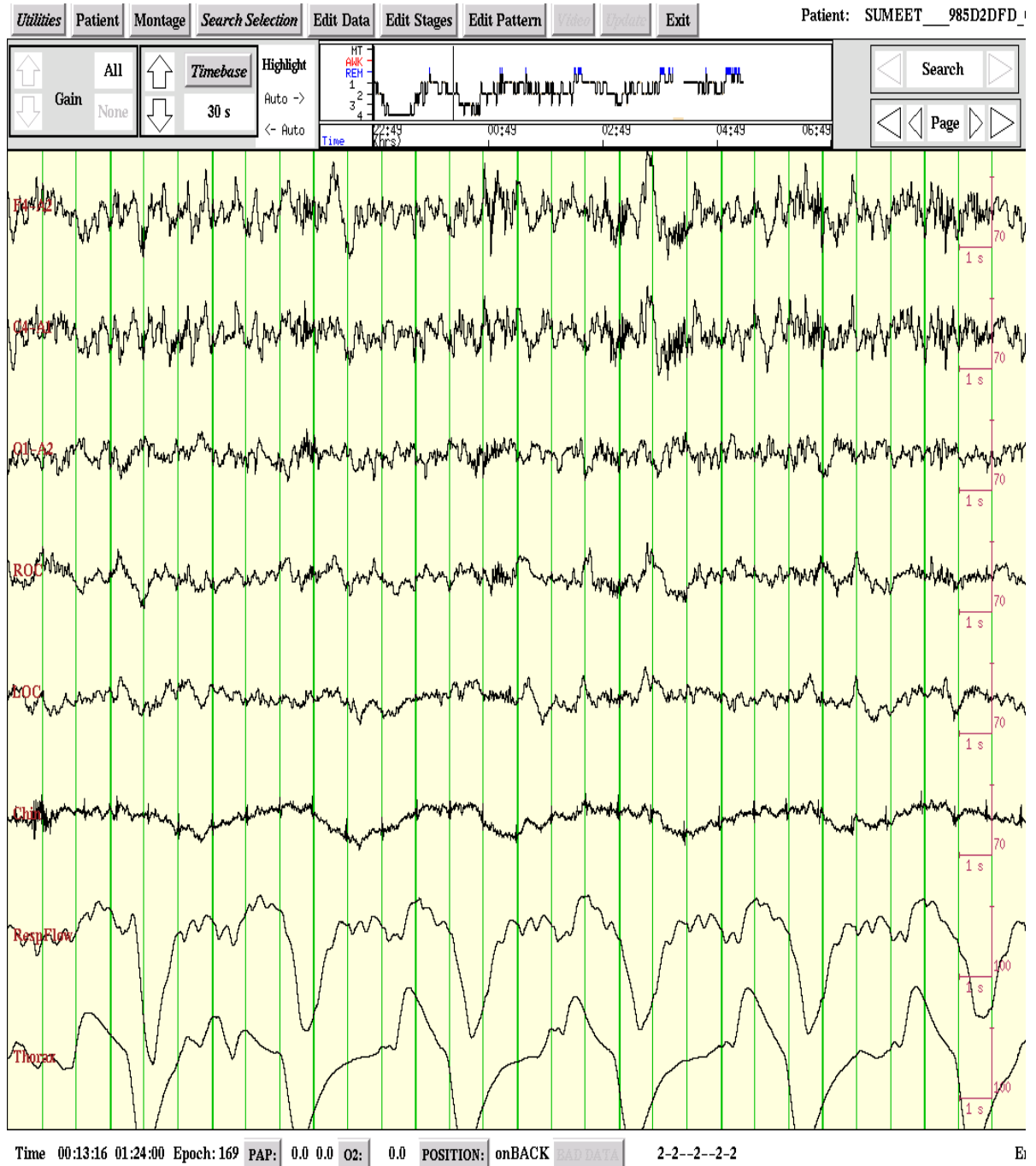


Plate 6.1.1. D: Tracing indicated the Stage –NREM-3

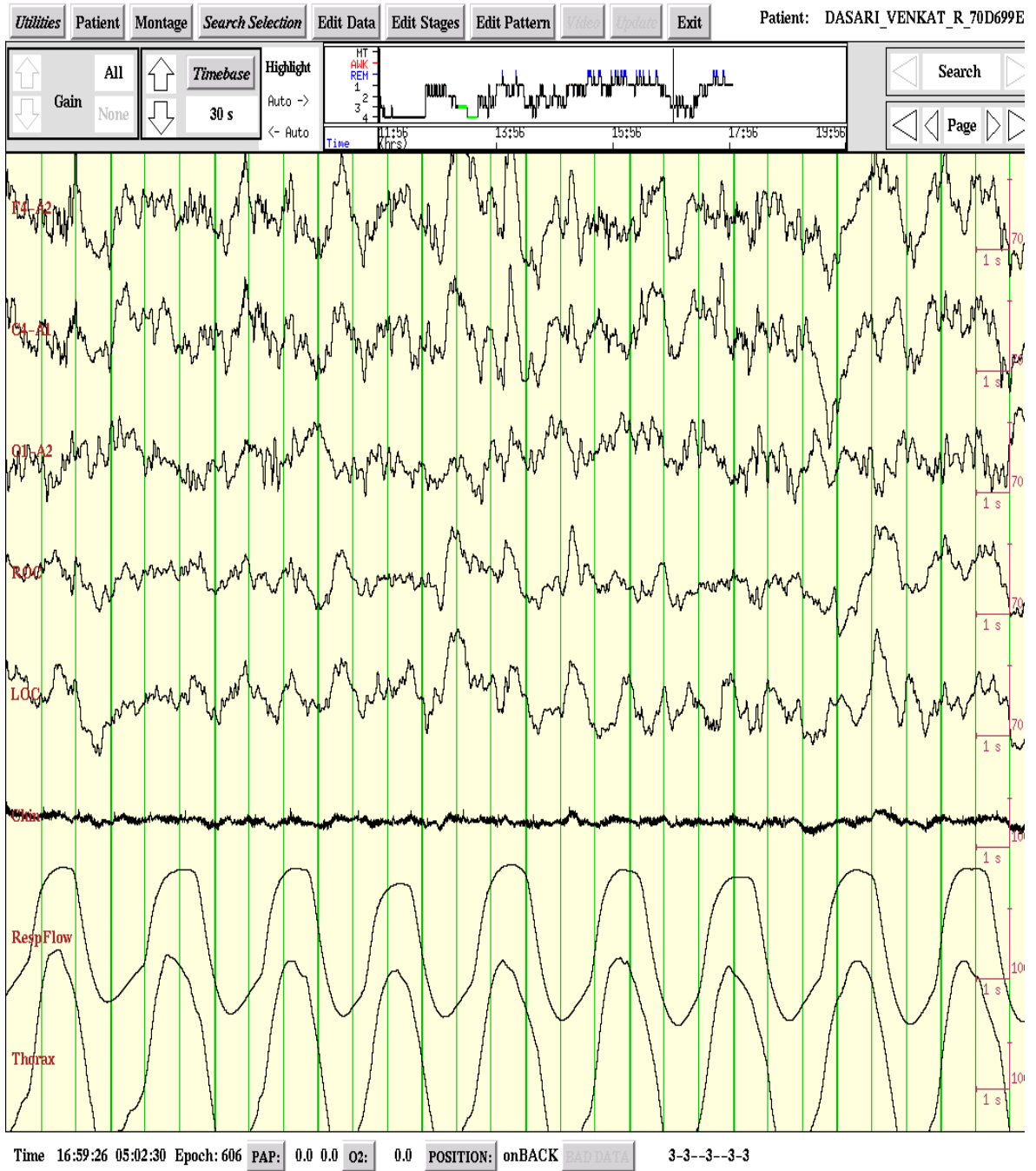


Plate 6.1.1. E: Tracing indicating the Stage –NREM-4

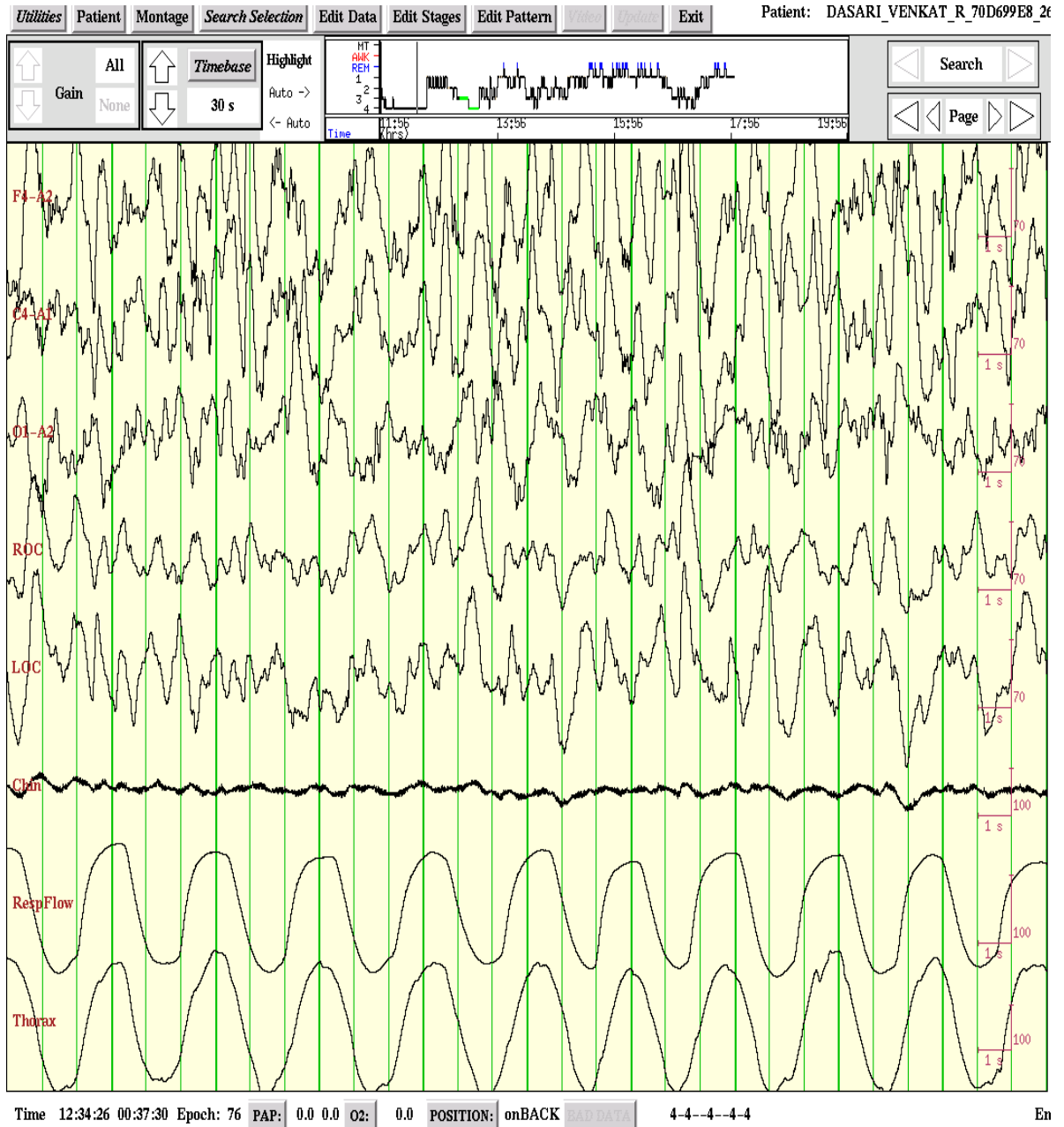


Plate 6.1.1. F: Tracing indicating the Stage –REM



Plate 6.1.1. G: Tracing indicating the Movement time of the subject (MT)

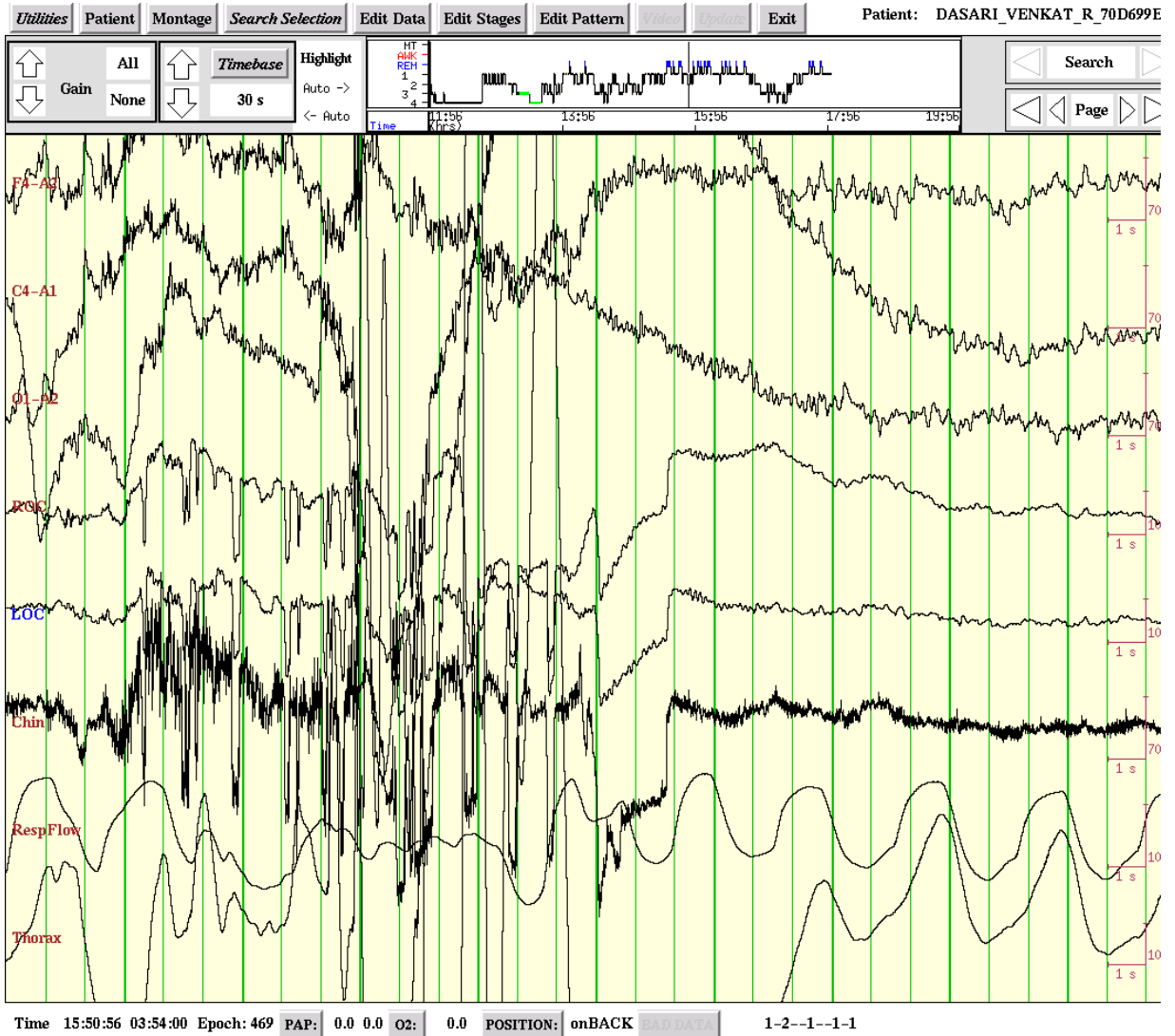
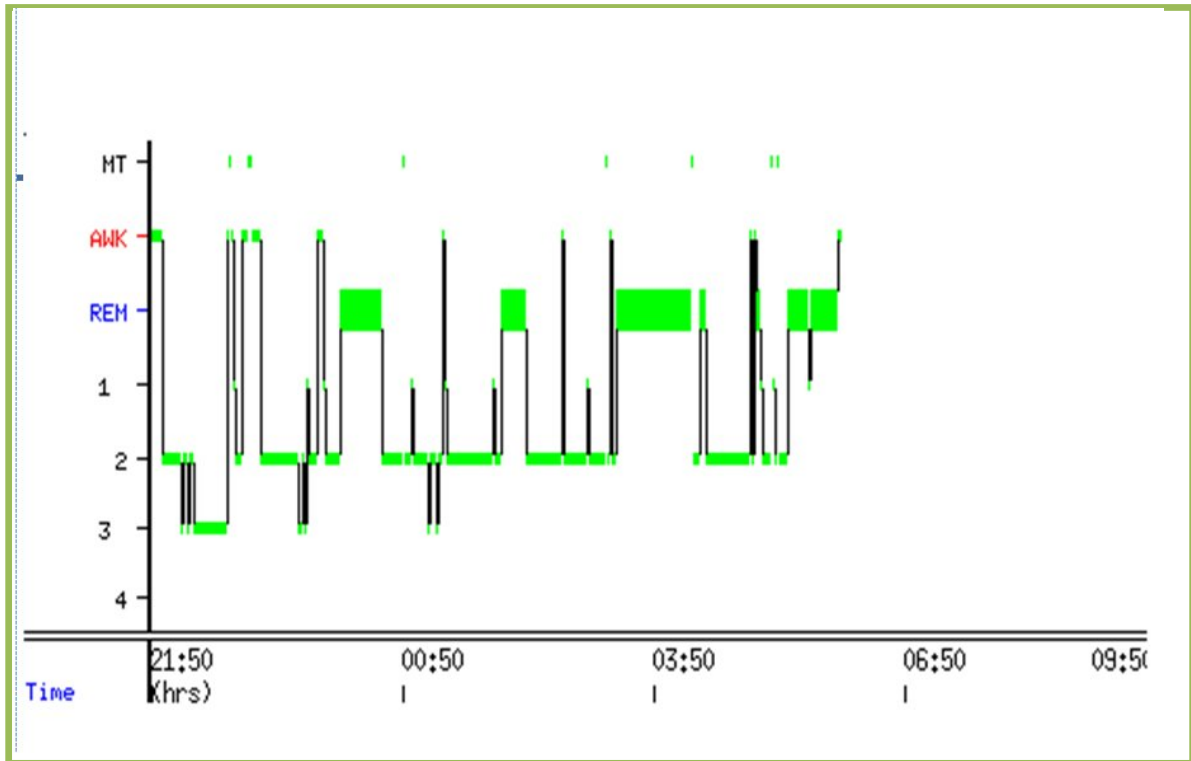


Plate 6.1.1. H: A manually scored Hypnogram of a subjecting showing different stages of sleep



7.1 POLYSOMNOGRAPHY (PSG)

The variables recorded during the whole night PSG session following the day during which participants practiced CM (called ‘CM-PSG’) were compared with those recorded during the PSG session following SR practice (called ‘SR-PSG’).

The CM-PSG showed higher SWS percentage ($p<0.01$), and lower REM percentage ($p<0.001$) and fewer awakenings per hour ($p<0.05$). Group mean values \pm S.D. are given in **Table 7.1. A**.

7.2 SELF RATED SLEEP

Self rated sleep based on the four item questionnaire showed that the time taken to fall a sleep ($p<0.05$) was lower, duration of sleep ($p<0.01$) was higher and number of dreams recollected ($p<0.05$) was less following CM than following SR.

Self rated sleep based on the subjective VAS rating showed that the following were better after CM compared to SR: (i) a feeling of being refreshed after sleep ($p<0.001$), (ii) feeling good in the morning ($p<0.01$), (iii) feeling less disturbed by sleeping in a laboratory ($p<0.001$) and (iv) less inconvenience experienced related to the electrodes used for recording. Group mean values \pm S.D. are given in **Table 7.2. A**.

7.3 HEART RATE VARIABILITY

The groups mean values \pm S.D. for heart rate, breath rate, time domain and frequency domain measures of HRV spectrum are given in **Table 7.3.1**.

Repeated Measures Analysis of Variance (REMANOVA)

There was a significant difference between sessions for (1) Very low frequency [$F = 4.568$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$]; (2) Low frequency [$F = 20.496$, $df = 1, 41$, $P < 0.001$; Huynh-Feldt $\epsilon = 1.000$]; (3) High frequency [$F = 20.355$, $df = 1, 41$, $P < 0.001$; Huynh-Feldt $\epsilon = 1.000$]; (4) The standard deviation of NN intervals per seconds [$F = 10.854$, $df = 1, 41$, $P < 0.01$; Huynh-Feldt $\epsilon = 1.000$]; (5) The square root of the mean squared differences of successive NN intervals [$F = 10.316$, $df = 1, 41$, $P < 0.01$; Huynh-Feldt $\epsilon = 1.000$]; (6) The number of interval differences of successive NN intervals greater than 50 ms [$F = 6.085$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$]; (7) and total index of NN intervals [$F = 14.102$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$].

Between states, there was a significant changes in (1) Low frequency [$F = 7.081$, $df = 1, 41$, $P < 0.01$; Huynh-Feldt $\epsilon = 1.000$]; (2) and High frequency [$F = 7.568$, $df = 1, 41$, $P < 0.01$; Huynh-Feldt $\epsilon = 1.000$].

There was a significant interaction between sessions and states in (1) The standard deviation of NN intervals per seconds [$F = 5.34$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$]; (2) The square root of the mean squared differences of successive NN intervals [$F = 5.827$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$]; (3)

The number of pairs of Normal to Normal RR intervals differing by more than 50 ms [$F = 7.026$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$]; (4) The NN50 divided by total number of all NN intervals [$F = 6.124$, $df = 1, 41$, $P < 0.05$; Huynh-Feldt $\epsilon = 1.000$] (5) And the total index of NN intervals [$F = 7.910$, $df = 1, 41$, $P < 0.01$; Huynh-Feldt $\epsilon = 1.000$].

Post Hoc Tests for Multiple Comparisons

Post hoc tests for multiple comparisons were performed with Bonferroni adjustment. Comparisons were made between During-sleep following CM with During-sleep following SR, Pre sleep CM with During-sleep CM, and Pre-sleep SR with During-sleep SR sessions.

A significant decrease in HR ($p < 0.01$), LF ($p < 0.001$), HF ($p < 0.001$), and TINN ($p < 0.01$) was observed when a comparison was made between During-sleep following CM with During-sleep following SR sessions. Also a significant decrease in LF ($p < 0.05$), HF ($p < 0.05$), and TINN ($p < 0.001$) was also observed, when a comparison was made following Pre-sleep following CM with Pre-sleep with SR session.

Time domain measures are given in rows 8 to 13 and frequency domain measures in rows 3 to 6.

Table 7.1.1 : Polysomnography related variables recorded on the nights following cyclic meditation (CM) practice and following supine rest (SR). Values of group mean \pm S.D.

Variables	Sessions	
	Recording after Cyclic Meditation (CM) Mean \pm S.D.	Recording after Supine Rest (SR) Mean \pm S.D.
Sample size(n = 30)		
Age (years)	26.27 \pm 4.61	26.27 \pm 4.61
Bedtime, clock time	22:24 (minutes)	22:18 (minutes)
Wake-up time, clock time	05:24 (minutes)	05:28 (minutes)
Total time in bed (TIB), min	406.10 \pm 33.88	412.73 \pm 34.10
Sleep period time (SPT) , min	377.03 \pm 34.76	382.27 \pm 35.74
Sleep- onset latency(SOL), min	17.63 \pm 19.91	18.80 \pm 15.41
Total sleep time (TST), min	352.77 \pm 41.35	353.03 \pm 35.90
Sleep efficiency (SE), %	86.92 \pm 7.59	85.85 \pm 6.25
Sleep stages in minutes		
1 (S1)	61.85 \pm 33.17	61.78 \pm 28.83
2 (S2)	117.25 \pm 36.38	114.80 \pm 28.21
SWS	105.62 \pm 29.16***	82.85 \pm 28.91
REM	58.22 \pm 20.82***	79.63 \pm 20.53
REM latency, min	149.90 \pm 46.77	146.13 \pm 38.27
Number of awakenings/hr. (AWN/hr.)	1.67 \pm 0.55*	2.03 \pm 0.72
Sleep stage, %		
Wake after sleep onset,(WASO)	5.31	7.44
1(S1)	16.40	16.16
2 (S2)	31.09	30.03
SWS	28.01	21.67
REM	15.44	20.83

*** p <0.001, using a paired t - test and * p <0.05, Wilcoxon signed ranked test, comparing the nights following CM practice with the nights following SR practice

Table 7.2.1: Scores in the self-rating of the sleep on night after practicing cyclic meditation (CM), compared with after practicing supine rest (SR). Values are group mean \pm S.D.

Variables	Sessions	
	Recording after Cyclic Meditation (CM)	Recording after Supine Rest (SR)
Sample size (n=30)		
Part-I		
Feeling that sleep was refreshing	7.49 \pm 1.46***	5.63 \pm 1.80
Feeling 'good' in the morning on awakening	7.73 \pm 1.65**	6.45 \pm 2.07
Degree to which sleep was influenced by being in a laboratory	2.05 \pm 1.63***	3.99 \pm 2.32
Discomfort induced by sleeping with electrodes	1.82 \pm 1.33***	3.44 \pm 2.17
Part-II		
Time taken to fall asleep	20.90 \pm 15.17*	28.63 \pm 25.99
Number of awakenings	2.33 \pm 1.56	2.80 \pm 1.65
Duration of sleep from start to finish	6.08 \pm 0.80**	5.52 \pm 1.16
Number of dreams recollected	1.87 \pm 1.33*	2.50 \pm 1.93

*** p <0.001, ** p <0.01, 'CM' session compared to 'SR' using a Wilcoxon signed ranked test for a paired data

Table 7.3.1: Heart rate, breath rate and measures of heart rate variability recorded Pre and During-sleep following cyclic meditation (CM) practice and following supine rest (SR). Values are group mean \pm S.D.

Variables	Pre sleep (CM)	Pre sleep (SR)	During sleep (CM)	During sleep (SR)
Sample size (n=40)				
Heart rate (bpm)	62.95 \pm 7.10*	63.88 \pm 7.89	62.73 \pm 4.94*	67.00 \pm 6.37
Breath rate (cpm)	18.72 \pm 2.50	19.15 \pm 3.45	18.72 \pm 2.50	19.15 \pm 3.45
Very Low Frequency VLF (n.u.)	14.44 \pm 12.88	18.72 \pm 10.77	16.75 \pm 5.00	18.69 \pm 6.72
Low frequency LF (n.u.)	46.21 \pm 20.66*	53.85 \pm 18.58	52.79 \pm 13.59***	60.86 \pm 11.75
High frequency HF (n.u.)	53.81 \pm 20.68*	46.16 \pm 18.58	47.21 \pm 13.59***	39.14 \pm 11.75
LF/HF ratio	1.30 \pm 1.29	1.67 \pm 1.48	1.67 \pm 1.09	2.29 \pm 1.24
STD/Sec	0.19 \pm 0.21	0.09 \pm 0.08	0.16 \pm 0.14	0.12 \pm 0.11
STD/Min	111.24 \pm 162.01	30.82 \pm 79.60	71.51 \pm 90.28	36.46 \pm 67.26
RMSSD	204.05 \pm 266.38	77.96 \pm 70.45	162.39 \pm 156.84	117.24 \pm 118.69
NN50 (counts)	149.38 \pm 134.97	85.75 \pm 85.37	109.43 \pm 58.89	95.91 \pm 56.20
pNN50 (%)	41.98 \pm 27.69	27.21 \pm 20.33	34.61 \pm 16.30	39.70 \pm 57.50
TINN (ms)	848.25 \pm 703.80***	440.50 \pm 391.41	661.78 \pm 428.26**	497.58 \pm 320.81

*** P <0.01, ** P < 0.05, using Repeated measures analysis of variance (ANOVA), post-hoc tests with Bonferroni adjustment, comparing CM with SR

Fig. 7.1.1: Total Time in Bed (minutes) following CM vs. SR.
Values are group mean \pm S.D.

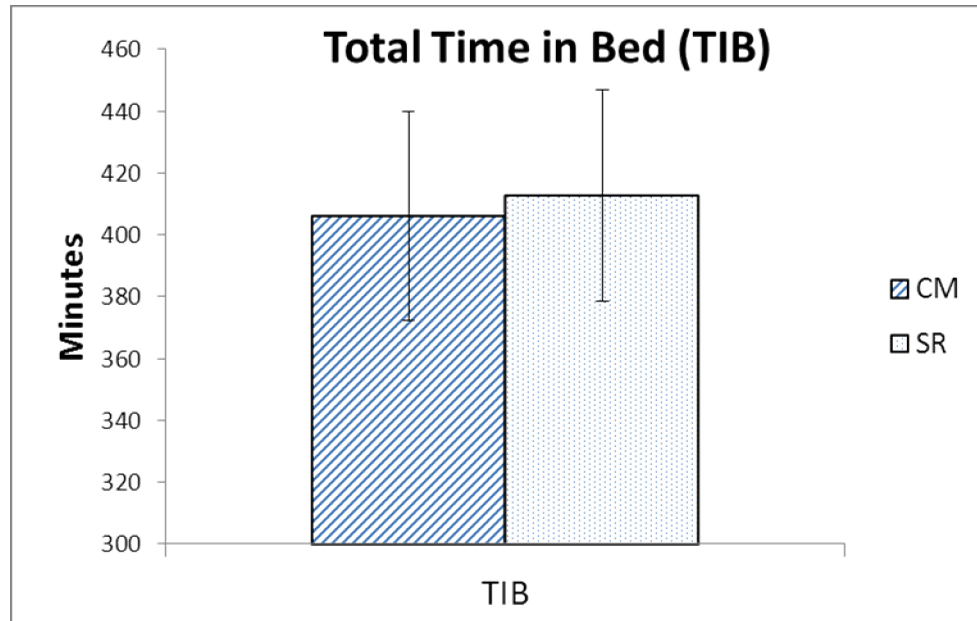


Fig.1.1.2: Sleep Period Time (minutes) following CM vs. SR.
Values are group mean \pm S.D.

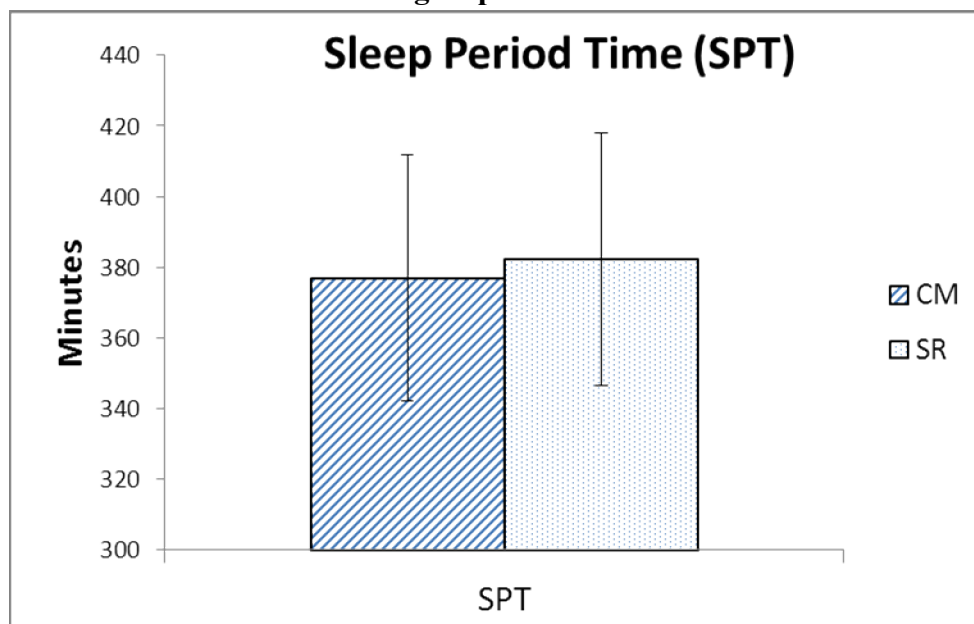


Fig.7.1.3: Sleep Onset Latency (minutes) following CM vs. SR.
 Values are group mean \pm S.D.

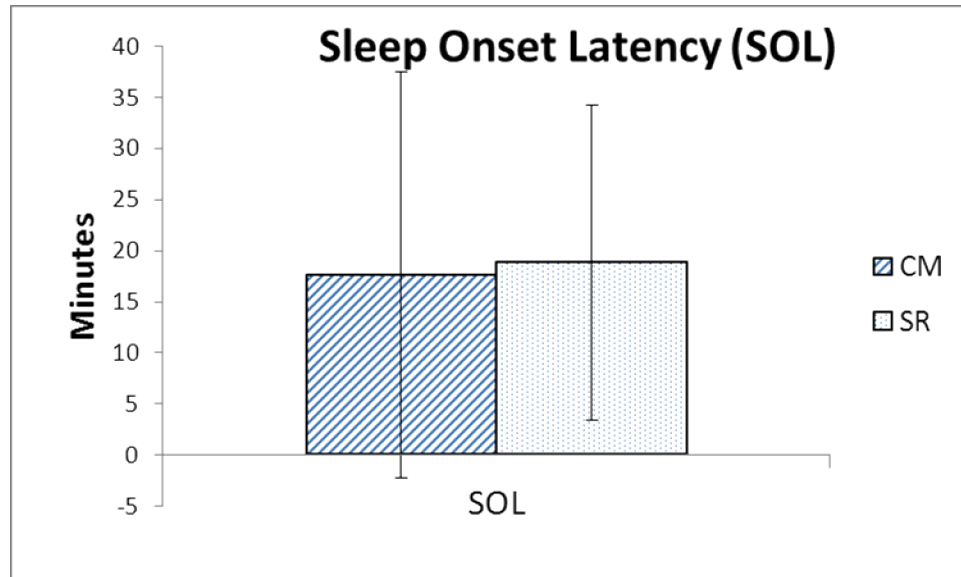


Fig.7.1.4: Total Sleep Time (minutes) following CM vs. SR.
 Values are group mean \pm S.D.

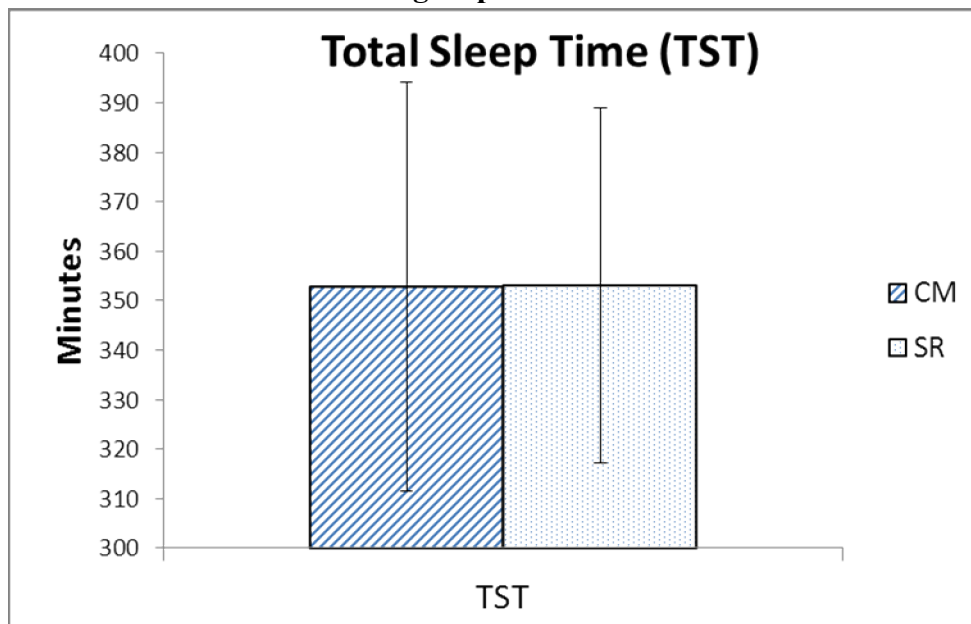


Fig.7.1.5: Sleep Efficiency (percentage) following CM vs. SR.
 Values are group mean \pm S.D.

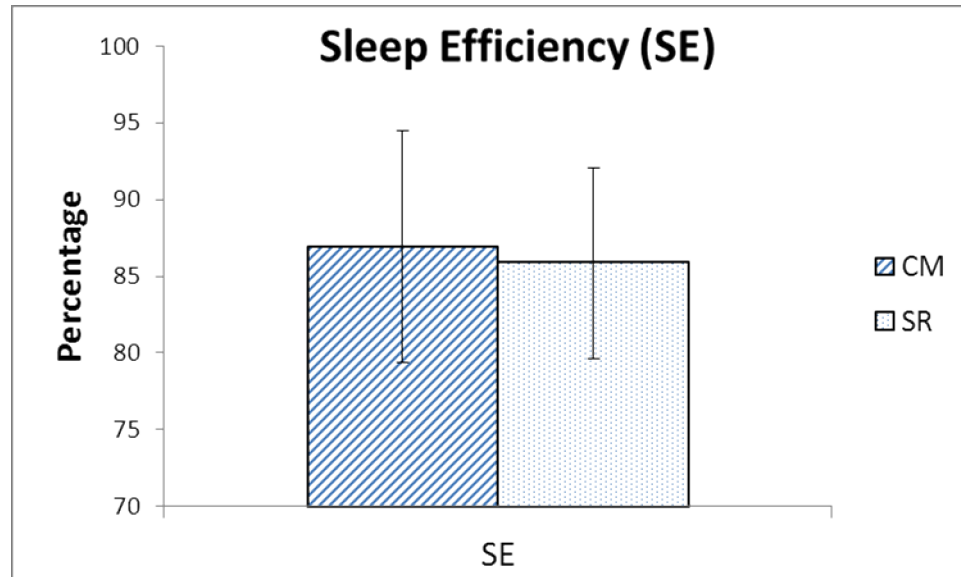


Fig.7.1.6: Non Rapid Eye Movements Sleep-I (minutes) following CM vs. SR.
 Values are group mean \pm S.D.

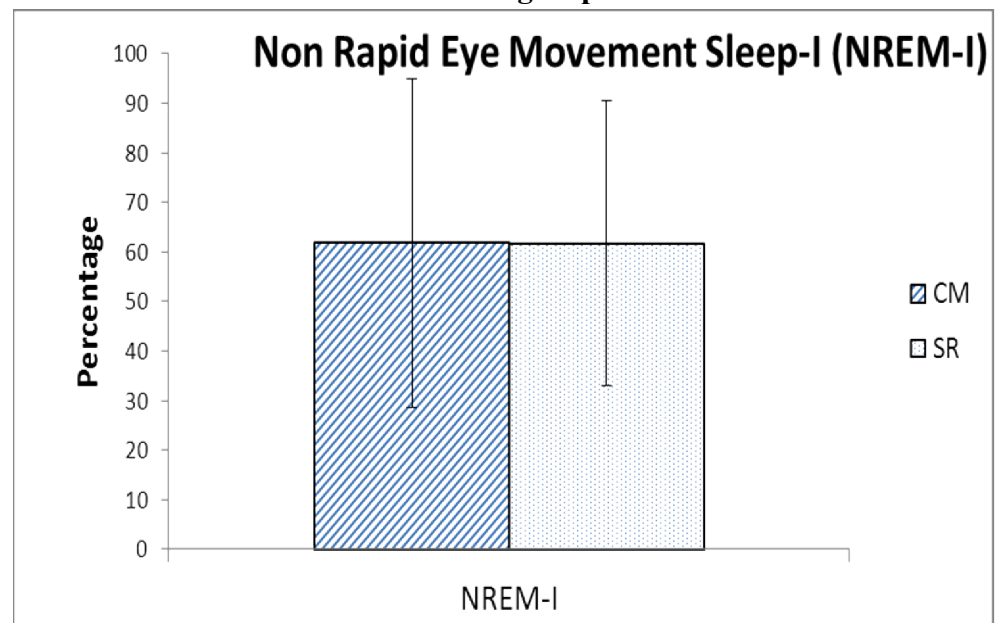


Fig.7.1.7: Non rapid eye movement sleep-II (minutes) following CM vs. SR. Values are group mean \pm S.D.

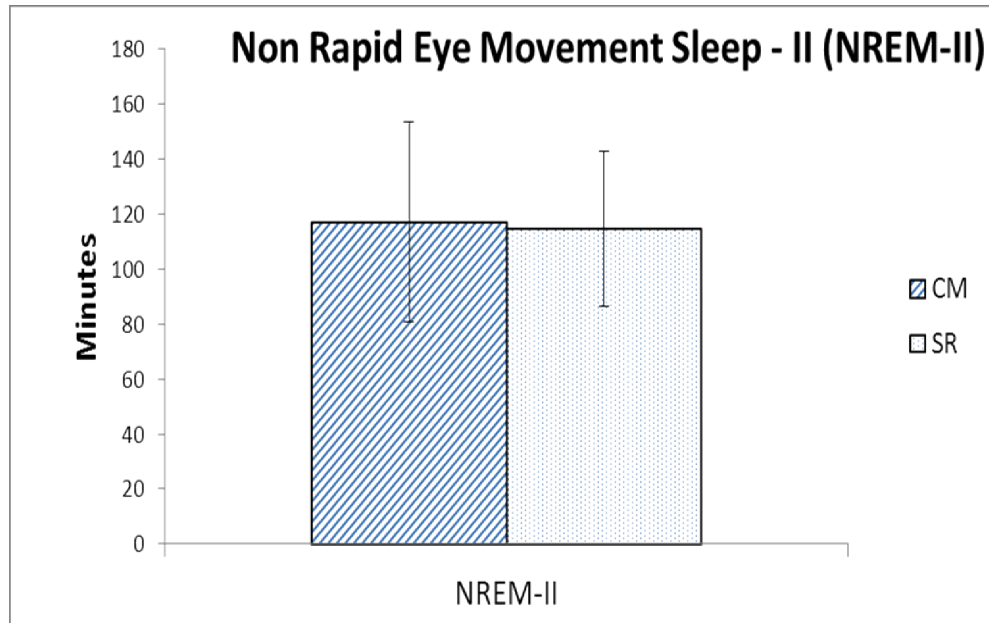


Fig.7.1.8: Slow wave sleep (minutes) following CM vs. SR. Values are group mean \pm S.D.

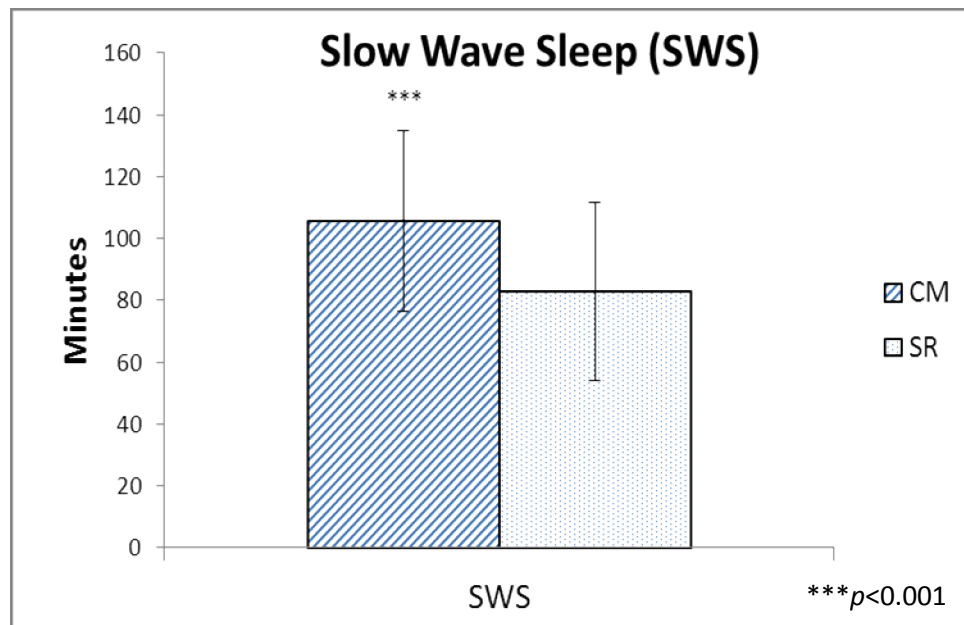


Fig. 7.1.9: Rapid eye movement sleep (minutes) following CM vs. SR. Values are group mean \pm S.D

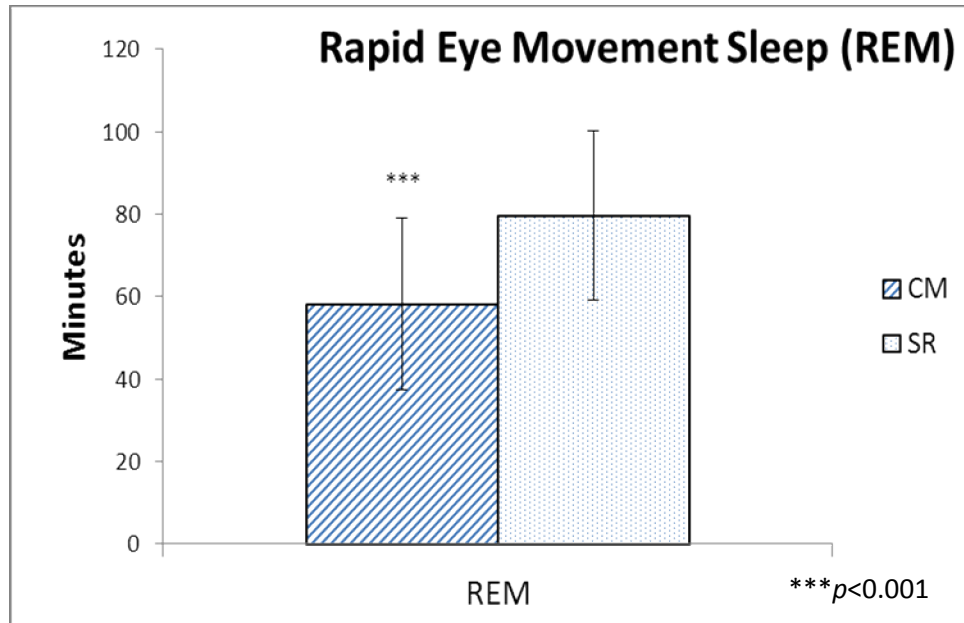


Fig.7.1.10: Rapid eye movement sleep latency (minutes) following CM vs. SR. Values are group mean \pm S.D.

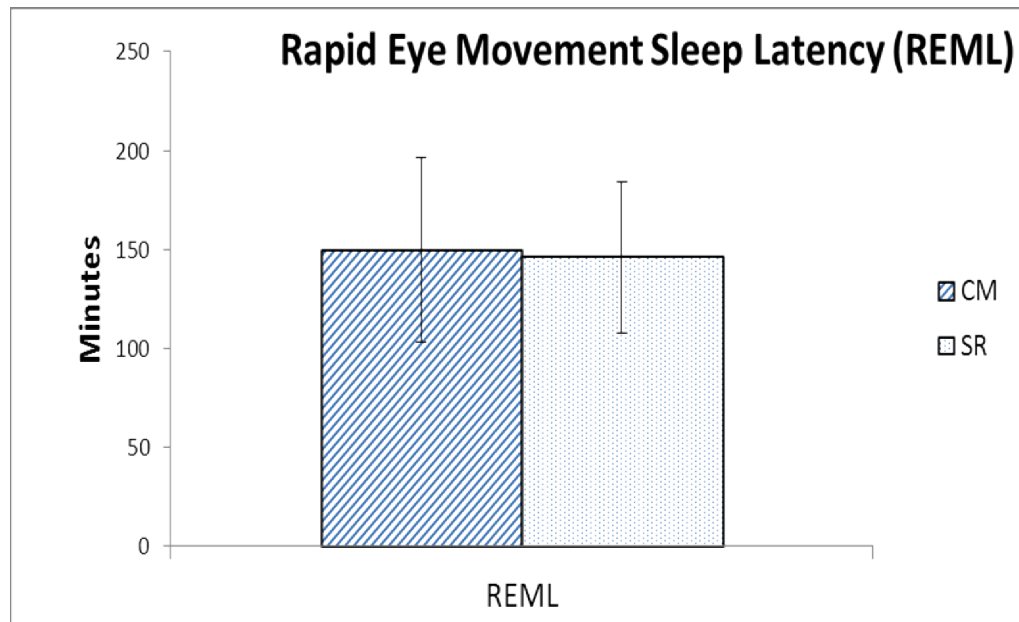


Fig. 7.1.11: Number of awakenings per hour (numbers) following CM vs. SR. Values are group mean \pm S.D.

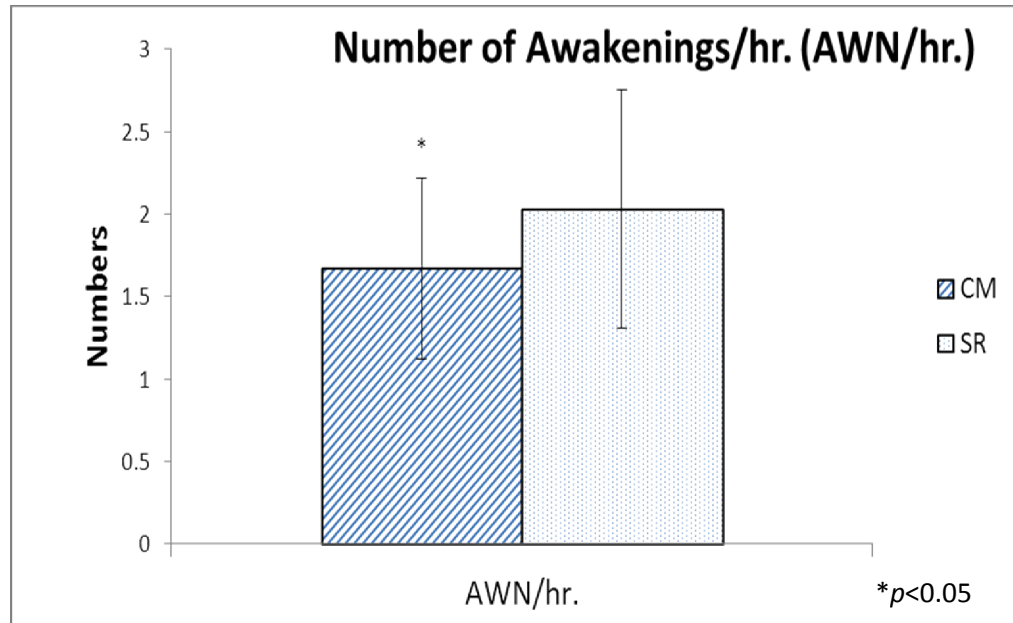


Fig.7.1.12: Wake after sleep onset (percent) following CM vs. SR.

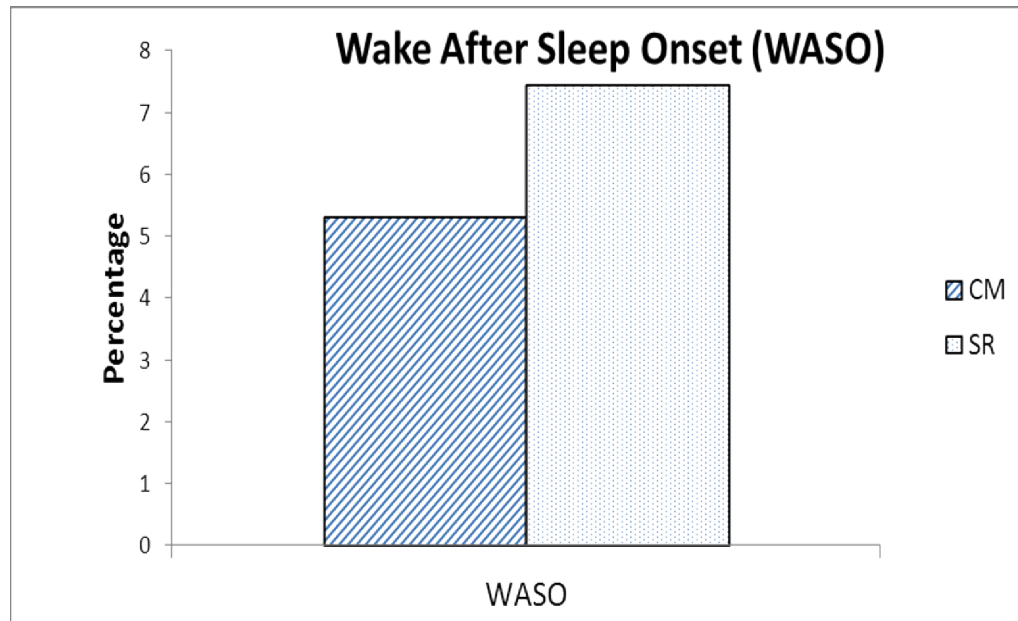


Fig.7.2.1: Visual analog scale-I (feeling that sleep was refreshing; cm) following CM vs. SR. Values are group mean \pm S.D.

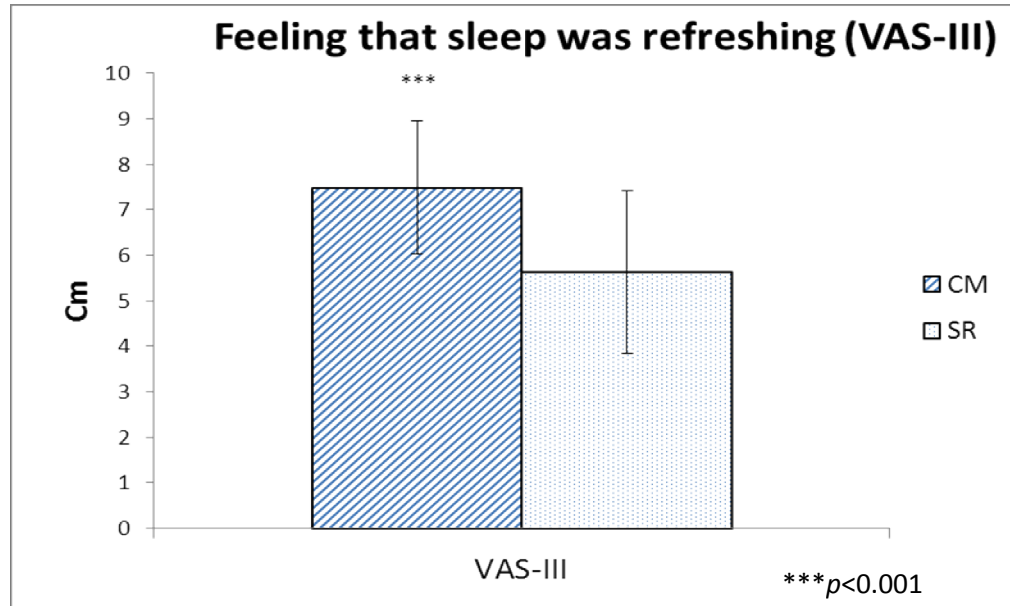


Fig.7.2.2: Visual analog scale-II (feeling good in the morning on awakening; cm) following CM vs. SR. Values are group mean \pm S.D.

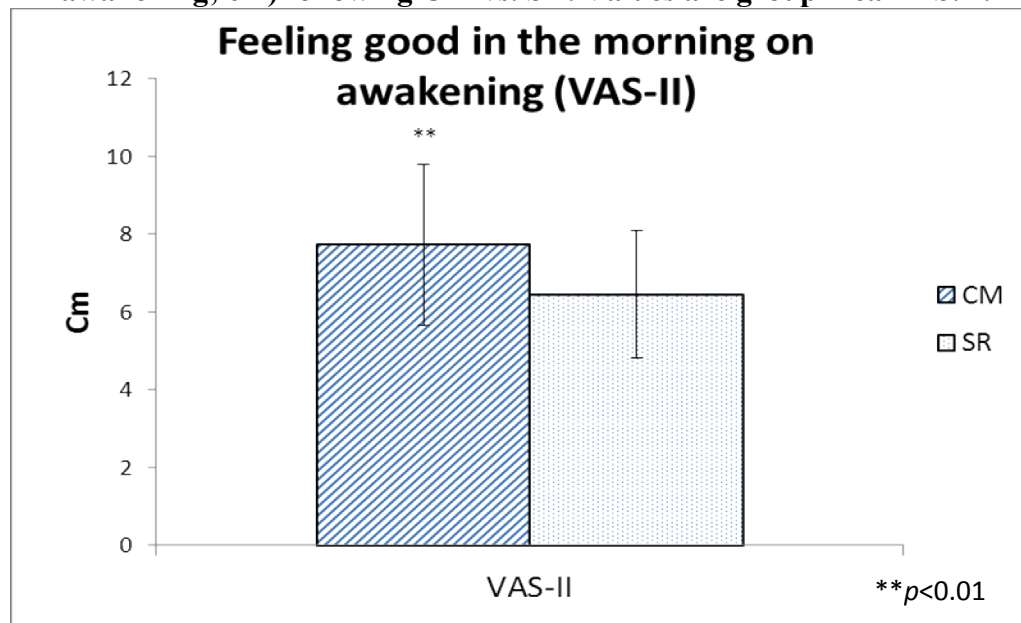


Fig.7.2.3: Visual analog scale-III (degree to which sleep was influenced by being in a laboratory; cm) following CM vs. SR. Values are group mean \pm S.D.

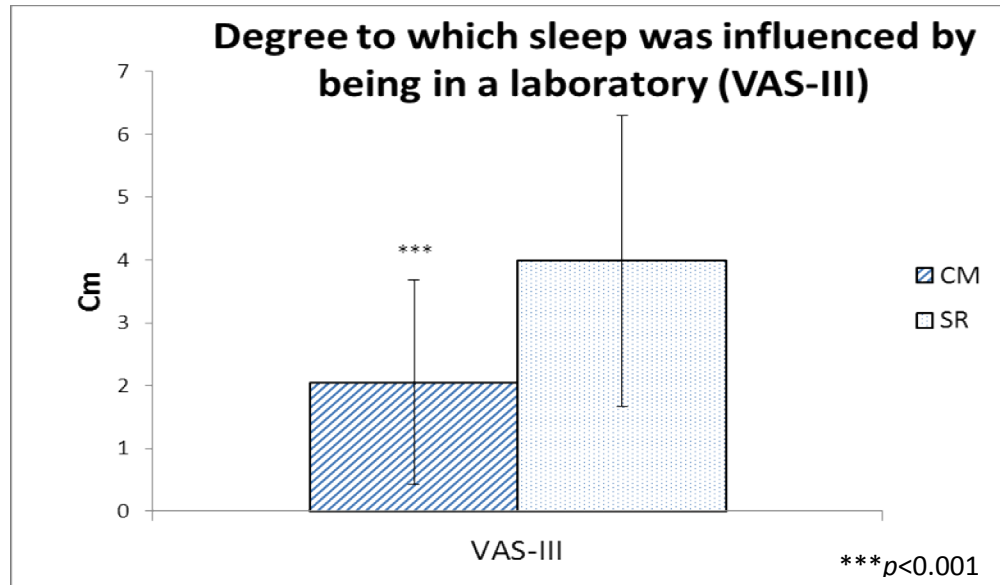


Fig.7.2.4: Visual analog scale-IV (discomfort induced by sleeping with electrodes; cm) following CM vs. SR. Values are group mean \pm S.D.

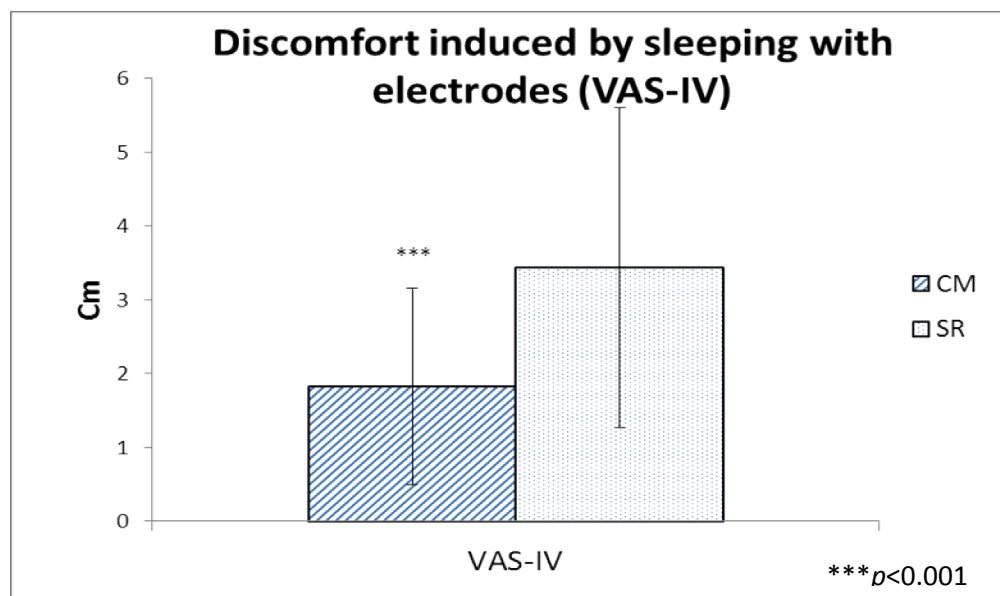


Fig.7.2.5. Time taken to fall asleep (minutes) following CM vs. SR.
 Values are group mean \pm S.D.



Fig.7.2.6: Number of awakenings (numbers) during night following CM vs. SR. Values are group mean \pm S.D.

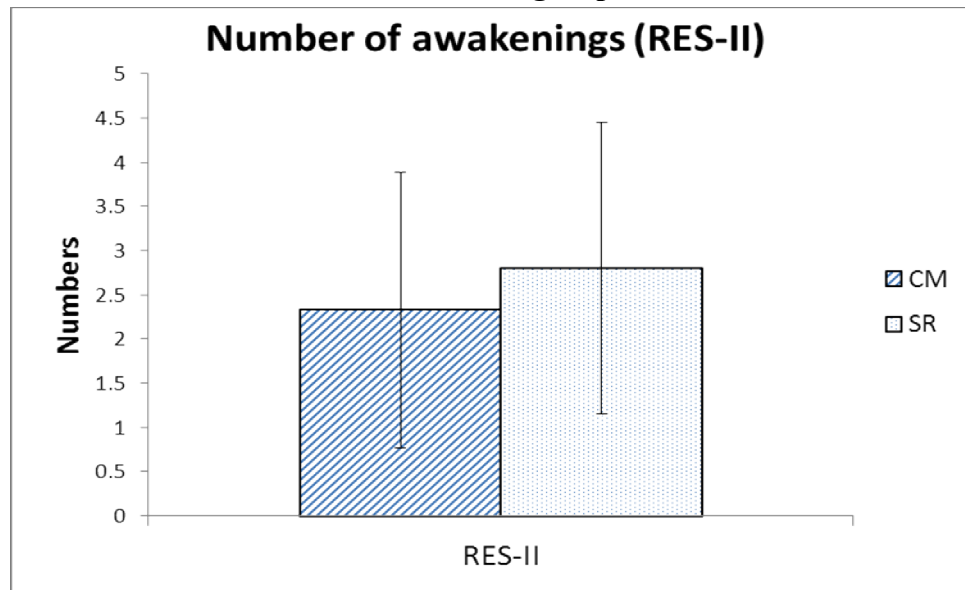


Fig. 7.2.7: Duration of sleep from start to finish (hours) following CM vs. SR. Values are group mean \pm S.D.

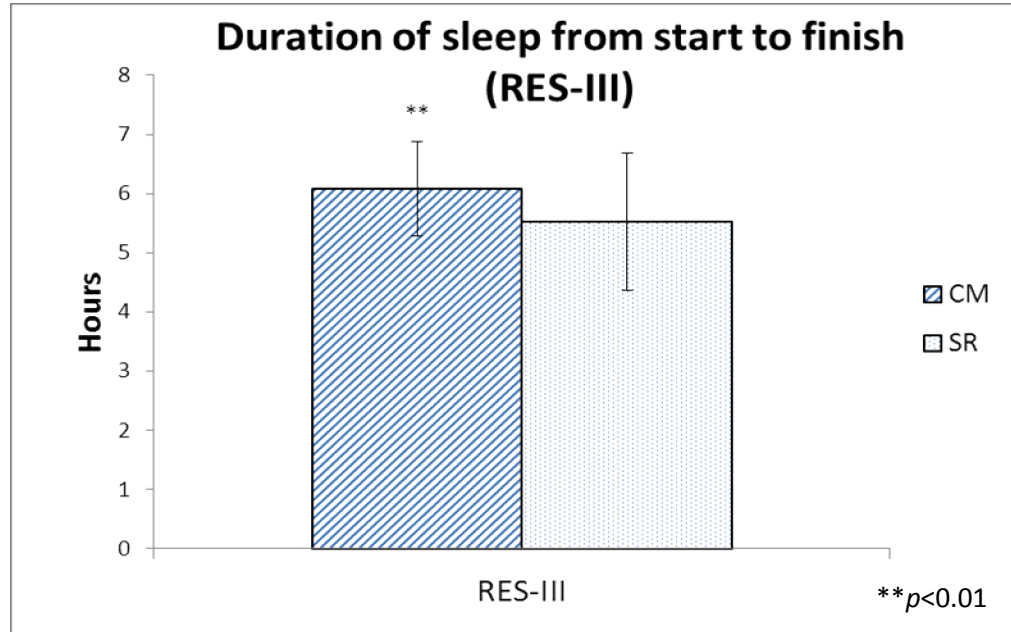


Fig.7.2.8: Number of dreams recollected (numbers) Following CM vs. SR. Values are group mean \pm S.D.

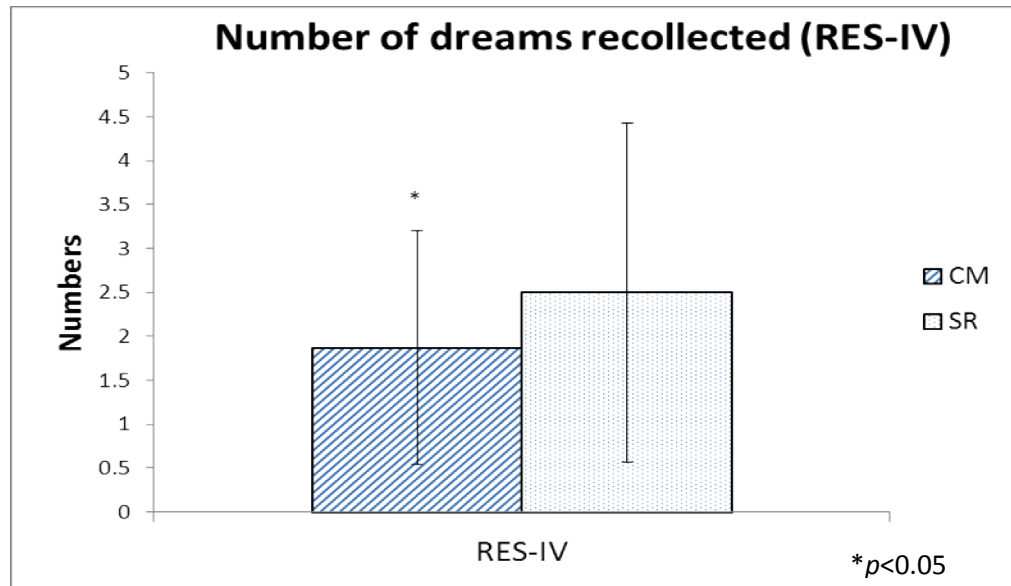


Fig.7.3.1: Hear rate (bpm) following CM vs. SR before sleep. Values are group mean \pm S.D.

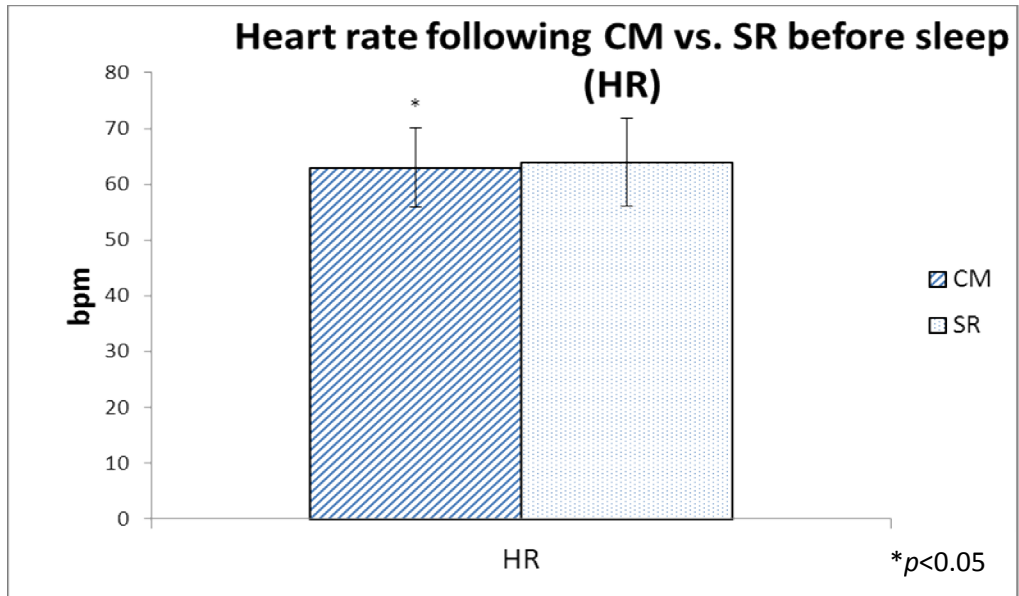


Fig.7.3.2: Hear rate (bpm) following CM vs. SR during sleep. Values are group mean \pm S.D.

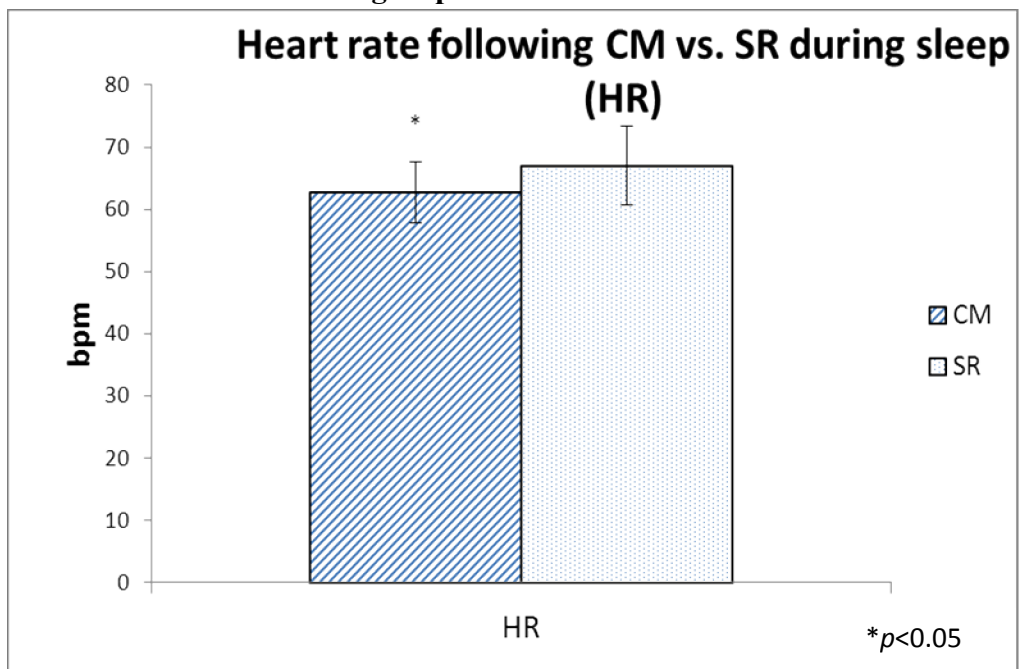


Fig.7.3.3: Breath rate (cpm) following CM vs. SR before sleep.
 Values are group mean \pm S.D.

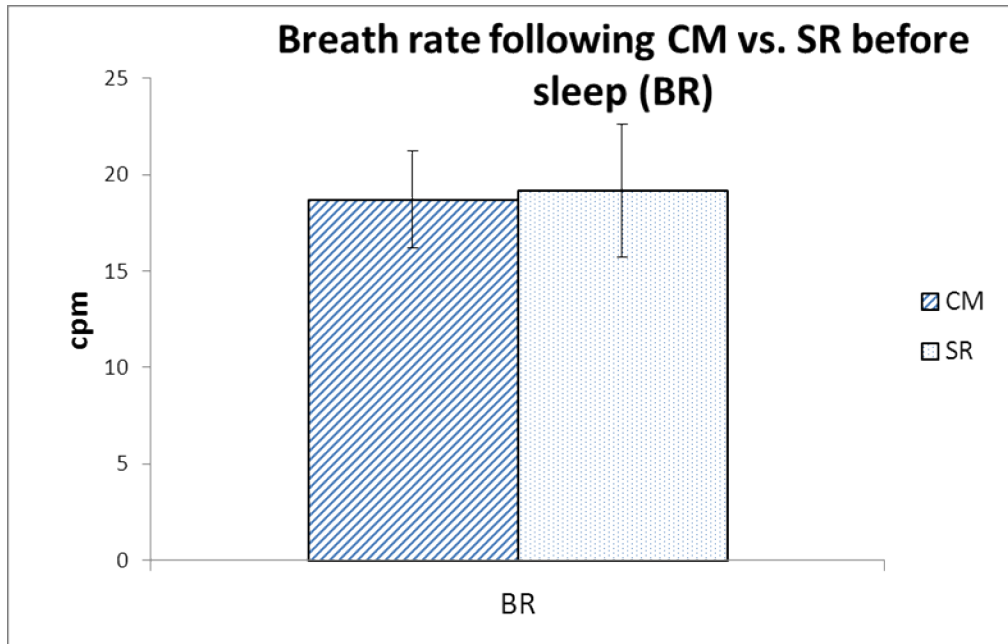


Fig.7.3.4: Breath rate (cpm) following CM vs. SR during sleep.
 Values are group mean \pm S.R.

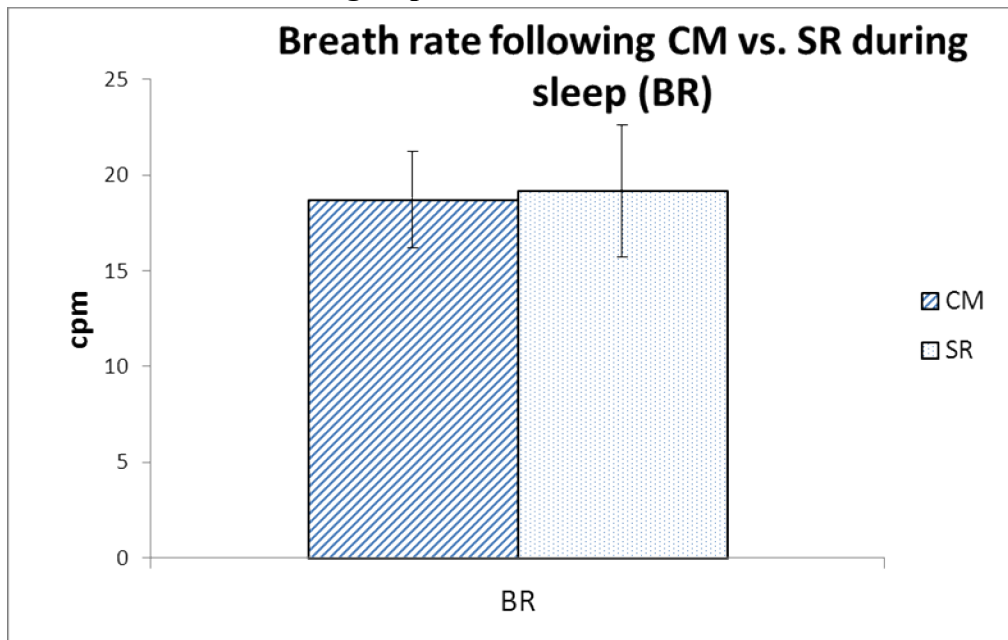


Fig.7.3.5: Very Low frequency (n.u.) following CM vs. SR before sleep.
 Values are group mean \pm S.D.

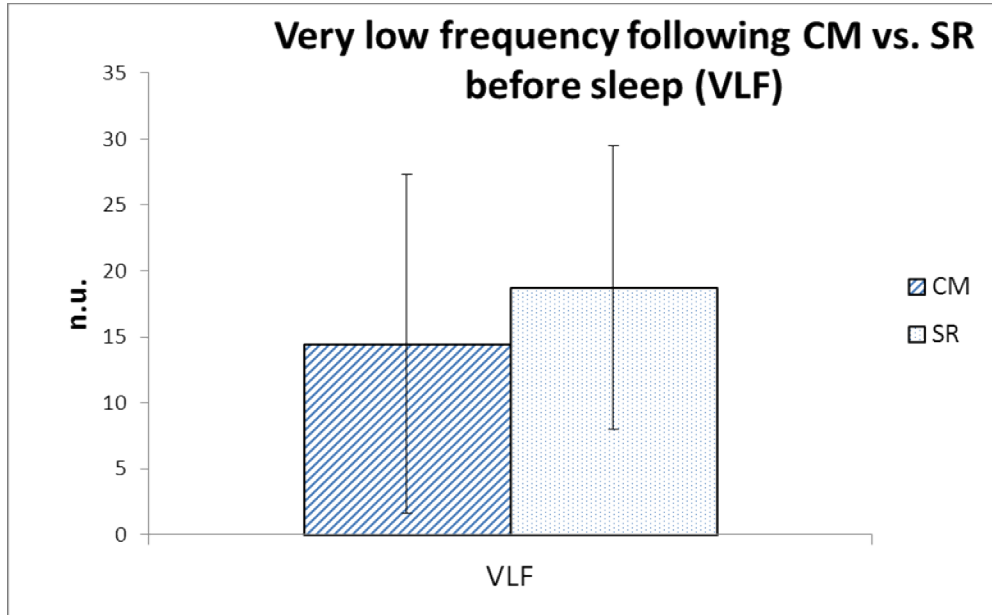


Fig.7.3.6: Very Low frequency (n.u.) following CM vs. SR during sleep.
 Values are group mean \pm S.D.

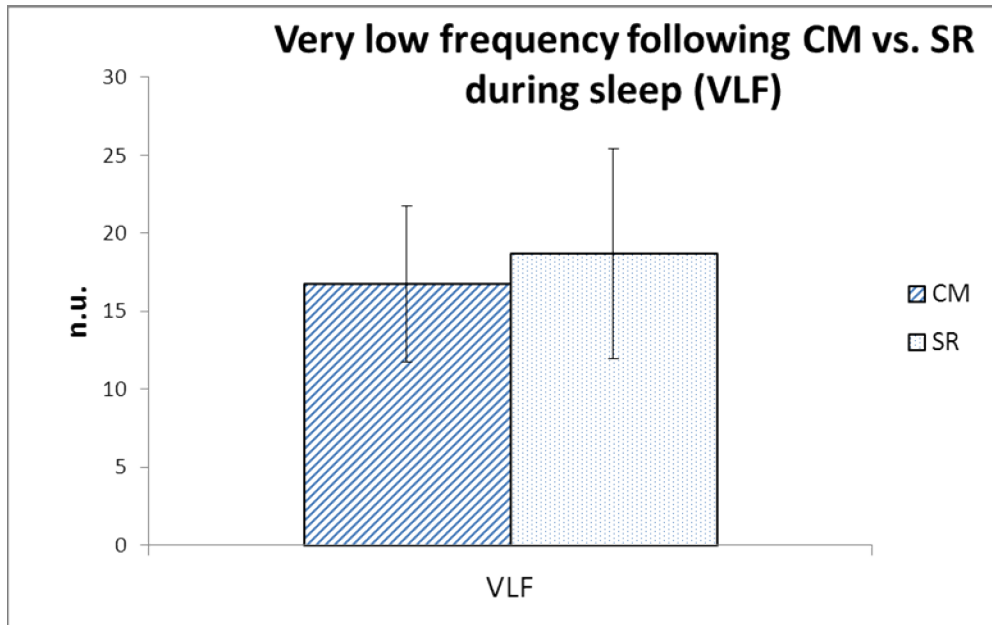


Fig.7.3.7: Low frequency (n.u.) following CM vs. SR before sleep.
 Values are group mean \pm S.D.

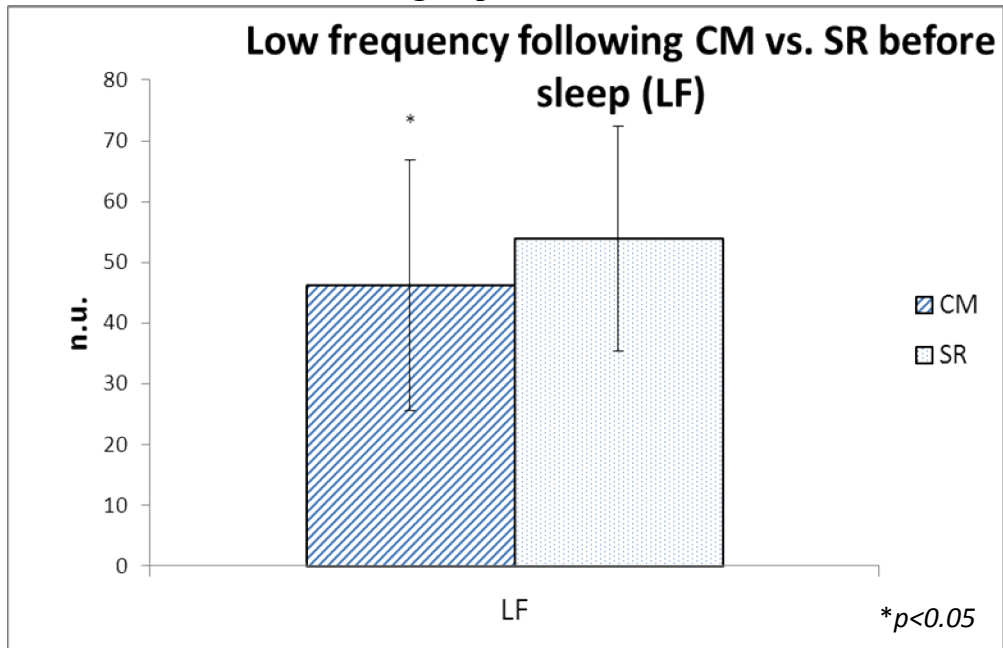


Fig.7.3.8: Low frequency (n.u.) following CM vs. SR during sleep.
 Values are group mean \pm S.D.

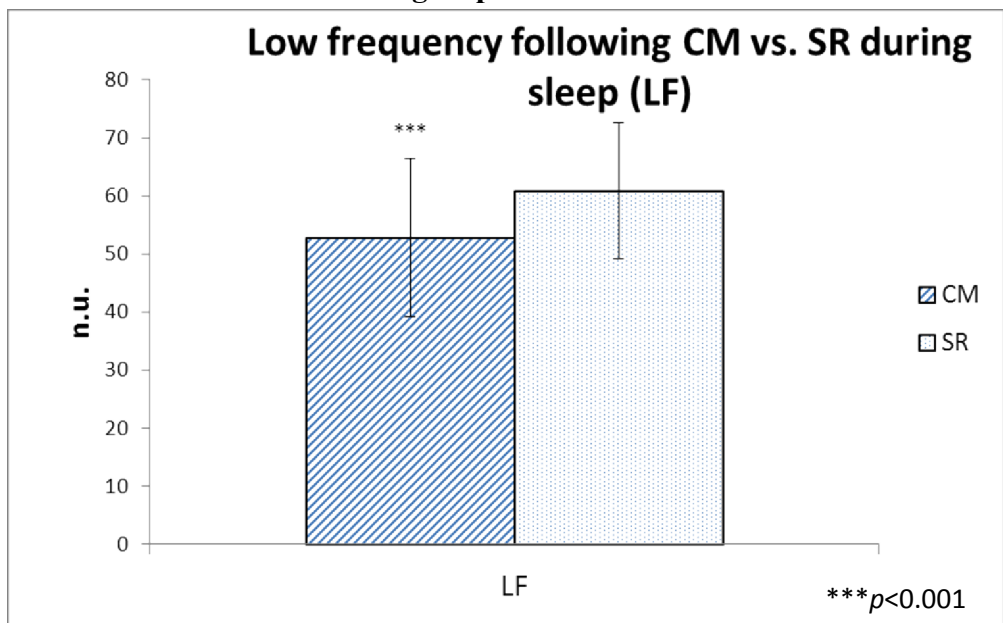


Fig.7.3.9: High frequency (n.u.) following CM vs. SR before sleep.
 Values are group mean \pm S.D.

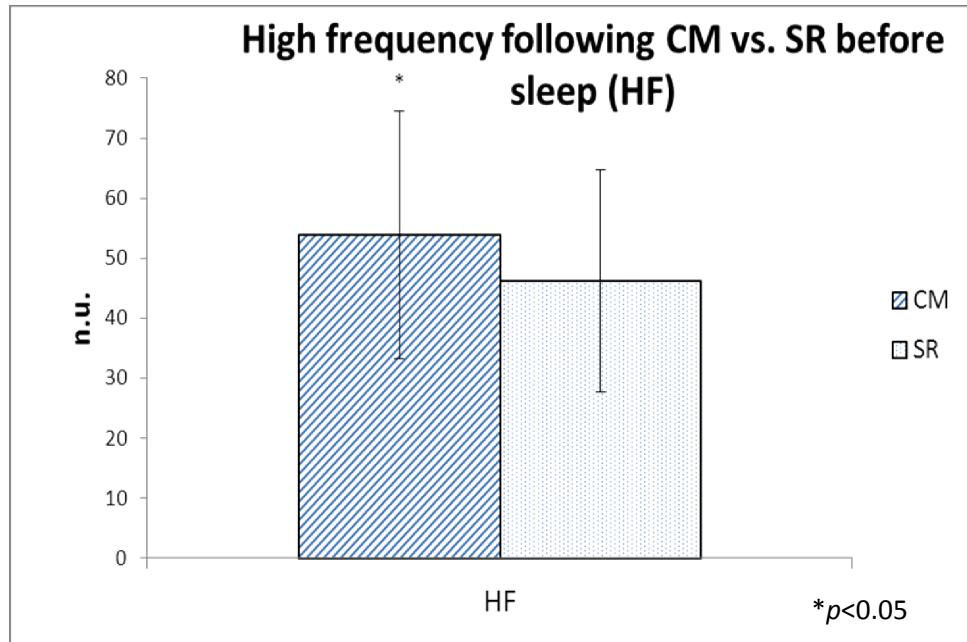


Fig.7.3.10: High frequency (n.u.) following CM vs. SR during sleep.
 Values are group mean \pm S.D.

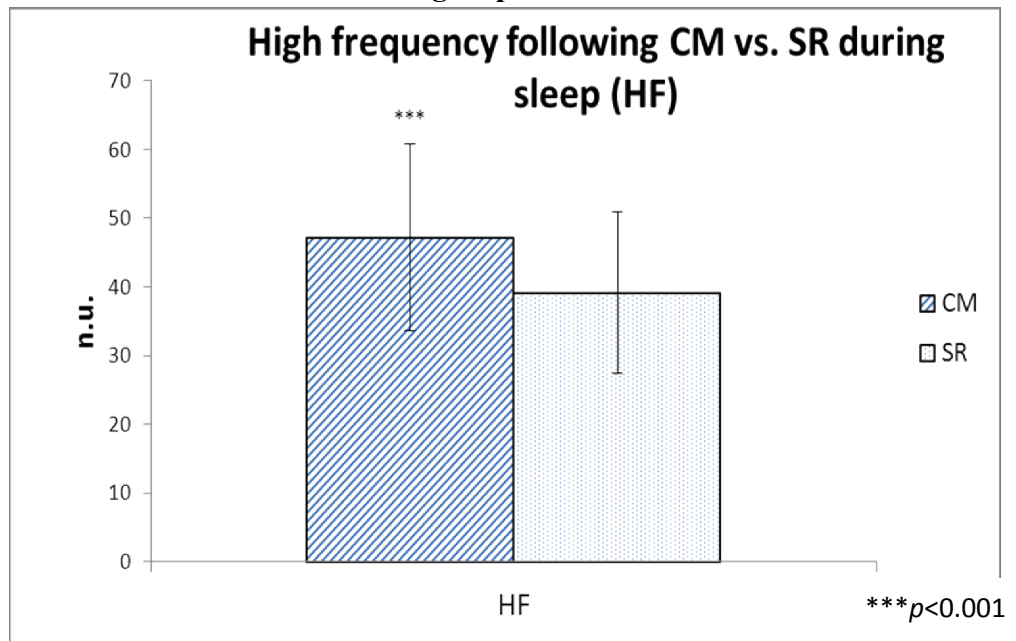


Fig.7.3.11: Low frequency and High frequency ratio following CM vs. SR before sleep. Values are group mean \pm S.D.

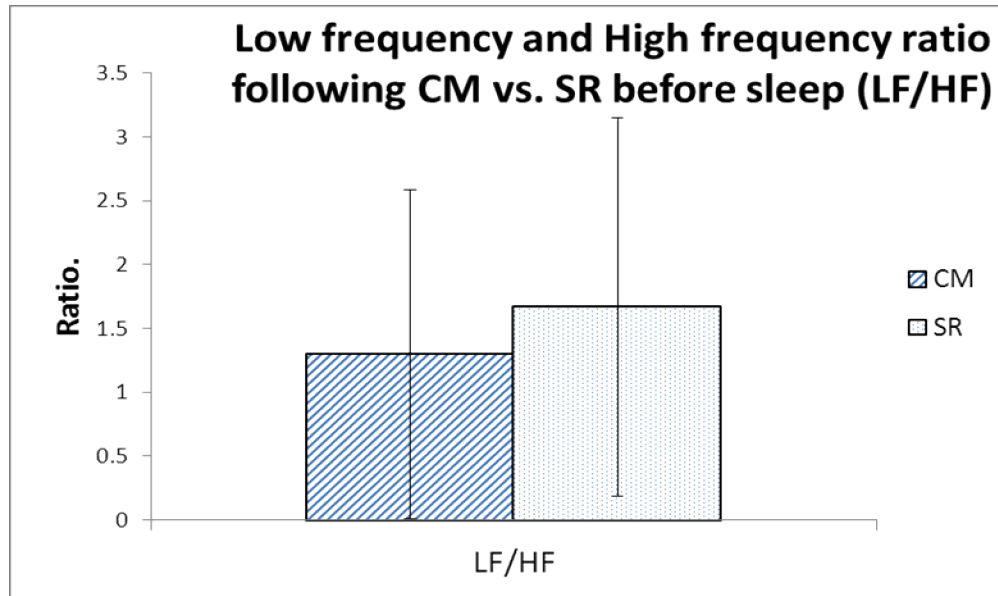


Fig.7.3.12: Low frequency and High frequency ratio following CM vs. SR during sleep. Values are group mean \pm S.D.

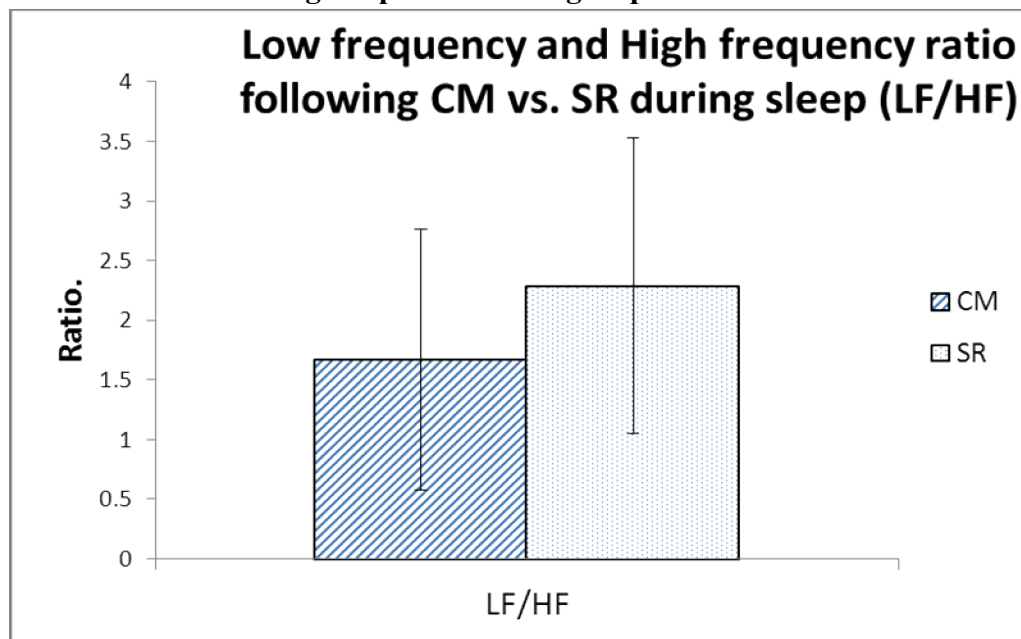


Fig.7.3.13: Standard deviation of the mean heart rate per second following CM vs. SR before sleep. Values are group mean \pm S.D.

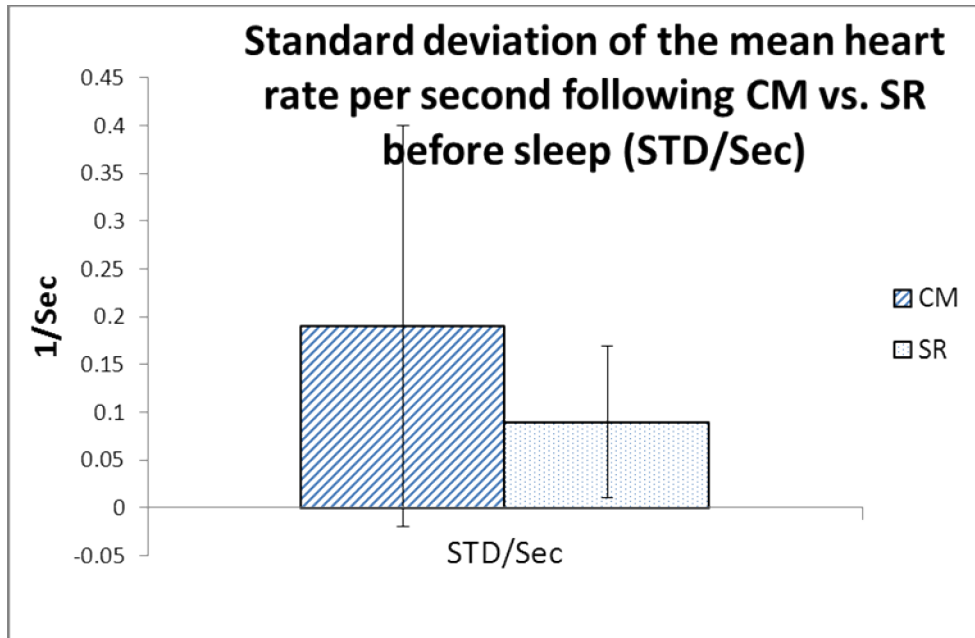


Fig.7.3.14: Standard deviation of the mean heart rate per second following CM vs. SR during sleep. Values are group mean \pm S.D.

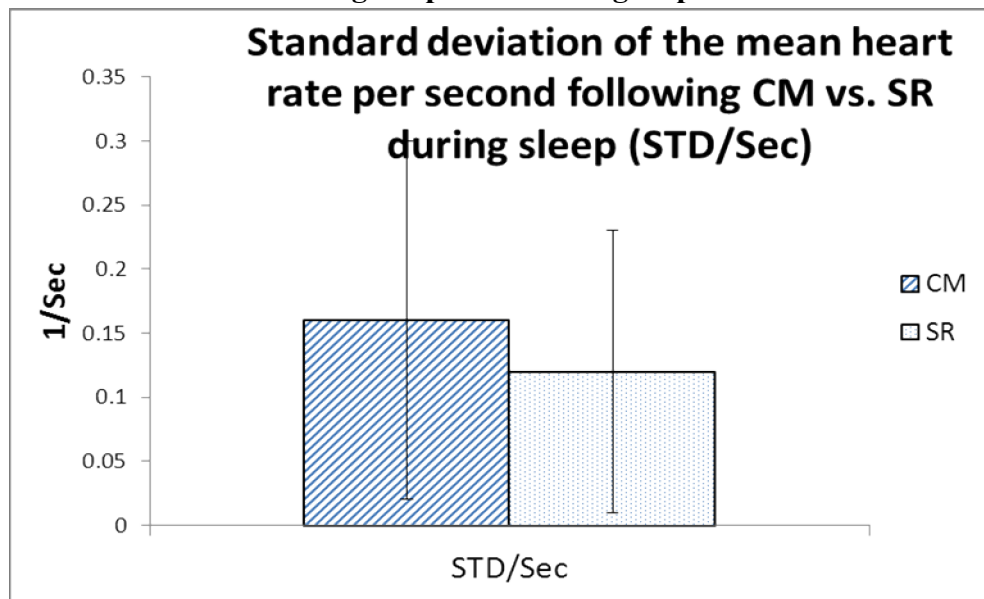


Fig.7.3.15: Standard deviation of the mean heart rate per minute following CM vs. SR before sleep. Values are group mean \pm S.D.

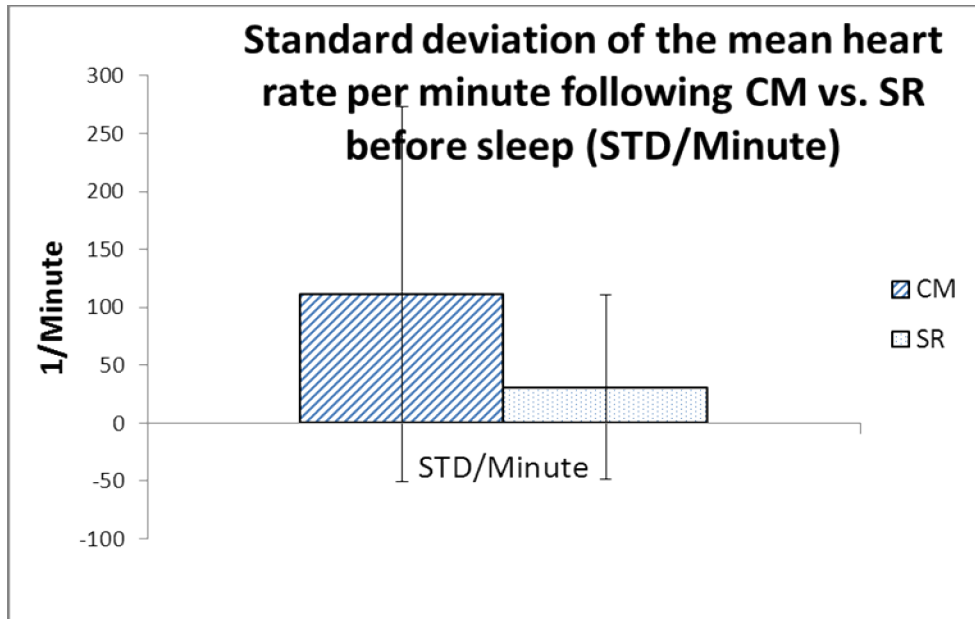


Fig.7.3.16: Standard deviation of the mean heart rate per minute following CM vs. SR during sleep. Values are group mean \pm S.D.

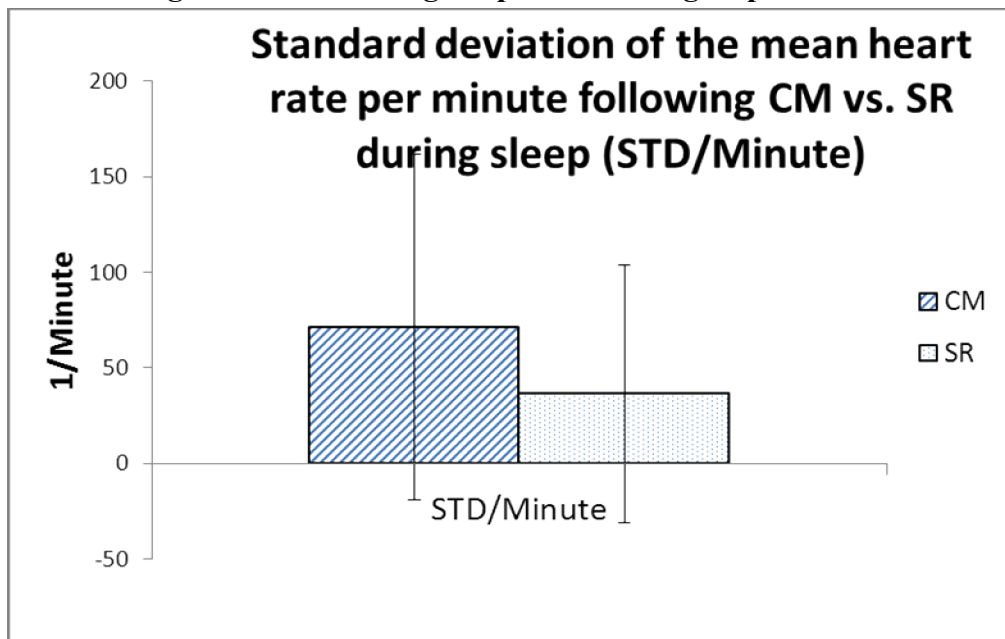


Fig.7.3.17: Root mean square of successive NN interval differences following CM vs. SR before sleep. Values are group mean \pm S.D.

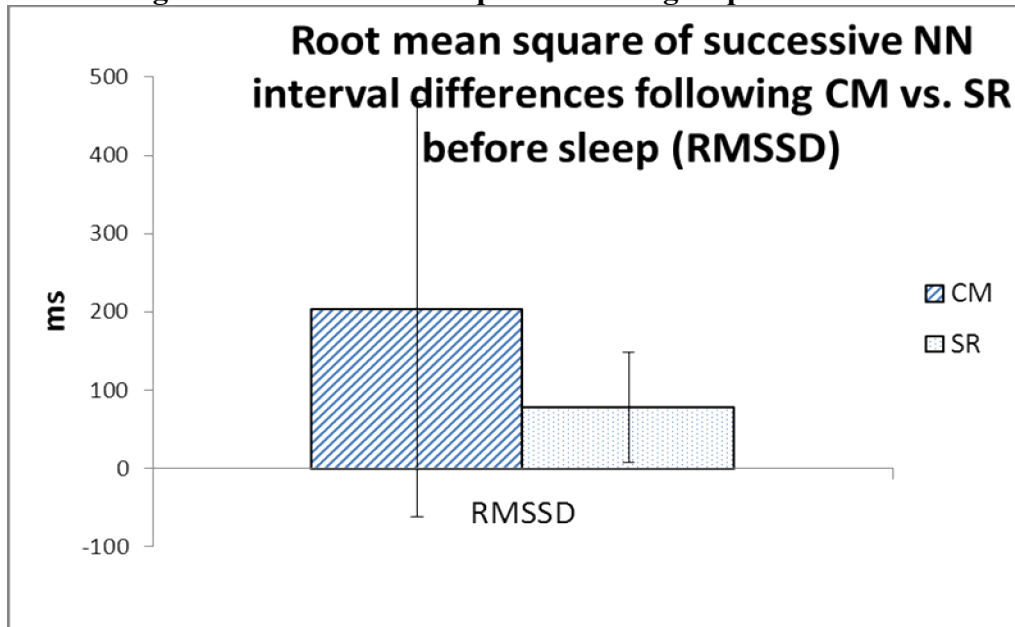


Fig.7.3.18: Root mean square of successive NN interval differences following CM vs. SR during sleep. Values are group mean \pm S.D.

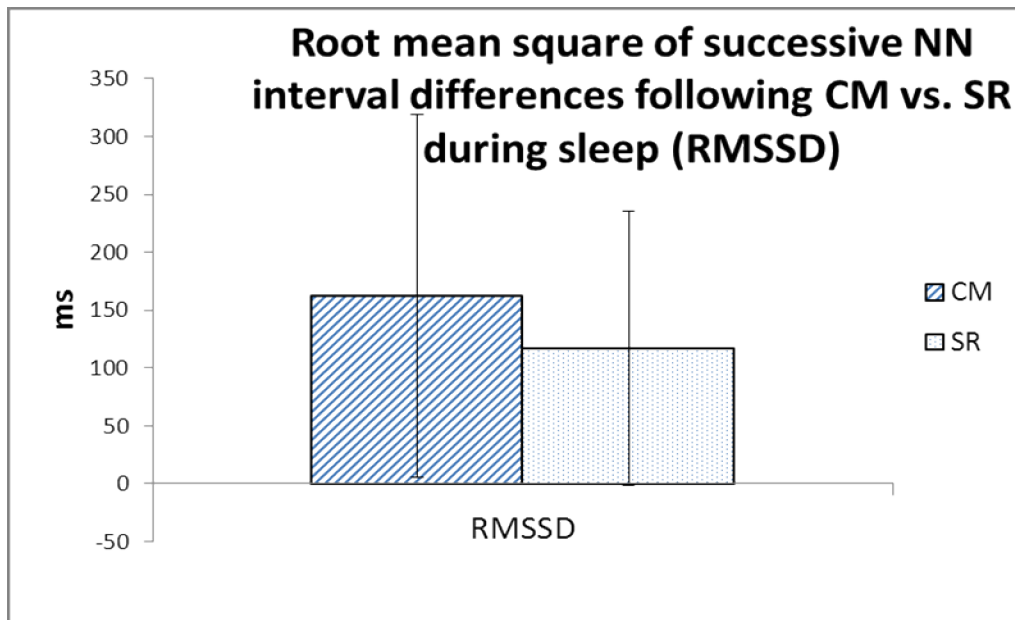


Fig.7.3.19: Successive NN intervals differing more than 50ms following CM vs. SR before sleep. Values are group mean \pm S.D.

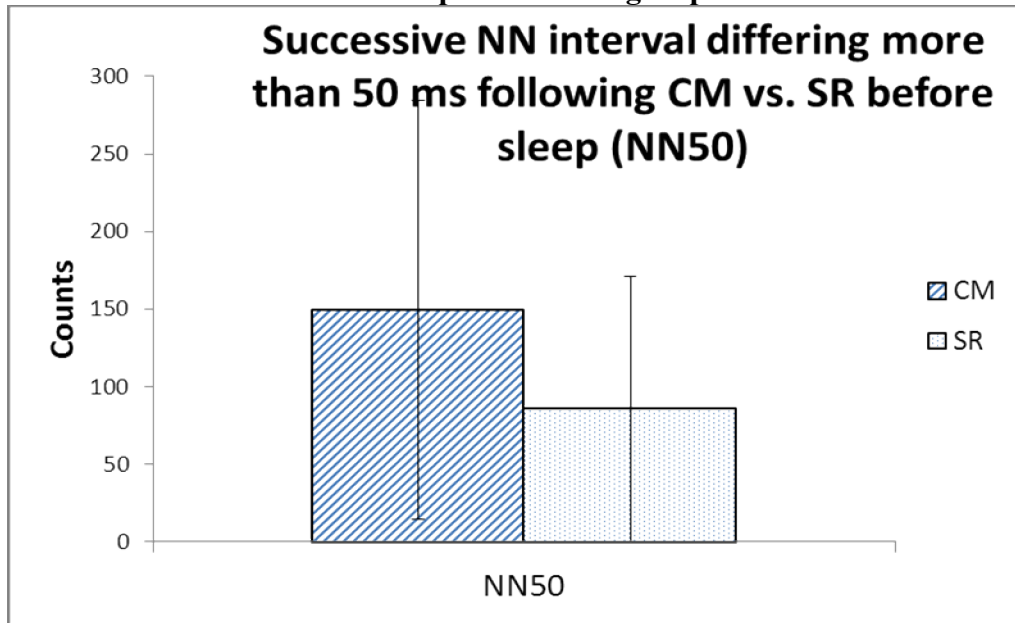


Fig.7.3.20: Successive NN intervals differing more than 50ms following CM vs. SR during sleep. Values are group mean \pm S.D.

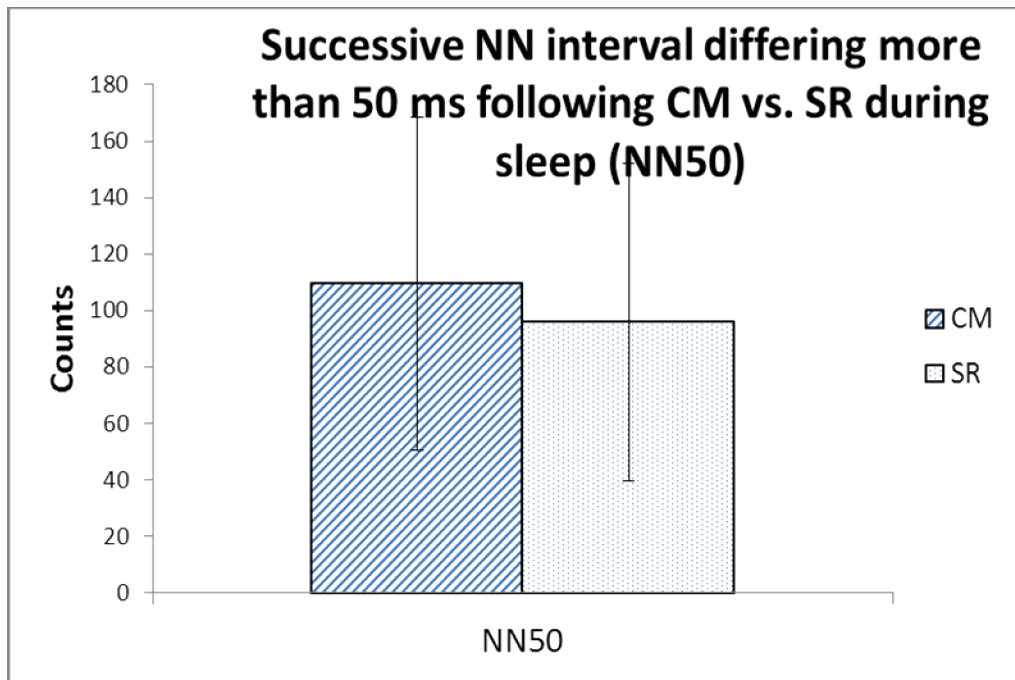


Fig.7.3.21: Percentage value of NN50 counts following CM vs. SR before sleep. Values are group mean \pm S.D.

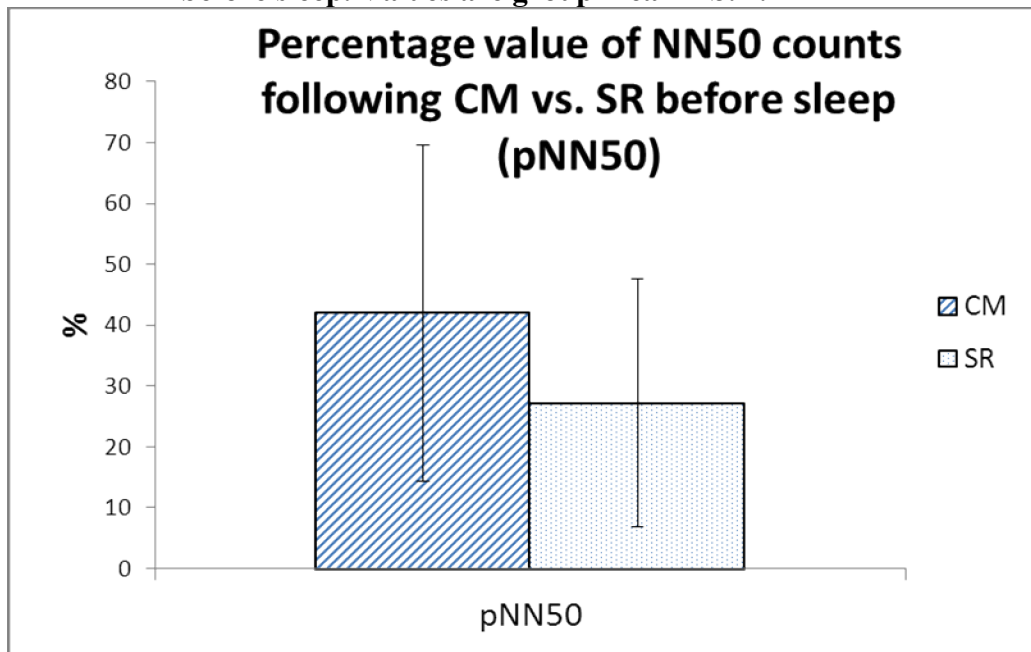


Fig.7.3.22: Percentage value of NN50 counts following CM vs. SR during sleep. Values are group mean \pm S.D.

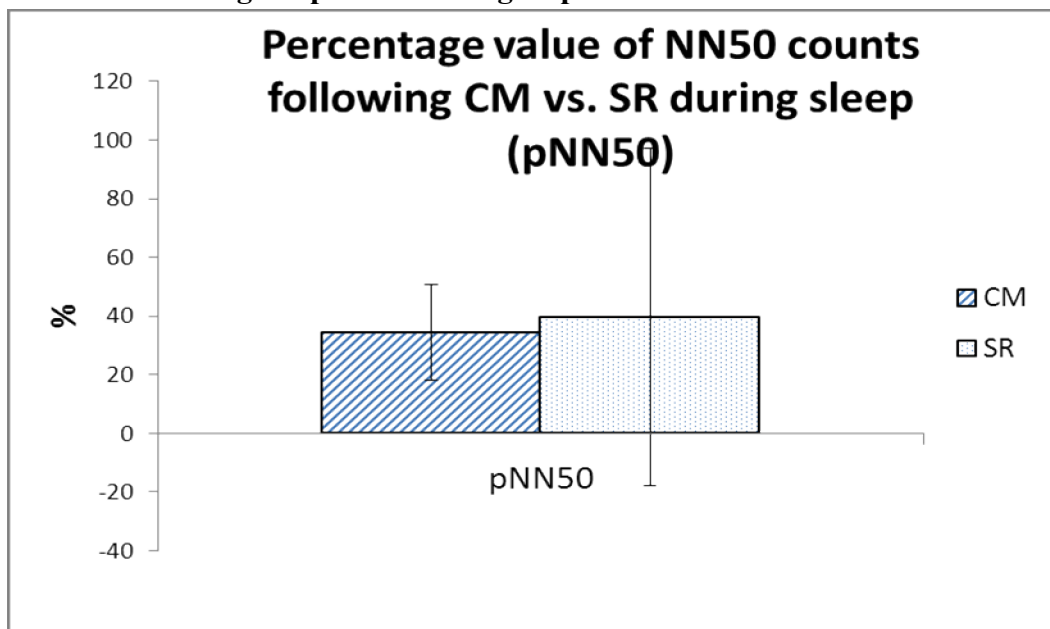


Fig.7.3.23: Total index of Normal to Normal intervals following CM vs. SR before sleep. Values are group mean \pm S.D.

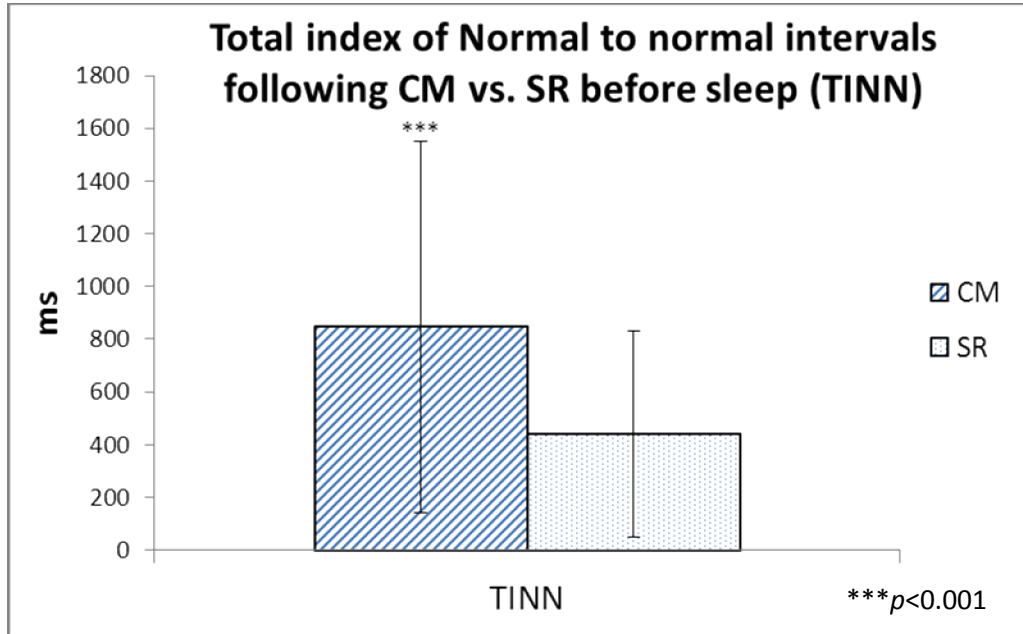
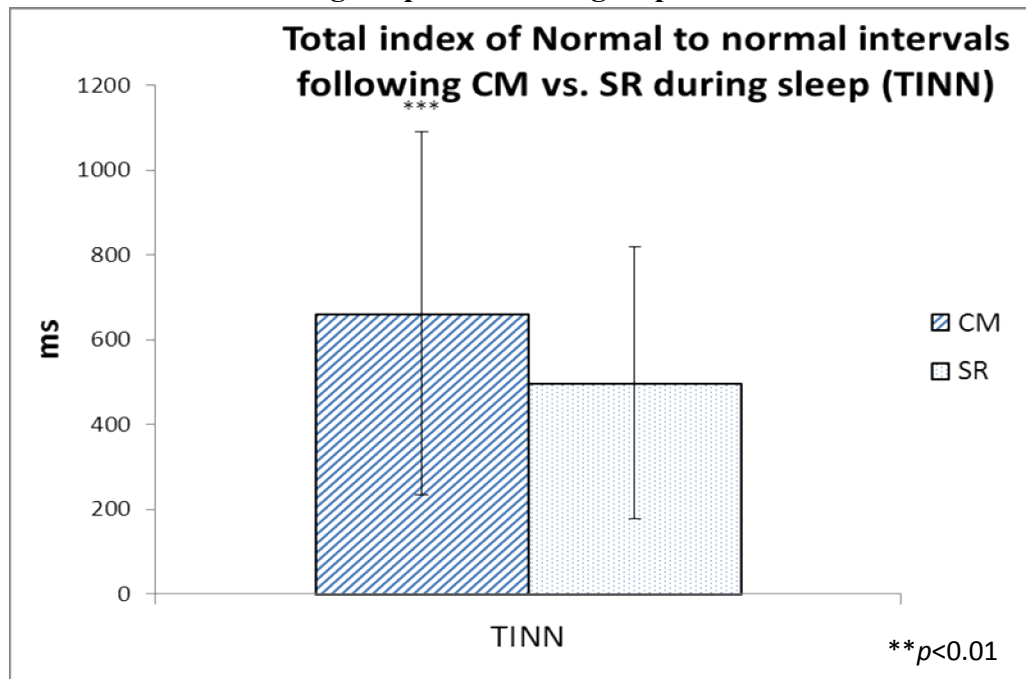


Fig.7.3.8: Total index of Normal to Normal intervals following CM vs. SR during sleep. Values are group mean \pm S.D.



9.1 SUMMARY

On the night following CM practice the percentage of slow wave sleep (SWS) was significantly more than the night following relaxation in SR, the percentage of rapid eye movement (REM) sleep was less, and the number of awakenings per hour was also less. Following CM the self rating of sleep based on visual analog scales showed an increase in the feeling that sleep was refreshing, an increase in feeling ‘good’ in the morning, an impression of an overall increase in sleep duration, a decrease in the degree to which sleep was influenced by being in a laboratory, as well as any associated discomfort.

So, practicing cyclic meditation twice a day appeared to improve the objective and subjective quality of sleep on the following night.

When heart rate variability was taken into account, it was observed that the night following day time CM practice there were the following changes; a decrease in heart rate, LF power (n.u.), an increase in HF power (n.u.) and an increase in the total index of all NN intervals (TINN). No change was seen on the night following SR. Hence yoga practice during the day appears to shift towards the parasympathetic dominance during sleep on the following night.

9.2 CONCLUSION

Persons who were already experienced in yoga practice, including meditation, practicing cyclic meditation (CM)

- i. increased the percentage of time spent in slow wave sleep (SWS)
- ii. decreased the time spent in rapid eye movement (REM) sleep

- iii. reduced the number of awakenings per hour.
- iv. the participants' subjective rating of sleep was also better following CM compared to the other recording day, after SR.

Therefore, it was concluded that the practice of Cyclic meditation during day time improved the objective and subjective quality of sleep on the following nights.

When heart rate variability was taken into account, it was observed that

- i. there was a reduction in low frequency power (LF)
- ii. Increase in high frequency (HF)
- iii. increase in total index of NN intervals (TINN)

Hence, it was concluded that the cyclic meditation practice (CM) during the day appears to shift towards the parasympathetic dominance during sleep on the following night.

9.3 STRENGTH OF THE STUDY

The strength of the study is in the fact that it has attempted to derive a comprehensive model of a meditation technique based on both the psycho- physiology and sleep structure following the practice of cyclic meditation during day time.

Studies on states within states (3 types of Jagrat, etc.) would unravel mysteries about the 3 states of consciousness. Day sleeping recording can be compared to night sleep studies. Effect of CM on day sleep to be investigated. Sleep structures in different disease states to be investigated and standardized. Their structure to be compared to normal sleep structure.

9.4 WEAKNESS OF THE STUDY

The main weakness or limitation of the study is that the yoga trainees would probably have been aware of the previous published findings on the effects of cyclic meditation compared to supine rest. This could be expected to have influenced their subjective ratings of sleep on the nights following the practice of cyclic meditation or supine rest in *shavasana* and variations in the subjects' routine as well as inherent differences between individuals may have accounted for the fact the participants' baseline values differed widely, which is a weakness of the study in heart rate variability during sleep. Volunteers with no experience in yoga should have been recruited in the study.

9.5 APPLICATIONS OF THE STUDY

The applied value of this present research are the following

1. the present technique (CM) can be used as a tool for stress reduction as it appears to shift sympatho-vagal balance in favor of parasympathetic dominance during sleep on the following night.
2. CM technique can also be used as a technique to alleviating the problems of acute as well chronic insomnia and other sleep related problems.

9.6 SUGGESTIONS FOR THE FUTURE

Further studies are required to understand the long term effects of practicing CM, and also to know whether the sleep architecture of long term practitioners differ from non-practitioners.

In the present study no attempt was made to correlate the HRV with the stages of sleep; as this presented certain technical difficulties. A future study with such a correlation would overcome this limitation and provide additional information.

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