SLEEP DISORDERED BREATHING IN CHILDREN

THIS PICTURE DEPICTS IDEAL. THE CHILD IS SLEEPING WITH HER MOUTH CLOSED AND IS BREATHING THROUGH HER NOSE. HER FACE, NOSE AND MOUTH ARE DEVELOPING NORMALLY.

SLEEP APNEA IN CHILDREN:

- Apnea is cessation of breathing during sleep
- Snoring is frequently associated with sleep apnea
- 90% or more of all apnea patients snore
- Apnea and snoring are collectively referred to as Sleep Disordered Breathing
- Failure to treat sleep disordered breathing in children puts them at risk for very serious health problems
- The gold standard for diagnosis of sleep disordered breathing is a polysomnographic study. It is performed at a sleep laboratory.

PARENTS, THIS IS ONE THING TO LOOK FOR. The child on the right is sleeping with her mouth open. Note the already protruding upper anterior teeth and the chapped lips. She is mouth breathing. The inspired air is not being properly warmed, humidified and filtered. She is developing an open bite, improper anterior tongue thrust swallow, and a narrow upper arch. She may or may not have obstructive sleep apnea, but this is not a healthy pattern. Talk to your pediatrician or dentist.

THESE KIDS ARE ALL MOUTH BREATHING BECAUSE SOME PART OF THEIR AIRWAY IS OBSTRUCTED

CONSEQUENCES OF KID'S APNEA - In children some of the morbid consequences associated with sleep disordered breathing are:

- Increased incidence of upper respiratory infections
- Neurobehavioral problems
- Failure to thrive
- Underdevelopment of the face and jaws
- Cardiovascular problems

The consequences of sleep disordered breathing - snoring and sleep apnea in children are not the same as in adults. Consequences however are different than causes.

- Children usually do not display sleepiness. They act out their tiredness with inappropriate emotional behavior.
- Kids' attention spans are extremely short
- Kids' school performance falls off
- Cognitive development is slow
- Motor development skills are delayed
- Successful treatment is addressed at both causes and consequences
- Treatment directed at causes involves effective prevention and correction of abnormal posture and functions of the mouth, tongue and face, and their relationships with breathing, the dentition, speech and feeding

BAD LIP POSTURE
Note how the lower jaw is retruded behind the upper teeth and lip. Lower jaw retrusion reduces space for the tongue and forces it to intrude into the oral airway. There are therapists for re-educating the lip posture and swallow and orthodontic devices to stimulate mandibular growth.

CAUSE DIRECTED TREATMENT

I. Physical obstructions in the oral nasal airway

- Tonsils and Adenoids – SURGICAL TREATMENT
- Nasal polyps – SURGICAL TREATMENT
- Allergy treatment – NONSURGICAL TREATMENT

II. Collapsibility of the airway – <u>EARLY ORTHODONTIC TREATMENT</u>

- Breathing, Swallowing and Posture
- Tonic and phasic function
- Under-development of the face and jaws
- Maxillary retrognathia, hypognathia
- Mandibular retrognathia, hypognathia
- Oral breathing
- Long face

- Short face

III. Lower brain level, reflex activity - BEHAVIORAL, MYOFUNCTIONAL RE-EDUCATION
- Head and lip posture
- Habit correction
- Swallowing
- Oral breathing
- Voice control

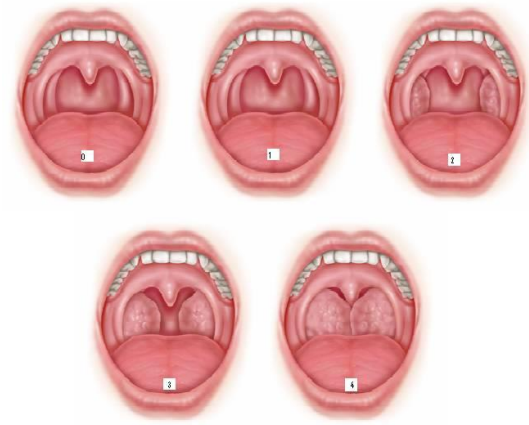
IV. Higher level neurobehavioral (prefrontal cortex) –ELIMINATE INTERMITTENT HYPOXIA
- Attention Deficit Hyperactivity Disorder
- Learning Disorder
- Executive dysfunction
- Cognitive skills

THESE ARE ORTHODONTIC DEVICES USED IN KIDS TO STIMULATE PROPER FACIAL GROWTH TO SUPPORT BETTER BREATHING

RESPIRATORY INFECTIONS - Children with sleep disordered breathing get more frequent upper respiratory infections. Adenoid and tonsillar hypertrophy can be divided into two categories, infection and hypertrophy. Frequent upper respiratory infections cause chronic hypertrophy of the tonsils and adenoidal tissue. Many microbes, viruses, fungi, and bacteria are capable of causing infections of the tonsils and adenoids. Antibiotics can kill some but not all of the pathogens. The cause of the hypertrophy in most cases is low grade infection. The hypertrophic tissue that occludes the airway during the day also contributes to obstruction of the airway at night.

Once the diagnosis of pediatric obstructive sleep apnea has been established the first line treatment is surgical removal of the tonsils and adenoids (adenotonsillectomy). About a dozen studies have consistently reported a cure rate of 80%. This is defined as a disappearance of physical signs and symptoms and normalization of respiratory measures. Post-operative persistence of the disease however remains at 20%.

The results of "watchful waiting" in children with tonsil and adenoid hypertrophy and obstructive sleep apnea may deny these children the potential for behavioral, neurocognitive, hypertensive, and somatic improvement and normal facial growth.



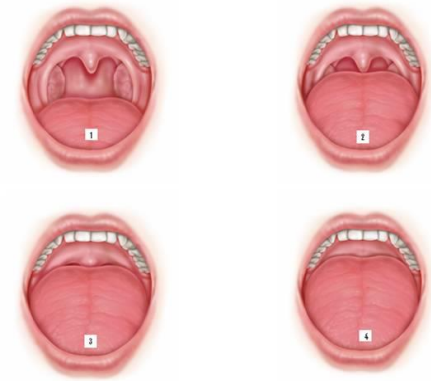
The chart on the left is a used by healthcare professionals for grading of tonsillar size. Large tonsils can contribute to airway obstruction. Parents, you may want to consult with your pediatrician if your kid's tonsils resemble those on the bottom row.

NEUROBEHAVIORAL - CONSEQUENCES OF SLEEP DISORDERED BREATHING

The consequences of sleep disordered breathing in children – snoring and sleep apnea are not the same as those found in adults.

- Children usually do not usually exhibit excessive daytime sleepiness. They act out their tiredness with inappropriate emotional behavior
- The attention span of children with sleep disordered breathing is extremely short
- Children with sleep disordered breathing have delayed development of motor skills
- Children with sleep disordered breathing have lower levels of academic achievement
- Cognitive development is slow in children with sleep disordered breathing
- Children with sleep disordered breathing have diminished ability to develop and sustain an organized, future-oriented and flexible approach to problem solving (executive dysfunction)
- There is a very high incidence of ADHD in children with obstructed sleep breathing
- Children who snore are more likely to have attention and hyperactivity problems. If untreated they are likely to become worse four years later

THESE FOUR ILLUSTRATIONS REPRESENT THE MALLAMPATI INDEX, USED BY DOCTORS TO RATE THE PATENCY OF THE ORAL AIRWAY BASED ON THE POSITION OF THE TONGUE RELATIVE TO THE SOFT PALATE.



FAILURE TO THRIVE - One of the better known consequences of obstructive sleep apnea in kids is the high risk of *failure to thrive*. Failure to thrive can exaggerate the other known morbidities of obstructive sleep apnea.

- One possible mechanism for failure to thrive as a result of obstructive sleep apnea is that dysphagia due to hypertrophic tonsils and adenoids may cause olfactory changes that contribute to decreased appetite, resulting in retardation of weight gain.
- Another hypothesis is that increased respiratory effort leads to increased metabolic expenditure.
- Or, that hormonal factors such as insulin growth factor-1 (IGF-1), binding factors for IGF-1 decrease appetite.

Indisputable is that early diagnosis and treatment of the kids' apnea is mandated to avert serious morbid and irreversible consequences.

Failure to thrive as a symptom of obstructive sleep apnea is in direct contrast to another more prevalent form of kid's apnea that is primarily associated with OBESITY.

In obese children the symptoms of apnea more closely resemble those of adults than those of kids' apnea. Kids with failure to thrive usually have large tonsils and adenoids and surgical removal affects a major reduction in apneic events. Obese children usually do not display marked adenotonsillar hypertrophy and adenotonsillectomy does not usually achieve a desirable result. A greater rate of excessive daytime sleepiness, systemic hypertension and insulin resistance is found in the obese kids with apnea.

CARDIOVASCULAR PROBLEMS - The autonomic or involuntary nervous system consists of two components, the sympathetic and the parasympathetic. The sympathetic governs what is referred to as the "fright or flight" response. It prepares us to deal with extreme stress by releasing epinephrine. The parasympathetic, via acetylcholine promotes relaxation. Sleep usually reduces cellular needs for oxygen and glucose. Sympathetic tone increases during obstructive sleep apnea in children and persists beyond sleep and suppresses vagal tone. The vagus nerve controls resting heart rate. It keeps a happy balance between stress coping and relaxation.

The autonomic regulatory changes affected by pediatric sleep apnea cause changes in the cardiovascular system. Obstructive sleep apnea in kids is consistently associated with hypertension or high blood pressure. Kids with obstructive sleep apnea are over 3 times more likely to have hypertension than kids not having it. Studies of kids with obstructive sleep apnea show them to have high blood pressure both day and nighttime, and the elevation is proportionate to the severity of the apnea. Furthermore, elevated blood pressure in children predicts cardiovascular risks later in life.

C-reactive protein was also shown to increase in children with obstructive sleep apnea. C-reactive protein is a sensitive marker for systemic inflammation. Inflammation contributes to endothelial dysfunction, resulting in vasoconstriction and eventually atherosclerosis (hardening of the arteries).

FAILURE TO TREAT PEDIATRIC SLEEP DISORDERED BREATHING APPEARS TO LEAVE CHILDREN AT RISK FOR LONG-TERM CARDIOVASCULAR CONSEQUENCES

PHYSICAL OBSTRUCTIONS - ADENO-TONSILLECTOMY - In children with obstructive sleep apnea the site of airway closure is in fact at the level of the tonsils and adenoids. Lymphoid tissue, especially the adenoids and tonsils, tend to become grossly enlarged in children exposed to second-hand smoke and other environmental irritants. Other factors that have been implicated in adeno-tonsillar hypertrophy are allergies and asthma. Despite the fact that the apnea is often said to be "cured" by adeno-tonsillectomy, the inflamed, enlarged, infected tonsils and adenoids are not the cause of the obstructive sleep apnea.

- Kids with obstructive sleep apnea at night do not obstruct during the day.
- Repeated research studies have not been able to relate the size of the tonsils and adenoids to incidence of obstructive sleep apnea
- There are children with large tonsils and adenoids who do not have obstructive sleep apnea.
- There are children with obstructive sleep apnea and large tonsils and adenoids who are not cured by adeno-tonsillectomy

Large, swollen, inflamed tonsils and adenoids therefore, are associated with obstructive sleep apnea, and possibly a predisposing factor, but not the cause. Obstructive sleep apnea is the result of a complex, dynamic process involving the interaction of specific sleep state, pressure-flow airway mechanics, respiratory drive, dilator muscle status, individual anatomic variations.

THIS PICTURE ILLUSTRATES A CROWDED AIRWAY. THE PHYSICAL OBSTRUCTIONS: LARGE TONGUE WITH SCALLOPED BORDER, LARGE TONSILS AND LARGE SWOLLEN UVULA

THUMB HABITS

THUMB PROPPING THUMB SUCKING

CAN YOU DETECT THE DIFFERENCE?

It is very important to set the record straight. There are two distinct thumb habits. This is also true of other finger habits – two distinct types of finger habits. SUCKERS and PROPPERS. There is a very important difference.

Sucking implies suction. Thumb or finger suckers are nose breathers. The lips seal around the digit to suck, so the nose must work properly for the child to breathe. Thumb or finger sucking is non nutritive and gives the child a feeling of warmth, comfort and security. Note the lip seal and apparent suction on the photo of the child sucking his thumb.

Closed lip posture and nasal breathing is normal and healthy. A child with nasal obstruction to his/her breathing must separate the lips and lower the tongue to be able to breathe air through their mouth. The natural condition for a nose breathing child is to close the lips when asleep. When a young mouth breathing child gets tired, the natural impulse is to close the lips, but they would then have difficulty breathing. The adaptive tendency of a mouth breathing child is to hold the thumb or other fingers in their mouth to keep it open when they get tired. The habit in mouth breathers is thumb or finger propping. They do not suck. The lips are not sealed. Sucking is very difficult when the nose is not working. Note the dry lips and open mouth on the above photo of a thumb propper.

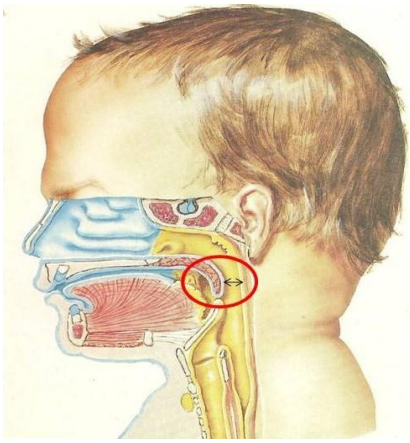
Mouth breathers are thumb proppers. This is an important and fundamental difference the finger or thumb is a prop to keep the mouth open so the mouth breather can continue breathing. The thumb sucker has a welt on the back of the thumb on the inner digit and the pad if the thumb may be creased. The thumb proper generally has no welt but the pad with the fingerprints is chapped or creased. The welt determines the sucker and the nose breather.

A search of the dental literature reveals that thumb suckers, if they stop before age 2, usually have no ill effects in the developing dentition. Children who suck past the age of 4 however, have twice the risk of malocclusion in the permanent teeth than children who stop sucking before age 2. The thumb can be a negative influence on the developing teeth if it lasts too long.

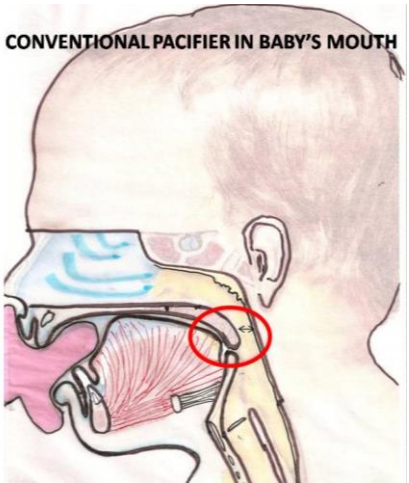
In thumb or finger proppers the digit or digits act as deleterious orthodontic device. Thumb proppers will almost always have a malocclusion noticeable by the time the baby teeth come in and it persists into the permanent dentition unless nasal patency is achieved. Examples of malocclusions resulting from thumb propping and mouth breathing are shown in the "Photo Gallery"section of this document.

Not treating thumb propping increases the child's risk of later developing apnea or may be one indicator of apnea. Propping increases the risk of malocclusion, snoring, temporomandibular disorders and headaches. The consequences of thumb sucking are not as serious and usually reverse if the habit discontinues by age 2 or possibly 3.

PACIFIERS - Breathing properly when a child is asleep is essential to their well-being, healthy brain function and behavior. When a child sleeps the healthiest natural positioning to create the most competent airway is nasal breathing, with the lips together and the tongue in the roof of the mouth.



Conventional pacifiers, clinically termed, "non-nutritive sucking devices", are in reality silicone or latex nipple substitutes. Sucking seems to give an awake baby a sense of warmth, well-being and comfort. Children who are bottle fed and those not given unrestricted breast feeding use the pacifier to satisfy these instinctive needs. Kids retain the pacifier in the mouth by creating suction. Pacifier users are nose breathers. Mouth breathing children need an open mouth to breathe. They repeatedly spit out the pacifier. Pacifiers are held in a baby's mouth in a nursing posture. The artificial nipple is positioned against the roof of the mouth and the tongue placed under the nipple in the floor of the mouth. Infants are often put to bed with a conventional pacifier in their mouth. While the nursing posture may work fine for daytime sucking and swallowing, it is a compromised



position for sleep breathing because the presence of the tongue in the floor of the mouth reduces airway patency.

When a conventional pacifier is in the child's mouth, the tongue is pushed back into a more posterior position. Normally the tongue rests on the palate. With an ever present pacifier, the developing teeth in the anterior and canine area have the pressure of the lips and cheeks sucking in and lack the counter balance of the tongue pressing up and out. This imbalance can result in reduced anterior arch width if the pacifier use continues beyond two or possibly three years of age. Children having prolonged non nutritive sucking have twice the risk of malocclusion as those who stop early. Pacifier use beyond the age of 2 can cause changes in the permanent teeth.

These children are probably too old to still use a pacifier.

BED-WETTING - Snoring is just one alerting signal that a child may have obstructive sleep apnea. Apnea is a sleep disorder that causes people to temporarily stop breathing numerous times during the night. According to a recent study, apnea also appears to be related to bed-wetting in children. The findings show that children with sleep apnea are at greater risk for nocturnal enuresis (bed-wetting) than children without sleep apnea.

Dr. Lee J. Brooks, a clinical associate professor of pediatrics at the University of Pennsylvania in Philadelphia reported in the Journal of Pediatrics that dealing with the sleep apnea might also help remedy bed-wetting. In this study of 160 kids ages 4 to 17 who were referred to sleep-disordered clinic for suspected breathing problems at night, 66 children (41 percent) were also bed-wetters. Of those who were diagnosed as having obstructive sleep apnea at more than one breathing pause per hour of sleep based on studies conducted while the children slept at the clinic showed that 47 percent had a bed-wetting problem, compared with 17 percent of those who had zero or just one breathing disturbance per hour. This demonstrates a high prevalence of bed-wetting in children with sleep apnea.

Two other studies corroborate these findings. Weider demonstrated that surgical removal of the upper airway obstruction led to a complete cure of enuresis in 76 percent of the apneic children studied. Robertson found mandibular advancement devices to be especially beneficial in curing enuresis in apneic children who were also retrognathic. The reasons for chronic bed-wetting in young children are not fully clear.

TRADITIONAL ORTHODONTICS - Orthodontics as a specialty in dentistry has a strange dichotomy. There are two distinct philosophies – cephalometrists and the

functionalists. Cephalometrists believe the facial skeleton is immutable, in that its size is genetically determined. They have arbitrarily defined certain bony landmarks in skull x-rays and established certain angles, distances and relationships that exist in beautiful people. Based on x-ray analyses their treatment is designed to move teeth in less than beautiful people into more favorable positions predetermined by the measurements. Thus, the cephalometrists rarely initiate treatment before the adult determinative landmarks can be established in cephalometric x-rays. This is about the time 95% growth has been completed – approximately age 13 in girls and 14-15 in boys. The cephalometrists believe that if the mouth and bones in which the teeth must fit is too small, then teeth must be extracted to make the teeth fit into the jawbones.

The functionalists believe that both improper tooth position and crowding are based on improper muscle function inhibiting proper growth. Changing the orientation of muscle function changes the direction of the forces they direct on the growth and development of the face and jaws. In extraction cases the tongue is forced backward and downward into a shrunken space, narrowing the airway and making it more collapsible. Rather than extract four bicuspid teeth, retracting the anteriors, collapsing the anterior face, and making the mouth smaller, functionalists stretch the dental arches to make room for all the teeth. This makes more room for the tongue.

In the unfolding development of an organism, as cells differentiate and organs form, it had been thought for a long time that the genetic code of the DNA was the sole determiner of phenotype. Now scientists are discovering that non-genetic factors such as environmental influences cause variations in the expression of genes without changing the DNA sequence. The "epigenetic theory" of development accounts for the differences in identical twins.

Many genes require environmental factors in order to be expressed. Environmental signals such as intermittent hypoxia (apnea episodes) influence development of a child's face. Early in a child's development, when the cells are less differentiated and the growth potential is at its optimal, is when the environmental influences are the maximal. The best time for environmental forces to exert the most positive effect on the genes for breathing, swallowing and facial growth is when the child is young.

FIND A FUNCTIONAL ORTHODONTIST WHO UNDERSTANDS THE IMPORTANCE OF EARLY TREATMENT

EARLY ORTHODONTICS - It was explained in the section TRADITIONAL ORTHODONTICS that many orthodontists assume that they only address facial esthetics. They wait until growth is complete or nearly complete to initiate treatment. In contrast, early orthodontics utilizes growth in its favor. By age four 60% of facial growth is done. By age six 80% of facial growth is complete. By age 11 or when the second molars have erupted, 90% of facial growth is completed. Orthodontic treatment between the ages of 6 and 11 often results in a catch-up of growth to normal by the age of 12. Treatment over the age of 12 virtually assures that there will be relapse.

Apneic kids cannot wait 8 years or more to breathe properly. Early orthodontics addresses breathing, swallowing and posture problems as well as making more beautiful faces and smiles. Kids

are happier, smarter and better behaved when they sleep well. Early orthodontics takes advantage of growth to make the job easier and reaps the physiological and psychological gains at as early an age as possible.

Facilitation of a patent nasal airway by adeno-tonsillectomy does not erase the old dysfunctional reflex patterns of swallowing and breathing. Expanding the dental arches to achieve the ideal functional climate for breathing, swallowing and sleep is the clinical goal. Expansion of the palate creates more space in the mouth for the tongue and facilitates positioning of the tongue anteriorly and laterally in the roof of the mouth. Orthodontic expansion of the maxilla facilitates nasal breathing because the roof of the mouth is also the floor of the nose. Palatal expansion widens the nasal passage and decreases resistance to oral-nasal airflow. Reducing nasal resistance reduces turbulence of airflow and decreases collapsibility of the flexible oropharynx. Kids whose airways no longer collapse at night also enjoy improved breathing during the day.

There is virtually universal agreement that the teeth and alveoli lie in a position of balance between the cheeks, lips, and tongue. Harvold has shown that interventions that disrupt the ideal situation of nasal breathing, lips sealed, tongue in the roof of the mouth, head balanced on the spinal column cause malocclusions as well as adaptive functional and structural changes.

The science of functional orthodontics is about understanding ideal physiological function and its attendant structure, analyzing the dysfunction that caused the malocclusion and addressing treatment at correcting both structure and function as close to ideal as possible. Early orthodontics is about doing it sooner rather than later to improve the quality of life and hopefully prevent neurobehavioral and learning disorders.

CURRENT TREATMENT METHODS - Obstructive sleep apnea (OSA) in children is a serious problem. ADHD, enuresis, failure to thrive, learning, cognitive and behavioral disorders, disrupted sleep and cardiovascular problems are some of the comorbid symptoms of OSA. Children with OSA generate 2.6 times the amount of healthcare expenses as non-OSA children.

Adenotonsillectomy is the first line of treatment. Surgery has an 80% reported success rate one year later. Adenotonsillectomy is both an invasive and very painful procedure. There is a significant rate of OSA relapse in subsequent years if the attendant problems such as open mouth, low tongue posture, dysphagia and malocclusions are not corrected.

Continuous positive airway pressure (CPAP) is commonly used as the second tier treatment modality for pediatric OSA. The long term use of CPAP, with its face mask is usually effective, but cumbersome, uncomfortable and has low compliance. At some point it must be recognized that many of these kids have a facial development problem. Midface hypoplasia, small mouths and crowded teeth, is a particularly undesirable consequence because it becomes a perpetuating factor for OSA in later years. CPAP is not currently approved by the FDA for use on children less than seven years of age. Pediatricians are in need of better treatment methods.

A multidisciplinary clinical protocol involving surgery, allergy treatment, orthodontic expansion, and oral myofunctional therapy as treatment of sleep apnea in children having deciduous dentition is

being suggested. This protocol is based on sound biologic and physiologic principles, logical multidisciplinary theories, reasonable scientific rationale, a significant number of medical publications reporting clinical success and in clinical practice "it works" and there is excellent evidence that the singular use of any modality has serious shortcomings.

NASAL BREATHING - Breathing is the transport of gases to and from the lungs and tissues. Breathing gets oxygen (O2) to the cells of the body, removes excess carbon dioxide (CO2) and regulates the chemical balance in the body between O2 and CO2. CO2 is the major chemical factor regulating ventilation. It is produced in the body by cell metabolism, exercise and digestion. CO2 can be stored in the blood, is a necessary factor to maintain pH by its buffering action as bicarbonate or carbonic acid. It can facilitate release of oxygen from hemoglobin, prevents smooth muscle from going into spasm and triggers breathing. As CO2builds up in the body it changes the pH of the blood, which in turn triggers the brain at the medullary center to take a breath. A pattern of breathing develops that maintains the appropriate blood O2 and CO2 levels with the minimum expenditure of energy. Breathing is carried on automatically. The exception is when we do not wish to use the breathing apparatus for some specific task such as trumpet playing, swallowing, vomiting or singing. Only then is breathing under conscious control.

The respiratory central pathway maintains the patent airway and dominates reflex control of the oral and pharyngeal region. It supersedes all other reflexes.

Human beings are obligate nasal breathers. The mouth is merely a back-up breathing organ. The nose is the ideal organ for warming, filtration and humidification of inhaled air. Breathing is a primal function necessary for survival. It is a reflex function that predominates over all regulatory activity of the brain. Evolutionary design of humans is based on facilitation of nasal breathing. Adaptation of humans to an erect posture requires the back and neck to balance the head in the upright posture. Ideal posture requires a balance of structure and function.

MOUTH BREATHING - When nasal breathing becomes obstructed the lips must separate to allow air to enter the mouth. The tongue lowers itself to the floor of the mouth to allow air to enter the pharynx. The hyoid bone which is attached to the tongue is also pulled lower and the mandible becomes retrognathic. The head position on the spinal column also assumes a more forward posture to facilitate oral breathing.

The respiratory central pathway of the brain can induce oral respiration when nasal breathing is obstructed. Once learned, the low tongue position of oral breathers becomes the predominant reflex, the child's swallowing and breathing mode both become dysfunctional, and permanent structural and postural changes occur. It is the lower tongue position, the narrowing of the airway and subsequent increased collapsibility during sleep that predispose to pediatric OSA and snoring. In fact OSA has become recognized as the most extreme variety of mouth breathing and snoring.

Environmental challenges that cause obstruction of nasal breathing result in a dysequilibrium between structure and function. If the accommodative changes become habitual, the posture and structure will permanently change. Anything that contributes to oral breathing, such as enlarged

tonsils and adenoids and swollen nasal membranes, alters rest position of the tongue. Habitual oral breathing results in skeletal changes, postural changes and alterations of normal function.

SWALLOWING - The swallow is the most complex reflex activity the human nervous system performs, and it is done without conscious effort. Reflexes provide the underlying framework of neural control upon which more complex motor responses can build. Reflexes from the oropharyngeal area protect the anterior portal of the gastrointestinal tract, transport food and liquids, provide an airway for gaseous exchange by the lungs and protect the lungs from aspiration of foods and liquids.

The ideal equilibrium for head balance is with nasal breathing, sealed lips, dental arches slightly apart at rest and the tongue positioned in the roof of the mouth. In deglutition, to provide maximum bracing for the head on the spinal column, the teeth touch in a position of maximum occlusion, the lips are sealed and the tongue propulses the bolus distally against the palate.

There is universal agreement that the teeth and dental alveoli lie in a position of equilibration between the cheeks, lips and tongue. Ideally the tongue is in contact with the roof of the mouth at rest, during subconscious swallow and during nasal breathing. The tongue exerts an outward and forward force, counterbalanced by the inward pressure of the cheeks and lips. When the tongue is positioned in the roof of the mouth it functions ideally and produces healthy palatal and dental development.

LOOK WHAT A TONGUE CAN DO TO A BITE. THESE KIDS HAVE OBSTRUCTED NASAL BREATHING

POSTURE - The most important function of the back and neck is to support our heads in the upright posture typical and unique to human beings. The adult head weighs 12 to 16 pounds and must be balanced on the spinal column. The head must be stabilized so it does not wobble each and every time we swallow.

In good posture the ears are in a vertical line over the shoulders, hips, knees and ankles. In kids, the head is heavier relative to the body than it is in an adult so the head balancing act is more problematic.

Human beings are obligate nasal breathers. Breathing is a primal function. We must be able to breathe to survive. The mouth is merely a back-up breathing organ. When the nasal airway is patent, normal resting or sleeping posture is with the lips together, teeth slightly apart, and the tongue in the roof of the mouth.

When nasal breathing becomes obstructed, the lips part, the jaws separate more to open the oral airway, and the tongue position shifts to the floor of the mouth to create a patent posterior oral

airway. These changes cause adaptations of the head on the spinal column to a forward posture. The back and neck adapt to keep the head over the feet.

Unilateral nasal obstruction in a nose with septal deviation causes unilateral changes such as higher ear, higher shoulder, and higher hip. Proper nasal breathing is essential for good body posture. Early orthodontics in conjunction with appropriate pediatric care results in restoration of nasal breathing and a catch up growth spurt that results in normal posture by the time all the permanent teeth are in the mouth.

UNDERDEVELOPED FACE AND JAWS - The first published theoretical framework for evolutionary theory came from Jean-Baptiste Lamarck in 1800. Lamarckian theory was based on the "inheritance of acquired traits". The physiological needs of organisms, created by their interactions with the environment, drove Lamarck's theory of evolution. He noted that a change in the environment caused changes in the needs of organisms living in that environment which in turn caused changes in their behavior such as greater or lesser use of a structure or organ. Lamarck's Second Law stated that such changes were inheritable. Scientists of his era ridiculed this theory and denigrated his character. Lamarck died in 1829 in poverty and disrepute because of his controversial beliefs.

Charles Darwin, in 1859, acknowledged the theory of Lamarck. Erasmus Darwin, Charles' grandfather, was actually an avid supporter of Lamarckian Theory. When Charles was studying the finches on the Galapagos, he noted changes in their beaks in times of drought that were passed on to their offspring, and population changes were noted in a few years rather than thousands of years. Lamarackian Theory was little more than a footnote in science history until very recently.

In a 2005 experiment at Duke University, female and male fat yellow agouti mice were mated and the females divided into two groups. One group got vitamin supplements equivalent to a prenatal human formula. The control group got the same mice food but no vitamin supplements. The supplemental group produced skinny brown mice. The control groups produced fat yellow mice. Both groups had identical DNA but the agouti fat yellow gene was not expressed in the vitamin supplemented group. This process is called methylation. When a methyl group binds to a gene it changes its expression without actually changing the DNA.

This scientific discipline studying changes like methylation is called epigenetics. Epigenetics established that the same gene does not always produce identical results. A given set of genes is not an immutable blueprint. The exact same set of genes can produce different outcomes in different organisms depending on which genes have undergone methylation. Environmental factors play a big role in gene expression.

What is of even greater interest is that the skinny brown mice when mated with each other continue to reproduce skinny brown mice. Environmental factors in the life of the mother can affect the inheritance of traits in her offspring. Score one for Lamarck. Epigenetic changes have been demonstrated to occur post-natal as well as intra uterine. Epigenetic changes have been shown to involve fathers as well as mothers and occur throughout life. Epigenetics provides a plausible explanation by which adaptive changes can occur that cause mouth breathing. Doctors

must now examine function, breathing and swallowing and treat early to prevent serious problems later in life. Environmental challenges can change gene expression so a simple look at the parents is not adequate.

There are two parts of the face that can be underdeveloped; the upper or maxilla and the lower or mandible. Either one or both can be underdeveloped depending on the interplay of genetics and environmental factors such as mouth breathing, lip posture, swallowing, and tongue posture. Breast feeding vs. bottle-feeding, presence of environmental pollutants, allergens, diet and nature vs. nurture have recently assumed a greater degree of importance in understanding kids mode of breathing and facial development.

FACIAL ABNORMALITIES - Two distinct varieties of facial form have been identified that occur with high prevalence in young children having obstructive sleep apnea (OSA): long face and short face.

The short face phenotype is characterized by retrognathia, deep overbite, and frequently large overjet. Characteristic of the adult short face is a mandibular step plane of occlusion. The anterior six teeth are at a higher plane than the posterior eight.During a swallow the teeth are kept from touching in occlusion by the sides of the tongue. The lateral border of the tongue has a scalloped border indicative of dysphagia (lateral tongue thrust).In swallowing the lateral borders of the tongue extrude over the lower posterior teeth and against the lingual-incisal edges of the maxillary posterior teeth. This lateral resting posture of the tongue between the posterior teeth prevents the mandibular posteriors from erupting to their full potential. Centric occlusion is an adaptive retrognathic position. These patients generally have excessively large freeway spaces from rest position to centric occlusion. In centric occlusion however, there is reduced vertical dimension, lingually tipped posterior teeth, and reduced space for the tongue, which as a consequence encroaches downward and posteriorly, narrowing the oropharynx.

The long face is characterized by an open mouth resting posture, narrow maxilla, high palatal vault, anterior open bite, usually a unilateral or bilateral crossbite and an anterior tongue thrust dysphagia. These children are predominantly oral breathers and have some form of nasal obstruction to inhibit or prevent nasal breathing. A significant number of these patients are prognathic. The swallow is dysfunctional in that the tongue initially protrudes forward during deglutition to create the necessary seal to initiate propulsion of the bolus. In the resting posture the mouth is open and the tongue is in the floor of the mouth to facilitate a patent oral airway.

In mastication the long face child is only capable of occlusion on posterior teeth. Typically the first and/or second molars are the only teeth that touch in mastication. The anterior open bite causes noticeable muscular strain for these children to seal the lips. The open mouth resting posture and the narrow maxilla result in a narrow nose. This is readily noticeable in the frontal section view of panoramic radiographs.

RE-EDUCATING REFLEXES - Reflexes are automatic responses by the nervous system that a person does not have to think about. Breathing, swallowing and posture are reflex activities. Humans do not think about breathing except in special circumstances such as playing a

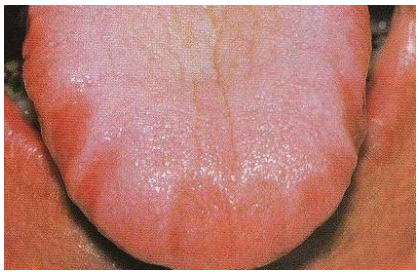
musical wind instrument. We don't usually think about swallowing either. When the tongue has adjusted to chronic mouth breathing, and there is a dysfunctional swallow the maladaptive reflex can be retrained.

There are two distinct types of oral function: tonic and phasic. Lip and tongue resting posture would be considered tonic functions. Swallow, speech, and breathing would be considered phasic functions. Psychophysiologic re-education of tonic function consists of getting the tongue to stay in the roof of the mouth and keeping the lips sealed at resting posture. This is essential for maintenance of structural and postural integrity. In some patients, doctors need to address both tonic and phasic function to get the best possible results. The combined problem of malocclusion and oral breathing is so complex that there is no one universal way to assure successful treatment. Treatment should be aimed as close to ideal function as possible.

There are two types of psychophysiological reeducation of oral function: conscious level (cortical) and subcortical neuromuscular (reflex level). Myofunctional therapy and speech therapy work at a conscious level, retraining by exercise such functional activities as lip posture, tongue posture, sealed lip posture, tongue activity during speech. Myofunctional therapy treats function to express skeletal and postural changes. Garliner and Hanson have written text books on myo-therapy. Studies by Falk and Wesson demonstrate that subcortical, neuromuscular facilitation also works. They suggest exercises involving brushing, icing and pressure that get excellent results. Caine suggests voice development to retrain oral posture.

Muscle movement retraining is not muscle strengthening. Retraining is far more important. Developing new muscle patterns to correct tongue and lip resting postures defines psychophysiologic re-education. Closed lip resting posture is very important. Integrating correct patterns of movement, posture and behavior are what prevent relapses of surgical and orthodontic cases. Unless the old dysfunctional reflex patterns are re-educated they will persist. Reflex patterns gain strength with time. Re-education should begin as early as possible.

PHOTO GALLERY



Above Left: Step-Plane of Occlusion
Mouth breathers need to establish an open oral airway. One way they can do this is by habitually keeping the lips and jaws apart, flattening the tongue laterally and positioning its lateral borders over the surfaces of the lower posterior teeth. In the dysfunctional swallow that develops, the lateral borders of the tongue are positioned between the posterior dental arches. This is identifiable by a scalloped lateral border of the tongue in rest position and a step-plane of occlusion on the lower arch with the front six teeth higher than the back teeth.

Above Right: Complete Over Bite
When the back teeth cannot erupt completely due to the tongue lying over the teeth during the dysfunctional swallow, an over bite is the result. The lower jaw needs to shift back in order for the back teeth to touch.

Above Middle:
Notice the scalloped borders of the tongue, indicative of the dysfunctional swallow that causes the step-plane of occlusion and overbite.

Above Left: Posterior Cross Bite
Mouth breathers need an open oral airway to breathe. first, they habitually parth the lips. The tongue adaptively positions itself in the floor of the mouth. With the tongue in this position, the mouth is open to facilitate passage of air. The cheeks exert inward pressure but with no tongue to oppose movement, the teeth are pushed inward narrowing the palate and floor of the nose as well, possibly causing crossbites. The patient swallows with the tongue in the floor of the mouth. The crossbite occlusion that results can be either unilateral or bilateral. The lower posterior teeth are lateral to the uppers when biting, a situation called crossbite.

Above Right: Anterior Crossbite
In this photo, the patient has both anterior and posterior crossbites.

Mouth breathers can adapt with a tongue posture in the floor of the mouth to facilitate oral breathing. In those kids with a strong upper lip, the maxillary anterior teeth shift inward. An anterior crossbite can develop. The lower jaw may not be overdeveloped but rather the upper arch could be underdeveloped in these patients.

Above Middle:
Anterior crossbite in a 6 year old child.

DIFFERENTIATING A NOSE BREATHER FROM A MOUTH BREATHER - "THE SNIFF TEST"
ASK THE PATIENT TO SEAL THE LIPS AND TAKE A BREATH THROUGH THEIR NOSE AS DEEP AND FAST AS THEY CAN.
MOUTH BREATHERS ARE NASALLY OBSTRUCTED, THE NARES CONSTRICT
IN NOSE BREATHERS WITH A PATENT NASAL AIRWAY, THE NARES FLARE

ON THE LEFT: LONG FACE
A **MOUTH BREATHER**, NOTE THE STRAINED LIP POSTURE TO CLOSE THE MOUTH,THE NARROW NOSTRILS FROM NASAL OBSTRUCTION, THE ALLERGIC SHINERS UNDER THE EYES
ON THE RIGHT: SHORT FACE
A **MOUTH BREATHER**, NOTE THE DEEP GROOVE UNDER THE LOWER LIP, THE STRAINED LIP POSTURE AND THE DOUBLE CHIN. THE PATIENT IS RETROGNATHIC. THE TONGUE,

SQUEEZED IN A SMALL MANDIBLE, RESTRICTS THE AIRWAY WHEN THE MOUTH IS CLOSED.

ANTERIOR OPEN BITE

Kids with an anterior open bite are mouth breathers. They swallow with the tongue pushing forward into an open space created between the upper and lower front teeth. There are several possible causes for this condition.

1. Many of these kids keep a thumb or finger(s) in their mouth much of the time. They use it as a prop to keep their oral airway open, especially when they get tired or because their nasal congestion is so bad they can breathe only through their mouth. the thumb or finger puts pressure on the upper teeth and shifts them outward.

2. Some theorize that large tonsils obstruct proper swallowing and the bolus of food cannot be normally propulsed into the esophagus without choking. The tongue adapts its shape, pushing forward during a swallow, so the food can get by the tonsils without choking the child.

Breathing is a primal reflex for survival. When nasal breathing is obstructed or compromised adaptive changes in function occur. The adaptive changes in function are accompanied by changes in structure. Probably both suggested causes of anterior open bite are operative to some greater or lesser extent, depending on the individual characteristics of the child.

Thumb Habit Quiz

Can you differentiate thumb suckers from thumb proppers?

A

B

C

D

Answers: Thumb suckers are A and D. Thumb Proppers are B and C.

WHAT CAN YOU DO

- LOOK, LISTEN AND READ
- Find doctors with whom you can comfortably discuss your questions and issues.

The take home message - Kids' apnea is a complex problem involving:

- Nasal airway that works
- Oral airway free of obstructions
- Proper position and function of tongue and lips
- Timely growth and facial development
- Coordination of breathing, swallowing, lip function, tongue function, and posture

Diagnosis can only be established based on a polysomnographic study.

Appropriate care involves prevention as well as treatment of symptoms, consequences and causes.

Successful treatment usually requires active parental involvement in a multidisciplinary approach.

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Ann C Halbower MD, Stacey L Ishman MD, and Brian M McGinley MD
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