

## TOWARDS UNDERSTANDING OF *SAMĀDHI* DURING MEDITATION BY TRANSIENT HEART RATE VARIABILITY DATA

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A study was conducted towards understanding the Samadhi during meditation. The heart rate (HR) and heart rate variability (HRV)[4] information was collected from the individuals undergoing meditation. Volunteered Buddhist monks and lay meditation practitioners are selected around the world for the test. The data was collected and analyzed in real time by using a wireless heart monitoring system [7]. "*Ānāpānasathi*" seated (*Zazen*) meditation method was selected as the meditation method out of many forms[1-2]. The transient properties of HR data was analyzed by using the HRV methods and the results are presented in this paper.

It is stated in the *Sutta Piṭaka*[1] that in Buddha's time there were many individuals have obtained enlightenment by using different methods and paths, and that Buddha has guided these individuals, monks and householders, to attain the ultimate state of *Nibbāna*[1-2] via various methods and techniques[1-2]. Such attainments, contrary to conventional belief in Buddha's time that could be inherited by birth or attributed to other external conditions, i.e. social status, country, physical appearance, were achieved by virtue of the individuals actions[1-2]. In addition, it is stated in the *Sutta Piṭaka*[1] that one also needs to cultivate certain level of Samadhi (*Jhāna* or *Samādhi*) in order to concentrate the mind for further spiritual development. Therefore many studies have been conducted to investigate and understand the depth and progress of one's Samadhi state by using scientific tools such as physiological data [5-6].

There have been numerous studies and experimentations conducted to understand the characteristics of the physiological parameters and their variations during meditation[5-6]. Monitoring the HR and then analyzing the HR data by using the HRV methods are the common practices in the field. However, the transient nature of the HRV has not been researched much. Most of these studies have compared the HR of non-meditated state and the

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meditated state. This study focused on understanding the depths of the meditation and how the HRV characteristics are changing during the meditation and the relationship of HR with the depths of the meditative states (Samadhi or Jhana state). It was also observed that overall power spectral density(PSD) of HRV improvement during meditation than in the non-mediation. Moreover the low frequency (LF <0.15Hz) power density is more than that of the high frequency (HF >0.15) power density.

It has been observed that meditative state (Samadhi) is correlated with time and comes to saturation after an individual attained some concentration (Samadhi or Zen state). It was expected that the HR and HRV characteristics to have a correlated behavior with the Samadhi. The experiment was focus to observe the characteristics of the HR and HRV during the meditation. It was observed as the meditation progresses power spectral density (PSD) [4] of the HRV characteristics moves towards Ultra LF (ULF<0.04Hz) region and lowering of the LF power spectrum and is a good indication of depth of the meditation. The ratio of the LF power to the ULF power is an indication of the depth of the meditation and it was defined to be the meditation depth index (MDI). It is a parameter that is expected to improve as the meditation depth increases.

$$\text{MDI} = (\text{Power density of the ULF}) / (\text{Power density of the LF})$$

**Keywords:** meditation, *samādhi*, heart rate and heart rate variability.

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