

## Effect of stress and yogic relaxation techniques (*Anulomvilom* & *Shavasana*) on cold induced pain perception in medical undergraduate students

Nilima Shankar\*, Asha Yadav, Shikha Gautam & Mayank Agarwal

Department of Physiology, University College of Medical Sciences & Guru Tegh Bahadur Hospital,  
University of Delhi, Dilshad Garden, Delhi -110095

\*E-mail: nilushankar@yahoo.com

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The current knowledge of stress and relaxation on the phenomenon of pain perception is extremely limited. The present study was undertaken to investigate the effect of mental stress, physical stress and the effect of yogic relaxation techniques like *Anulomvilom* and *Shavasana* on the perception of pain, measured by the cold pressor test, in medical undergraduate students. The results for pain threshold showed that its value in basal condition and during mental stress was significantly less compared to pain threshold in physical stress and after yogic relaxation techniques. The results for pain tolerance showed that its value in basal condition was significantly less as compared to pain tolerance in physical stress while the mean value of pain tolerance in condition of mental stress was significantly less compared to pain tolerance in physical stress and after yogic relaxation techniques. This study suggests that both stress and yogic relaxation techniques have an effect on pain perception. It however raises several questions for which the definitive answers are yet to be determined and therefore serves to emphasize the importance of the same for future research on pain or in clinical practice.

**Keywords:** Pain perception, Stress, *Anulomvilom*, *Shavasana*, Cold pressor test, Medical undergraduates

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Stress is the body's reaction to a change that requires a physical, mental or emotional adjustment or response. Hans Selye, who was the first to use the term 'stress' in a biological context, defined stress as a wide range of strong external stimuli, both physiological and psychological, which can cause a physiological response called the 'general adaptation syndrome'. In today's world, nearly everyone is a victim of stress and this has led to an increase in stress related disorders like hypertension, angina, psychiatric diseases, insomnia, etc. Exposure to stressful stimuli is perceived as a threat to an organism's homeostasis and elicits a variety of physiological adaptation, encompassing endocrine, autonomic and behavioral aspects<sup>1</sup>. At the same time, there are many complex factors which appear to influence an individual's pain sensitivity<sup>2</sup>. Earlier studies have shown that gender along with age, cognitive level and family factors together with ethno-cultural factors and in conjunction with the variety of pain people experience over time, all influence how people behave when they have pain

and even how they perceive pain. Anxiety and stress have also been implicated in the perception of pain. Keogh *et al.* examined the effect of gender and anxiety sensitivity on the experience of pain and reported that females had a lower pain threshold and were less tolerant to pain than men. High anxiety sensitive females reported greater sensory pain than low anxiety sensitive females<sup>3</sup>. Bemant *et al.* concluded from their study that the differential response in the changes in pain perception is related to anxiety and stress levels prior to and during the cognitive stressor, indicating that psychosocial characteristics can help determine the stress-induced pain response<sup>4</sup>. However, our current knowledge regarding the differences and similarities of stress and relaxation techniques on pain perception is extremely limited.

In this study, the cold pressor test was selected as the experimental pain induction and assessment technique because this test is routinely used in pain research as well as in chronic pain management clinics. The test creates an aching or crushing pain in the limb on submersion in cold water that is totally reversible within a few minutes of removing the limb

\* Corresponding author

from the water. The main dependent measures are pain threshold and pain tolerance wherein threshold is the time (in seconds) from immersion to first pain sensation and is considered to be an unlearned component, mostly dependent on physiological variables, whereas, tolerance is the time (in seconds) from immersion to withdrawal of the limb from the water due to unbearable pain and is considered to be a learned component of pain, mostly related to psychological and cultural factors. An increase in the value of both is indicative of blunting of the pain perception<sup>5</sup>.

Relaxation can be achieved in several ways and there are a number of relaxation techniques available in yoga which can reduce the stress response in individuals<sup>6</sup>. The origin of yoga, an ancient system of practices based on the scientific principles of exercise, breathing, meditation and philosophical beliefs concerning life and thinking, has been ascribed to the Indus Valley Civilization (2600-1900 BC) although some researchers suggest more ancient origins<sup>7,8</sup>. Though it has been practiced through the ages, participation in yoga has increased dramatically throughout the world in recent decades<sup>9</sup>.

Stress is omnipresent amongst the medical undergraduate students, due to the vast academic curriculum and huge family and social expectations on them. When the stress becomes excessive, students experience physical and psychological impairment<sup>10</sup>. It tends to overload the mental and physical resources and interferes with the effective use of skills, and thus, affects negatively on their performance<sup>11</sup>. The present study was undertaken, as part of an ongoing study on pain in our laboratory, to investigate the effect of stress, both mental stress and physical stress on the perception of pain in medical undergraduate students and to study the effect of relaxation techniques like yogic breathing (*Anulomvilom*) and *Shavasana* on the perception of pain.

### Methodology

This was a cross sectional study and included 36 healthy male subjects of age group 17-20 yrs studying as medical undergraduates in the University College of Medical Sciences, Delhi. The study was approved by the institute's ethical committee. Informed and written consent was obtained from each participating volunteer before commencement of the study. Only male students were included in the study as gender has been shown to affect the pain perception in previous studies. All the subjects

included in the study were free from any acute or chronic illness, were non-smokers and were not taking any kind of drug or medication.

The pain threshold and pain tolerance was measured in each subject on each occasion using the cold pressor test (CPT). The CPT involves the subject submersing his dominant hand till the wrist in water at a temperature of 4 ° Celsius. The experiment was held in a temperature regulated quiet room where the experimenter was monitoring the subjects one at a time. After explaining the procedure a stopwatch was started, when the subject immersed his hand in water, to record both parameters of time. Pain threshold was determined as the duration of time (in seconds) between the onset of immersion and when the subject first reported pain on exposure to the painful stimulus while pain tolerance was determined as the duration of time (in seconds) from immersion until the subject withdraws his hand from the test water due to intense pain. Using the technique of CPT, the same group of 36 subjects was assessed on 4 different occasions as follows:

**Group 1 (G1): Under basal condition (mental and physical rest).** Here the pain threshold and pain tolerance of the subjects were measured in the basal condition that is when they were free from any kind of apparent mental or physical stress.

**Group 2 (G2): Under mental stress.** Here the subjects were assessed for their pain threshold and pain tolerance when they were in a condition of mental stress while waiting to appear in an assessment viva in the department of Physiology.

**Group 3 (G3): Under physical stress.** Here the subjects were assessed for their pain threshold and pain tolerance when they were in a condition of physical stress induced by making these volunteers perform a standard exercise using the Master's step stool. Procedure of the Master's step test is that the subject ascends to the top of the 2 steps (height of each step being 23 cm) and then without turning descends the same steps. This is counted as 1 trip. This way he was asked to make 20 trips per minute for 5 minutes. To ensure that the required trips were made the subject was asked to climb each step to the rhythm of a metronome. The exercise was supervised.

**Group 4 (G4): Under effect of yogic relaxation techniques.** Here the pain threshold and pain tolerance of the volunteers was assessed after practicing relaxation techniques consisting of deep breathing (*Anulomvilom*) and guided relaxation of the

body while lying down (*Shavasana*). Subjects were made to practice *Anulomvilom* for 5 minutes followed by *Shavasana* for the next 20 minutes. This procedure was carried out before meals, in the yoga laboratory of the department of Physiology by a trained instructor, in a dark, temperature-regulated and silent environment. For *Anulomvilom* the subject sits down in *Padmasana* or *Siddhasana* and focuses his attention on the breath. Then the subject closes his right nostril with right hand's thumb and inhales through his left nostril deeply and slowly. When the lungs are full, the subject slowly exhales through the right nostril closing the left nostril with right hand's index finger. Then keeping left nostril closed, inhales through the right nostril and ultimately exhales the breath through the left nostril. This constitutes one cycle of *Anulomvilom*. The practice of *Shavasana*, which is the simplest method of relaxation, is practiced by the subject in the flat lying position wherein he follows the spoken instructions of the yoga instructor towards a guided relaxation of the body starting from the toes and gradually moving upwards. The practice includes the resolve, body part awareness, breath awareness and visualization<sup>12</sup>.

### Statistical Analysis

The results of CPT in all the 4 groups were analyzed by repeated measure ANOVA followed by Tukey's test at 5% significance.

### Results and Discussion

This study demonstrates the effect of mental stress, physical stress and relaxation techniques using *Anulomvilom* and *Shavasana*, on the perception of pain induced in healthy male volunteers using the CPT. The results for pain threshold showed that its mean value in basal condition was significantly less as compared to mean

value of pain threshold in physical stress and after yogic relaxation. The mean value of pain threshold in mental stress was also significantly less as compared to mean values of pain threshold in condition of physical stress and after yogic relaxation techniques (Table 1). The results for pain tolerance showed that its mean value in basal condition was significantly less as compared to mean value of pain tolerance in condition of physical stress while the mean value of pain tolerance in condition of mental stress was significantly less as compared to mean value of pain tolerance in condition of physical stress and after yogic relaxation techniques (Table 2). Both the pain responses were different but not significantly so between mental stress and basal conditions. Thus, both the pain threshold and tolerance, as measured by the CPT were found to be different in different physiological conditions of stress and relaxation as compared to that in the basal condition.

A few earlier studies on this subject have shown that participants under mental stress reported less pain than those in a condition of rest<sup>13</sup>. In another study on pilots, it was found that physical exercise increased pain threshold in pilots with a history of acute in-flight neck pain attacks but not so in the control group<sup>14</sup>. Other researchers have also shown that individuals in conditions of stress reported less pain during CPT than those in conditions of rest<sup>15</sup>. Koltyn *et al.* have examined the influence of isometric handgrip exercise on pain threshold in men and women and documented that pain threshold for the women increased significantly after isometric exercise but did not change for the men<sup>16</sup>. Krejci *et al.* have similarly demonstrated that yoga through its techniques of meditation, *asanas*, and *pranayama* yields a positive effect in the management of stress in adolescents<sup>17</sup>.

Table 1—Pain threshold values (in seconds, using cold pressor test) under different conditions and the inter-comparison between groups.

Groups (n = 36)	Mean ± S.D (in seconds)	*P value ANOVA	Significance using Tukey's test			
			G1	G2	G3	G4
G1	10.53 ± 3.62	<0.001			*	*
G2	11.00 ± 5.73	<0.001			*	*
G3	13.64 ± 5.38	<0.001	*	*		
G4	13.44 ± 4.56	<0.001	*	*		

(G1- basal condition, G2- mental stress, G3- physical stress, G4- yogic relaxation techniques)

Table 2—Pain tolerance values (in seconds, using cold pressor test) under different conditions and the inter-comparison between groups

Groups (n = 36)	Mean ± S.D (in seconds)	*P value ANOVA	Significance using Tukey's test			
			G1	G2	G3	G4
G1	35.64 ± 11.27	<0.001			*	
G2	33.61 ± 10.42	<0.001			*	*
G3	46.50 ± 20.02	<0.001	*	*		
G4	41.06 ± 11.23	<0.001			*	

(G1- basal condition, G2- mental stress, G3- physical stress, G4- yogic relaxation techniques)

Exposure to stress triggers hormonal and behavioral responses. It has been shown that the endogenous opioid system plays a role in some physiological reactions to stress. The opioid system has been described to mediate a decrease in the pain perception (analgesia) induced by mild stressors and to modulate the activation of the hypothalamic-pituitary-adrenal axis. Previous research has indicated that stress-induced analgesia could be mediated by at least two distinct neuronal mechanisms: opioid (naloxone-reversible) vs non-opioid (naloxone-irreversible). It was demonstrated that the type of stress-induced analgesia was partly determined by the severity of stress. Collateral inhibition between opioid and non-opioid mechanisms was also demonstrated, with both pathways being mutually antagonistic. Environmental stress has been shown to activate the endogenous pain inhibitory systems even in animals<sup>18</sup>. Yilmaz *et al.* have studied mildly painful pressure stimuli in conditions of mental arithmetic combined with increasing levels of noise as a stressor during functional MRI. They concluded that post-stress pain threshold and pain tolerance were significantly higher as compared to pre-stress levels. They documented that stress-induced analgesia led to an increase of the blood-level-dependent oxygenation response of the brain in the primary somatosensory cortex, bilaterally in the anterior insula, and in the secondary somatosensory cortex. The increase in pain tolerance correlated significantly with activation in the rostral anterior cingulate cortex. Stress-induced analgesia seems to activate similar brain networks as produced by placebo-analgesia or analgesia mediated by diffuse noxious inhibitory controls and involves sensory, affective and cognitive modulatory circuits<sup>19</sup>.

Relaxation is considered as the physiological opposite to stress, enabling regeneration and recuperation after stress. It is also an integral component of various yogic practices. It is widely known that the science of yoga is a powerful stream of knowledge, which enables the practitioners to achieve radiant physical health with a serene mind, continues the spiritual upliftment of the individual and creates the ability for harmonious social living<sup>20</sup>. Udupa *et al.* have concluded from their study that yoga has the potential to influence the stress disorder and it helps the sufferer to achieve physical and metabolic stability<sup>21</sup>. The effect of relaxation techniques could be partially explained by the nonspecific decreased activation of the brain due to

decreased input of stimuli from the internal as well as external environment. The decreased anxiety and depression, following the practice of relaxation techniques, also influences the emotional component of pain. The effectiveness of slow and especially deep breathing, as it is in *Pranayama* breathing exercises, which are a part of any comprehensive yoga therapy, are well documented<sup>22</sup>. In a study on chronic low back pain patients Tekur *et al* reported that a short-term intensive residential yoga program, which included both *Pranayama* and meditation, significantly reduced the pain-related disability and improved spinal flexibility in patients. They attributed their results to the relaxing effect of *Pranayama* on the sympathetic nervous system<sup>23</sup>.

Different relaxation-inducing techniques have common features like muscle awareness as well as muscle relaxation, breath awareness, autosuggestions, and suitable imagery. All these elements are present in yogic techniques like *Shavasana* and *Yoga Nidra* which are known to enhance one's ability to combat stressful situations. The effectiveness of *Shavasana* in producing psychosomatic relaxation has been documented by previous researchers<sup>24</sup>. In an earlier study, 3 months practice of *Shavasana* demonstrated an improvement in patients who had problems of headache, insomnia, and nervousness<sup>25</sup>. Another study has shown that even 7 days of *Shavasana* training reduces the stress induced by CPT and reduces the load on the heart by blunting the sympathetic response<sup>26</sup>. Bera *et al* have also reported that the effects of stress are reversed in a significantly shorter time by practicing *Shavasana*<sup>27</sup>. Similarly, Kumar has also demonstrated the beneficial effect of *Yoga nidra* on stress and anxiety in college students<sup>28</sup>.

It is oftentimes difficult for medical students to commit to stress-reducing practices due to the time restrictions incurred by vast curriculum and long college teaching hours. It is postulated that introducing even small time yogic relaxation techniques into the students' daily schedules could provide a time-effective, convenient and practical method of negating the damaging effects of stress.

## Conclusion

This study raises several questions for which the definitive answers are yet to be determined. What this study does suggest is that stress both mental and physical as well as relaxation techniques have an effect on pain perception which is too

large to ignore. It also emphasizes their importance for future research on pain, on a larger number of subjects, or in clinical practice.

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