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## SPECIAL ISSUE

# Voluntary Breath Regulation in Yoga: Its Relevance and Physiological Effects

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*Regulating the breath is an important part of yoga practice. Descriptions in traditional yoga texts mention breath regulation as a way of getting spiritual realization. In yoga, there are several ways to modify breathing, such as changing the rate and depth, holding the breath, breathing through the mouth, or breathing alternately through one or both nostrils. These voluntarily regulated yoga breathing techniques are called pranayamas in Sanskrit. Brief descriptions of these techniques in traditional yoga texts as well as their physiological effects are given here.*

### General

All life processes are sustained by some form of energy; hence, those organisms that can efficiently procure and use the energy they need are likely to have a better chance of survival in a competitive environment (Poon, 1992). In the ancient Indian science of yoga, there is a definite emphasis on respiration and respiratory control. In Indian texts (the *Upanishads*, circa 1500 B.C.), the process of breathing is considered important for a spiritual aspirant to reach his or her ultimate goal (Gambhirananda, 1985). The way in which breath regulation is believed to help in attaining this goal is interesting. This can be better understood from another yoga text, *Hatha Yoga Pradipika* (circa 300 A.D.). The description here is as follows: "When the breath (used interchangeably with *prana* or subtle life energy) moves, the mental forces move; when the breath is steady, the mental forces are without movement . . . by this practice the yogi attains steadiness . . . and hence should regulate the breath" (Muktibodhananda, 2002, chap. 2, verse 2).

In yoga, there are several techniques to consciously regulate the rate and depth of breathing (Niranjanananda, 2004). Yoga techniques may include a period of breath holding following either inspiration or expiration. Still others include breathing through one or both nostrils or even through the mouth. These voluntarily regulated yoga breathing techniques are called *pranayamas*. This is derived from two Sanskrit words, namely, *prana*, which means "vital force" or "life energy" but can also be used to convey "breath," and *ayama*, which means "to prolong." Hence,

most simply, pranayama techniques are a way to voluntarily slow down and prolong breathing. In general, the correct way of breathing according to yoga is recognized to be slow, deep, and with inhalation and exhalation in a ratio of 1:2 (Singh, Wisniewski, Britton, & Tattersfield, 1990).

The description that follows covers the physiological effects of practicing these techniques and their applications in treatment.

### Yoga Breathing Techniques That Involve Breathing Through One or Both Nostrils

There is an ancient yoga text (called the *Swara* yoga text, where *swara* refers to the flow of air through the nostrils in the form of energy) that described different and distinct effects of breathing through the right nostril, the left nostril, or through both nostrils alternately (Muktibodhananda, 1999). This text states that breathing through the right nostril is supposed to be heat generating and that a person should carry out energetic activities, such as studying the scriptures, hunting, scaling a fort or mountain, controlling an elephant, horse, or chariot (*Shiva Swarodaya*, chap. V, verses 114–123). In contrast, breathing through the left nostril is described as heat dissipating, and it is mentioned that while breathing through the left nostril, one should carry out passive activities such as building a temple, rendering service, cultivating the land, and performing religious rites (*Shiva Swarodaya*, chap. V, verses 102–113). It has also been mentioned that when breath flows through both nostrils, one should remain quiet (possibly introspective) and avoid any activity (*Shiva Swarodaya*, chap. V, verse 128).

There are pranayamas that involve breathing through either or both nostrils (Ramdev, 2005). Breathing through the right nostril is called *surya anuloma-viloma pranayama* (where *surya* means the sun), whereas left-nostril breathing is called *chandra anuloma-viloma pranayama* (where *chandra* means the moon), and alternate-nostril breathing pranayama is called *nadisuddhi* (which means cleansing the channels for subtle life energy). The nostrils are manipulated using the fingers of the dominant hand assuming a particular gesture (*mudra*), in which the index and middle fingers are

flexed against the palm, the right nostril is occluded using the thumb, and the left nostril is occluded with the ring finger.

Scientific studies have partially, but not wholly, corroborated the descriptions of these practices in ancient texts. For example, right-nostril yoga breathing over a 1-month period as well as when practiced for 45 minutes increases oxygen consumption and causes sympathetic activation (e.g., an increase in peripheral vasoconstriction, increased systolic blood pressure, and increased heart rate; Telles, Nagarathna, & Nagendra, 1994, 1996). These effects may be taken to suggest the energizing and heat-generating effects of right-nostril yoga breathing described in the ancient texts.

*Nadisuddhi pranayama* has been shown to result in a slowing of breath after the practice as well as an increase in variation in heart rate during the phases of breathing (i.e., respiratory sinus arrhythmia; Jovanov, 2005). In an earlier study, it was shown that after practicing nadisuddhi pranayama for 4 weeks, volunteers showed a decrease in heart rate and systolic blood pressure both at rest and when they held their breath until the breaking point. Hence, nadisuddhi pranayama practice appears to reduce sympathetic activation associated with breath holding to the breaking point (i.e., the point at which the urge to breathe can no longer be resisted; Bhargava, Gogate, & Mascarenhas, 1988). The effects of left-nostril yoga breathing are not as clear.

Apart from these changes in oxygen consumption and autonomic variables, forced uninostril breathing practices have lateralized effects on the cerebral hemispheres. These results were based on the electroencephalogram as well as on performance in tasks specific to a particular cerebral hemisphere, and they suggested that forced uninostril breathing activates the opposite cerebral hemisphere (Shannahoff-Khalsa, Boyle, & Buebel, 1991; Wernitz, Bickford, & Shannahoff-Khalsa, 1987). However, yoga-based uninostril breathing was not shown to have a lateralized effect on performance on hemisphere-specific tasks, as all participants who practiced right, left, and alternate-nostril yoga breathing showed improved scores in a right hemisphere-specific task (Naveen, Nagarathna, Nagendra, & Telles, 1997). Also, the immediate effects of right-nostril yoga breathing on bilaterally recorded auditory-evoked potentials were compared with the effects of an equal duration of breath awareness as a control (Raghuraj & Telles, 2004). During right-nostril yoga breathing, the peak amplitudes of two of three evoked potential components increased on the right side, suggesting an ipsilateral effect, with recruitment of greater numbers of neurons on the right side during the practice.

## Yoga Breathing Techniques That Alter the Depth of Breathing

Most pranayama techniques make breathing deeper. In *bhastrika pranayama* (where *bhastrika* is “bellows” in Sanskrit), both inhalation and exhalation are forceful and the depth of breathing is increased, which is associated with an increased breath volume as well as greater contraction and expansion of the thorax and the abdomen. Most studies have focused on the oxygen consumption during this practice. Consistently, oxygen consumption increased during this practice (Behanan, 1937; Miles, 1964).

## Yoga Breathing Techniques That Involve a Period of Breath Holding

Certain pranayama techniques involve a period of breath holding, which could follow either inhalation or exhalation. This is called *kumbhak* (meaning “a pot” in Sanskrit). The practice of *kumbhak pranayamas* has to be done with care and with specified physiological locks or *bandhas* (Nagendra, 1998). The period of breath holding could follow either inhalation or exhalation or both. Also, in certain types of pranayamas, the duration of breath holding is shorter than either inhalation or exhalation, whereas in other pranayamas, the duration of breath holding exceeds that of inhalation or exhalation. A study compared the oxygen consumed during long breath-holding pranayamas with that of short breath-holding pranayamas (Telles & Desiraju, 1991). There were five participants in each category, and each person was tested in 10 repeat sessions. Interestingly, varying the duration of breath holding compared with inhalation-exhalation made a significant difference to the oxygen consumption. Long breath holding was associated with a 19% decrease in oxygen consumption during the practice, whereas short breath holding was associated with a 56% increase in the oxygen consumed. The mechanisms underlying these differences remain to be understood.

## Yoga Techniques That Involve Exhaling With the Production of a Sound

Although yoga techniques are usually practiced in silence and with the attention directed inward, there are certain pranayama techniques in which the practitioner breathes out and produces a sound. Two examples of this are *bhramari pranayama* (where *bhramari* means “bumblebee” in Sanskrit) and chanting of a syllable with sacred connotations in Indian culture, *OM*. Practicing *bhramari pranayama* every day for 10 minutes along with 20 minutes of left- and alternate-nostril yoga breathing over an 8-week period reduced symptoms of anxiety in patients diagnosed with anxiety neurosis (Crisan, 1984). The patients also exhibited

a decrease in pulse rate and metabolites of epinephrine and norepinephrine in urine collected for 24 hours and an increase in skin resistance levels. Very recently, paroxysmal gamma waves were observed in eight participants practicing bhramari pranayama (Vialatte, Bakardjian, Prasad, & Cichocki, 2008). This was described as most probably nonepileptic in origin and was considered a possible neural correlate of the mental state associated with yoga and meditation.

When the immediate effects of chanting *OM* were compared with the effects of chanting *one*, chanting both *OM* and *one* decreased the heart and breath rates, whereas chanting *OM* alone was associated with a decrease in skin resistance levels, which was interpreted as a sign of mental engagement with the content of chanting, in this case, the syllable *OM* (Telles, Nagarathna, & Nagendra, 1998).

### Yoga Breathing Techniques That Involve Breathing Through the Mouth

There are certain pranayamas that involve inhaling through the mouth and exhaling through the nose. To breathe in through the mouth, certain maneuvers are done. For example, practitioners may clench their teeth, drawing their lips apart and breathing in through clenched teeth (*sadanta pranayama*); fold their tongue backward so that the tip of the tongue touches the hard palate (*sitkari pranayama*); or fold their tongue like a beak with the sides folding upward and breathe through the tunnel formed by the tongue (*sitali pranayama*). This is contrary to the conventional description of “correct” breathing. Perhaps because air is inhaled through the mouth and does not have the warming effect of passage through the nostrils, these have been called cooling pranayamas. In descriptions of these practices based on the experiences of yoga practitioners, practicing these pranayamas is supposed to be good for oral health and may even help to reduce the body temperature of a person with a fever (Ramdev, 2005). None of these claims have been examined. However, these practices have been used in therapy. They were included as part of an add-on yoga therapy program given to patients with pulmonary tuberculosis undergoing conventional treatment (Naveen & Telles, 2004). Among other benefits, the patients who practiced yoga reported a decrease in fever compared with a control group. However, because the yoga program had several components, the effects of these supposedly cooling pranayamas could not be evaluated separately.

### Yoga Breathing Techniques That Alter the Rate of Breathing

Almost all pranayama techniques modify the rate of breathing, most often by slowing down respiration. However, there are

a few techniques in which the rate of respiration is increased. One such technique is *kapalabhati*, where *kapal* means “the forehead” and *bhati* means “shining” in Sanskrit (Telles, Raghuraj, Dhananjay, & Naveen, 2008). This is commonly interpreted to mean that this practice is mentally stimulating. In this high-frequency yoga breathing technique, participants breathe at rates between 60 and 120 breaths per minute. It is essentially a cleansing process, or a *kriya* in Sanskrit. This practice was associated with better performance in a cancellation task that assesses attention, visual scanning, and repetitive motor responses (Telles et al., 2008).

### Mechanisms Underlying the Effects of Pranayama Practice

The exact way in which voluntary breath regulation in pranayama influences the mental state is not known. There is a speculation that voluntary slow deep breathing stretches the lung tissue, which produces inhibitory signals from two sources: (a) by the action of slowly adapting receptors and (2) hyperpolarizing currents (Jerath, Edry, Barnes, & Jerath, 2006). These inhibitory signals are believed to synchronize neural elements, leading to changes in the autonomic nervous system and a resultant condition characterized by reduced metabolism and parasympathetic dominance.

As already mentioned, these are merely speculations, and further research is required to understand why pranayama practice produces the many and diverse effects that are reported. Finally, any description of pranayamas would be incomplete without this verse from *Hatha Yoga Pradipika* (chap. 2, verse 16): “By the proper practice of *pranayama*, all diseases are eradicated, through improper practice all diseases can arise” (Muktibodhananda, 2002).

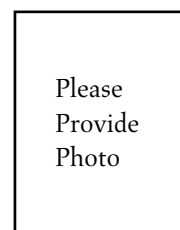
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