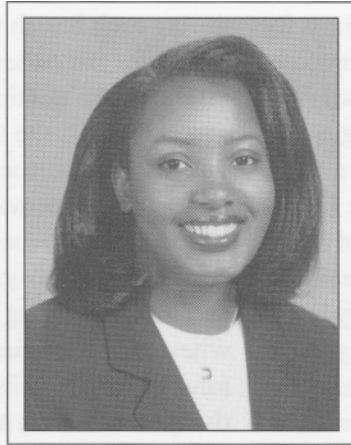
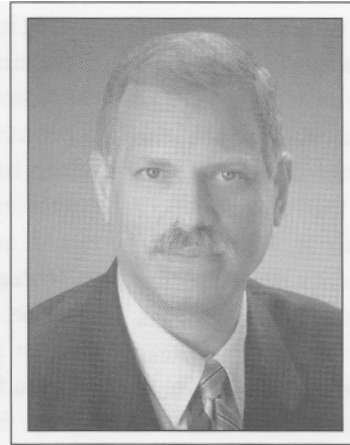


Laryngeal Granulomas

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Laryngeal granulomas are benign (noncancerous) masses that usually occur on the vocal processes of the arytenoids.^{1,2} The arytenoids are cartilages of the larynx (the voice box) to which many of the muscles that move the vocal folds attach. The part of the arytenoid to which the vocal fold attaches is called the vocal process. Granulomas also can occur in other regions of the larynx, including the portion of the larynx above the vocal folds (referred to as the supraglottic larynx), the portion of the larynx below the vocal folds (referred to as the subglottic larynx), and on the portions of the vocal folds that vibrate during phonation (referred to as the musculomembranous vocal fold).

CAUSE OF LARYNGEAL GRANULOMAS

Granulomas are masses that develop as a result of chronic irritation and inflammation of the area that forms them. The source of the irritation can be from chronic reflux of gastric juices from the stomach onto the larynx (laryngopharyngeal reflux), from the placement of a breathing tube through the larynx (intubation), from direct trauma to the larynx, or from repeated forceful contractions of the muscles of the larynx during talking, singing, yelling, or coughing (vocal misuse or abuse).³

Laryngopharyngeal Reflux

Laryngopharyngeal reflux is not often recognized by persons who suf-

fer from it or by many doctors who are not otolaryngologists, because when most physicians refer to reflux, which is the regurgitation of acid and enzymes from the stomach into the esophagus (the swallowing tube), the pharynx (the throat), or the larynx, they associate it with the feeling of heartburn. Heartburn may occur with reflux of a significant amount of acid into the esophagus. However, the esophagus is much more resilient to the presence of small amounts of gastric juice, which consists of both stomach acid and stomach enzymes, than is the larynx, and heartburn may not occur with small episodes of reflux. Furthermore, when the esophagus is exposed to even large amounts of acid for months or years,

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it may become less sensitive, and the sensation of heartburn may disappear.⁴ Unlike the larynx, the esophagus also has a mechanism for protecting itself from the stomach acids.

The mucosa (the lining tissue) of the larynx is much more sensitive to small amounts of acid and reacts more than the esophagus to less exposure. Often, the only symptoms of laryngopharyngeal reflux are the presence of a throat tickle, chronic throat clearing, the sensation of phlegm in the throat, bad breath, chronic cough, and/or the sensation that something is stuck in the throat. There may be only one of these symptoms, or there may be several of them present at one time. Each of these symptoms is related to the irritation that the acid causes as it contacts the delicate laryngeal mucosa. Unlike the reflux that causes esophageal problems, reflux laryngitis may not occur persistently throughout the day.

There are characteristic changes in the larynx that commonly are caused by reflux. Chronic irritation of the larynx by stomach acid causes chronic inflammation of the posterior larynx, which is the part of the larynx closest to the opening of the esophagus. This inflammation may take the form of a granuloma, which is a chronic inflammatory lesion much like the scab that forms on a wound that is irritated chronically. Alternatively, the inflammation may present as erythema (redness), edema (swelling), pachydermia laryngeus (thickening of the mucosa), or ulceration of the posterior—and occasionally the entire—larynx.^{3,5} Each of these is an inflammatory lesion. Inflammation is the body's way of healing itself. Erythema results

from the dilation and increased number of local blood vessels that form to help the body bring nutrients to the injured area. Edema occurs as fluids are released from the blood vessels in the healing process. Pachydermia laryngeus is the larynx's way of protecting itself from repeated injury. By producing multiple layers of mucosa, the tissue underneath the new layers is protected from the injuring agent, which in the case of reflux is acid. A granuloma is the result of the formation of an excessive amount of tissue to protect the area from trauma. Ulceration occurs when the body is unable to produce multiple layers of mucosa fast enough to overcome the injury. Each time the tissue is injured, it dies and sloughs away, leaving a crater or ulcer. Typically, isolated erythema and/or edema are signs of early and mild forms of laryngopharyngeal reflux. The presence of pachydermia laryngeus, granuloma, and/or ulceration indicates more chronic and severe forms of laryngopharyngeal reflux. Laryngopharyngeal reflux alone can cause the formation of granulomas, but more commonly, reflux contributes to the formation of granulomas in concert with other traumatic insults to the larynx, such as intubation, laryngeal trauma, vocal abuse (yelling, screaming, or severe coughing), or vocal misuse.^{1,3}

Endotracheal Intubation

Granulomas can form from irritation caused by contact with an endotracheal tube. These tubes are placed in the glottis, which is the opening between the vocal folds, and into the trachea (the windpipe) when patients need artificial ventilation, a process termed endotracheal

intubation. Patients usually require intubation for artificial ventilation when they are unable to breathe adequately on their own or when they undergo general anesthesia for surgery. The movement of the endotracheal tube during swallowing or during each breath that the machine makes for the patient can cause irritation of the portion of the airway against which the tube is touching, which can be either the part of the airway that is providing the greatest support for the tube or the narrowest portion of the airway. Because most patients are lying on their backs when they are being ventilated, the force of gravity pulls the tube against the posterior larynx and the vocal process, causing irritation there. In children, the site of the greatest irritation is the subglottic larynx because it is the narrowest part of their airways. In other patients, the narrowest part of the airway may be the musculomembranous portion of the vocal fold or the supraglottic larynx. The chronic irritation from movement of the tube results in inflammation. This inflammation can take the form of mild erythema, edema, ulceration, or granuloma formation. The inflammation that results can happen soon after the endotracheal tube is placed or can happen several weeks later. There is no way to predict which patients will have a significant inflammatory reaction and which patients will have a completely uneventful period of intubation, but the presence of reflux laryngitis appears to be the most important risk factor.

Laryngeal Trauma

Granulomas can form as a result of direct trauma to the larynx.^{1,3} La-

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ryngeal trauma can result in granuloma formation because the trauma often incites an inflammatory reaction. Many situations can result in laryngeal trauma. If an endotracheal tube is placed in an emergency situation, the force used to place the tube may cause injury to the lining tissues of the larynx. Similarly, accidental removal of the endotracheal tube can injure the lining tissues of the larynx as the tube is pulled out. Blows to the neck can cause blunt laryngeal trauma, and penetrating injuries, such as gunshot or stab wounds, can cause direct tissue trauma in the larynx. Additionally, any surgery or endoscopic procedure that involves manipulation of or around laryngeal tissue may cause trauma. Each of these forms of trauma can result in injury to the lining tissues of the larynx, thus stimulating an inflammatory re-action that can result in the formation of granulomas.

Vocal Abuse and Misuse

Granulomas can form in patients who abuse or misuse their voices chronically.³ Yelling, screaming, and forceful coughing are forms of vocal abuse. Vocal misuse can occur with incorrect or excessive singing, talking, or acting. When a person yells, screams, or coughs severely, the vocal folds are brought together forcefully with a significant amount of contraction of the muscles in the larynx and neck. The vocal folds slam against each other with a greater force than occurs with normal phonation, and trauma occurs in the portions of the vocal fold that receive the most force, the "striking zone" (the middle one-third of the musculomembranous vocal fold) and the vocal process. As a result, submu-

cosal hemorrhage, which is bleeding within the tissues, may occur in the region of the striking zone. The irritation of the cartilages of the two vocal processes hitting each other may result in an abrasion.

After such an episode, hoarseness or pain in the throat may accompany talking and/or swallowing. The affected person may inadvertently adopt new ways of talking that initially may alleviate some of the pain or hoarseness. Often, this change involves increasing the tension in some of the muscles of the larynx or in some of the accessory muscles of phonation to produce a more audible sound, a condition referred to as muscle tension dysphonia. This new way of talking may become an everyday habit of speaking. The persistent tension in the muscles with phonating creates a chronic state of increased forceful closing of the vocal folds, resulting in chronic trauma and irritation of the vocal processes and the striking zone. This irritation causes chronic inflammation, which may evolve to form a granuloma on the vocal process, or nodules (thickened scar-like masses), cysts (fluid filled sacs), or polyps (soft, inflammatory masses) in the striking zones of the vocal folds.^{6,7}

In vocal misuse, the affected person has a pattern of speaking or singing that results in increased tension in the muscles of the larynx with voice production. Some people have spoken with increased muscle tension in their larynges for most of their lives. Others may develop an abnormal vocal pattern that results in increased laryngeal muscle tension after suffering a change in the larynx, most commonly an upper

respiratory tract infection such as a cold, laryngitis, or mild weakness of one or both vocal folds (paresis). The affected person tries to compensate for a hoarse or painful voice during the illness and incorporates new behaviors into his or her routine speech.^{6,7} In singers and actors without formal voice training, abnormal laryngeal muscle tension may develop from singing and/or acting.^{6,7} More commonly, those with formal voice training may not remember to use their training during "normal" speaking, and they can develop problems related to vocal misuse during noial conversation.^{6,7} In instances of vocal misuse that result in granulomas, the mechanism is the same as in patients with vocal abuse; but the chronic irritation from forceful closure of the vocal folds happens over a longer period of time.

SYMPTOMS

Granulomas can cause a variety of symptoms, and sometimes may cause no symptoms at all. If the granuloma is in a location on the vocal process or the vocal fold that interferes with complete closure or the normal mobility of the mucosal cover of the vocal folds, then hoarseness will be present. This hoarseness is perceived as a harsh sounding voice if the mobility of the mucosal membrane is affected. A breathy quality to the voice is perceived if the vocal folds do not close completely. When the granuloma is in a position that prevents the vocal folds from closing completely with normal effort, a greater degree of force is needed to bring the vocal folds together, and a greater force is needed to push air

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from the lungs through the vocal folds to create sound. Over the course of a conversation or the course of the day, these attempts at compensation can become tiring, both physically and vocally. The person who is affected in this way usually complains that the voice fatigues easily or that a lot of energy is needed to create a loud voice.

The inflammation that causes the formation of granulomas may cause irritation of the nerve endings underneath. This irritation of the nerve endings may result in the sensation of pain, either constantly or with eating, talking, or singing, depending on the proximity of the nerves to the inflamed area. The pain may be perceived as throat or ear discomfort. Ear pain occurs because of a phenomenon called "referred pain." The same nerves that sense problems in the throat also sense problems in the ear. For unknown reasons, when the nerves relay information from the throat to the brain, the brain may interpret the signal as pain coming from the ear. The individual then perceives that he or she is having pain in the ear. The irritation of the nerve endings may also result in the sensation of a lump in the throat, the sensation that something is stuck in the throat, the sensation of a chronic tickle with or without chronic cough, or the persistent sensation that the throat needs to be cleared.^{5, 8} The exact sensations that any individual experiences depend on which nerve endings are affected and how much irritation they are experiencing. Because of individual differences in the way our bodies are made, the same degree of inflammation may cause different symptoms in different people.

Because granulomas are the result of an intense inflammatory reac-

tion, they can continue to get bigger, if they remain untreated and exposed to repeated trauma. Rarely, they can grow to a size that is large enough to reduce significantly the amount of air that is able to go through the larynx and into the trachea and lungs.⁸ This airway obstruction may cause symptoms of shortness of breath at rest or with exertion. If the inflammation causes a break in one of the small blood vessels underneath it, blood may be coughed up. This occurs rarely with granulomas and more often is a sign of a more serious illness. A granuloma that sits in a location in the larynx that does not affect the vocal folds, does not obstruct the airway, and does not irritate the nerve endings may not cause any symptoms at all.

When symptoms do occur, the onset may be sudden or gradual, depending upon the reason the granuloma is formed and how fast it enlarges. Sudden development of symptoms is associated with traumatic events such as yelling, screaming, severe coughing, or intubation during surgery or a hospitalization. Gradual development of symptoms is seen after an upper respiratory tract infection, with vocal misuse, and when laryngopharyngeal reflux is the sole cause. The symptoms that one experiences from granulomas are fairly persistent. Occasionally, the symptoms may fluctuate depending upon changes in edema of the vocal folds. However, they rarely resolve completely without treatment.^{1, 3, 5, 8}

PHYSICAL EXAMINATION

The diagnosis of granulomas is made by a laryngologist or an otolaryngologist. Typically, these physi-

cians see the patient to evaluate the cause of the symptoms described above. The physician may ask the patient many questions about the symptoms to help exclude other possible causes and to help narrow the potential list of problems.

After the physician has completed taking a history of the patient's problems, he or she will examine the patient. The physical examination will include a complete evaluation of all of the structures of the head and neck. This complete examination is performed because there are some illnesses that affect many different regions of the head and neck, and they all should be assessed. In patients with granulomas, the examination of each of these regions should be normal unless another illness is also present, with the exception of examination of the larynx and possibly the hypopharynx (the portion of the throat behind the larynx and above the esophagus).

Examination of the larynx and the hypopharynx may be performed initially with a light and mirror. The mirror is often warmed first with water, a flame, or heated beads to prevent it from fogging during the examination. The tongue is held forward, and the mirror is placed into the mouth and positioned above the back of the tongue to permit adequate visualization of the larynx. On examination with the mirror, the physician may see the granuloma in the larynx. The granuloma will appear to be a smooth, flesh-colored mass that may be pedunculated (on a stalk) or sessile (broad-based) and may be associated with surrounding erythema and ulceration. Changes in the posterior larynx and hypopharynx associated with reflux, as previously described, may also be seen. Because subtleties

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in detail are difficult to assess with mirror examination, if an abnormal lesion is found, the otolaryngologist will almost always perform either flexible or rigid laryngoscopy, or both, for better identification of the lesion. The choice of instrumentation is based on the physician's preference.

A flexible laryngoscope is a thin, lighted flexible telescope that is placed through the nose and into the throat and usually does not cause pain, although it may cause a slight discomfort in the nose. The patient is seated and awake during the examination. The flexible laryngoscope allows the physician to see the larynx in its natural position, without the distortion that sometimes occurs with holding the tongue forward for mirror and rigid telescopic examinations. In viewing the larynx in its natural position, the physician can assess changes in laryngeal muscle tension while the patient is talking or singing. From this assessment, the physician can diagnose abnormal voice use patterns that may be associated with the development of granulomas. Because of the ability to guide the tip of the laryngoscope into difficult to see positions, flexible laryngoscopy allows assessment of lesions that are not viewed easily with mirror examination and allows a closer view of the mass for better identification.

Rigid laryngoscopy presents a more magnified and optically superior view of the granuloma than the mirror or flexible laryngoscopic examination. This procedure is performed with a rigid telescope placed through the mouth with the tongue held forward. The patient is awake and seated in a forward position during the examination with the chin held slightly upright in a "sniffing" position. This position helps to pull

the base of the tongue forward so that the larynx can be viewed more easily. Occasionally, a sensation of gagging is experienced during the examination; otherwise the examination does not cause much discomfort. This magnified view of the granuloma can give the physician clues as to whether the mass is truly a granuloma or whether it is another type of lesion, such as a cancer, polyp, or papilloma. Each of these lesions has characteristics that distinguish it from others, similar to the characteristics that distinguish a tangerine from an orange, clementine, or grapefruit. However, like the tangerine and clementine, these differences may be subtle. Biopsy may be required for definitive diagnosis if any doubt exists.

Stroboscovideolaryngoscopy may be performed, usually with the rigid telescope, but it also can be performed with the flexible laryngoscope. Stroboscovideolaryngoscopy involves the use of synchronized flashing lights through the telescope to evaluate the function of the mucosal wave of the vocal fold. This allows a magnified assessment of the composition of the mass and helps to distinguish solid from fluid-filled lesions. In addition, a more accurate assessment of the effects of the mass on the ability of the vocal folds to close completely or on the mucosal wave to vibrate normally can be performed. Other changes in the larynx, such as those associated with reflux, can be seen more clearly too.

DIAGNOSTIC EVALUATION

Once the examinations are complete, the otolaryngologist makes a decision as to whether or not he or

she is certain that the lesion visualized is a granuloma. This decision is usually based on the otolaryngologist's previous experiences with laryngeal granulomas and other laryngeal masses and on the appearance of the patient's lesion. The history that the otolaryngologist obtains from the patient also helps him or her to decide on the likelihood of the lesion being a granuloma or another lesion. In general, most people with granulomas have a history of vocal abuse or laryngeal trauma and, on examination, have signs of reflux laryngitis and vocal misuse. If the otolaryngologist is reasonably certain that the lesion is a granuloma, then he or she will begin treatment.

With atypical-appearing lesions at the time of the initial examination, a biopsy, which is sampling of the tissue for microscopic examination and diagnosis, is warranted. There are several other lesions that can mimic granulomas, and these usually will not resolve with the treatments that are used to treat granulomas. The other possibilities include cancer, benign tumors (noncancerous abnormal growths), tuberculosis (infection with the tuberculosis bacteria), fungal infections, papillomas (abnormal growths in response to infection by the Human Papilloma Virus), and granulomatous diseases (conditions in which the body recognizes itself as foreign and has an abnormal reaction to itself—not to be confused with granulomas which are inflammatory responses to injury).⁸

Biopsy

Biopsies are performed as outpatient procedures in the operating room. The patient is given general anesthesia; that is, the patient is put

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to sleep and often intubated, although a technique called "jet ventilation" may be used instead of traditional intubation. A laryngoscope that allows close visualization and palpation (touching) of the larynx is placed through the mouth. This procedure is called direct laryngoscopy and often takes thirty minutes to one hour to perform. A microscope is often used with the laryngoscope to obtain better definition of the lesion. With the aid of the microscope, the lesion is either excised entirely or a portion of the lesion is sampled and sent to the pathologist. If the lesion is relatively small, then usually the entire lesion is excised. If the lesion is large or if excision of the entire lesion would result in a significant permanent functional deficit, such as problems with talking, singing, or swallowing, then a sample of the lesion is obtained.

The pathologist looks at the biopsy specimen (the sampled lesion) under the microscope. When the pathologist makes the diagnosis of granuloma, he or she has seen signs of chronic inflammation without the presence of other disease processes. The presence of lymphocytes (the blood cells that help with wound healing), thickened mucosa, ulcers, collagen (scar tissue), fibroblasts (the cells that make collagen), and an increased number of blood vessels are all elements of chronic inflammation that help the pathologist make the diagnosis of granuloma.^{2, 3, 9, 10}

Twenty-Four-Hour pH Probe and Barium Swallow

The adequacy of reflux control is evaluated with the aid of a twenty-four-hour pH probe study and a barium swallow study. The twenty-four-hour pH probe study is a monitoring

system that involves the placement of a thin, plastic-coated probe through the nose and into the esophagus. The probe has two sensors on it that detect the presence of acid. One probe lies just above the lower esophageal sphincter (the region at the junction of the stomach and esophagus that prevents reflux), and the other probe sits near the cricopharyngeus, the upper esophageal muscle that sits behind the larynx and opens during swallowing to allow food to pass into the esophagus. The probe is secured to the nose with an adhesive and stays in place for about twenty-four hours. There is a small processor that the patient wears on the belt, like a radio, that records the output of each sensor.

The patient goes home with the probe in place and is asked to resume normal daily activities. The patient is given a diary and is asked to record the activities of the day, such as meals, drinking, sensation of reflux symptoms, exercise, singing, sexual activity, and bedtime. Sometimes the processor that the patient wears on the belt has buttons that the patient can press to record these events directly into the processor. The probe is removed after twenty-four hours, and the information is analyzed. The information that can be gained from the twenty-four-hour pH probe monitor includes the number of episodes of reflux into the pharynx and esophagus in the twenty-four-hour period, the degree of acidity of the reflux material, and the relationship of the reflux episodes to daily activities.¹¹ This information can help the otolaryngologist tailor the antireflux treatment to the patient's specific problem areas. Occasionally, the results of the twenty-four-hour pH probe monitor are not helpful. This

occurs if the patient does not happen to have any reflux episodes during the twenty-four hours that the monitor is in place, or if the patient's activities or diet are altered on the day of the study.¹¹ For singers, it is important to sing while the pH probe is in place, as reflux may occur only during singing and may not be detected otherwise.

The barium swallow study is a study in which the patient is given a barium liquid to drink and X-ray pictures and video-recordings are taken of the patient as he or she swallows the barium liquid. The barium is seen readily on the X-ray as it travels from the mouth into the pharynx, esophagus, and stomach. If the patient has reflux during the study, it will be seen as regurgitation of the barium from the stomach into the esophagus. If no reflux is seen, then a procedure called barium swallow with water siphonage may be performed. In this procedure, water is swallowed after the routine barium study has been completed. X-ray pictures and video-recordings are taken again during these maneuvers. If reflux of the barium is seen after the water is drunk, then a diagnosis of reflux is made.¹¹ Because most people who have reflux do not reflux every time they eat or drink, laryngopharyngeal reflux may not be seen on the barium swallow at the time that it is performed. For these reasons, both the barium swallow and the twenty-four-hour pH probe monitoring are performed as complementary studies in some patients.

Laryngeal Electromyography

Occasionally, the patient has an underlying paresis of the muscles that move the vocal folds for which he or she tries to compensate by ex-

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cessively and abusively using other muscles of the larynx. Such hyperfunction may cause or aggravate granulomas. This can sometimes be seen with flexible laryngoscopy and stroboscoped laryngoscopy during vocal exercises that require the vocal folds to abduct (open) and adduct (close) rapidly. Sometimes, these abnormalities can be missed on examination. When paresis is seen on examination or when a neurologic problem is suspected, a laryngeal electromyography (LEMG) is obtained. This is a diagnostic test in which small needles are placed in the muscles of the larynx. The nerves of the larynx produce an electric current whenever they signal the muscles of the larynx to move. The needles that are placed into the muscles sense the electricity that the nerves produce and transmit the signal to a monitor. A healthy and strong nerve produces a different signal than does a paretic (weak) nerve or a paralyzed (nonfunctioning) nerve.^{12, 13} If paresis of a specific nerve or muscle group is noted on LEMG, therapeutic approaches that are aimed at augmenting vocal fold function can be taken.

TREATMENT

Once the physician sees a lesion that he or she suspects is a granuloma, there are several courses of action the physician may take. The one chosen depends on the physician's certainty that the lesion is indeed a granuloma, on the presence of other signs and/or symptoms of laryngopharyngeal reflux, on the presence of abnormal muscle tension with singing or talking as seen on flexible laryngoscopy, and on details of the

antecedent history (intubation, upper respiratory tract infection, vocal abuse, etc.). If the appearance and location of the lesion is very typical for a granuloma, the patient is treated for laryngopharyngeal reflux and is given a course of voice therapy.

Management of Reflux

The treatment of reflux consists of both medications and behavioral modifications in the patient's lifestyle. The medications commonly used to treat laryngopharyngeal reflux are proton-pump inhibitors, H₂-receptor blockers, and antacids. These medications function by decreasing the amount of acid in the stomach; they do not prevent reflux episodes from occurring. By decreasing the amount of stomach acid, they decrease the amount of acid exposure the larynx experiences from the reflux episodes. Greater amounts of acid on the larynx cause a greater degree of injury and inflammation. Gastric motility agents are used occasionally in the treatment of reflux as well. These agents work by increasing the motility of the gastrointestinal system, which limits the amount of time that gastric contents stay in the stomach, thus limiting the number of reflux episodes. Gastric motility agents are used seldom because they have many side effects. The only way to prevent reflux from occurring is to have surgery to tighten the muscle that prevents the stomach contents from regurgitating into the esophagus. Few people need the surgery to control the reflux adequately. Most people do well with the medications and with behavioral modifications.^{3a}

Behavioral modifications to help control laryngopharyngeal reflux include: elevating the head of the

bed, avoiding eating or drinking for at least three hours before bedtime, avoiding exercising any sooner than two hours after eating, increasing exercise activity, losing weight, avoiding excessive amounts of beverages and foods that contain caffeine, avoiding excessive amounts of foods and beverages high in citric acid content, avoiding excessive amounts of dairy products, and stopping smoking and/or the use of other tobacco products. Nicotine (which is present in tobacco products) and caffeine cause relaxation of the lower esophageal sphincter (the muscle that prevents reflux), thus rendering it unable to perform its function.¹⁴ The avoidance of caffeine and tobacco can have a substantial positive effect on this muscle's ability to maintain its tone and prevent reflux episodes. Dairy products and foods and beverages high in citric acid increase the acid content of the stomach, thus increasing the acidity of the reflux material that reaches the larynx. Eating and drinking stimulate the stomach to produce acid and stimulate the stomach to churn as a part of the digestive process. If this occurs within three hours of lying down to sleep, the churning of the stomach can force the excess acid produced for digestion into the esophagus and up to the larynx.

Elevation of the head of the bed by at least six inches relative to the foot of the bed helps to keep the larynx higher than the level of the stomach while sleeping, and the force of gravity helps to keep the stomach contents in the stomach. The use of more than two pillows is discouraged because this form of head elevation often results in a bending of the body at the waist, which results in pressure on the stomach. This pressure

squeezes the stomach and may increase the number and duration of reflux episodes. Exercising too soon after eating has a similar effect on abdominal pressure and increases re-flux. Singing, which requires a significant amount of abdominal support, is a form of exercise. Excess weight in the abdominal region also exerts a pressure effect on the stomach, especially while lying down. Weight loss of as little as five to ten pounds can have a beneficial effect, decreasing the number of reflux episodes.

Voice Rehabilitation

Speech and voice therapy are beneficial and probably are the most important components of the treatment of granulomas. Speech and voice therapists evaluate the patient's current vocal patterns and behaviors and help the patient to modify those behaviors that may be damaging to the larynx. Most often, patients with laryngeal granulomas show signs of muscle tension dysphonia. As described earlier, muscle tension dysphonia is the abnormal or excessive use of the accessory muscles of phonation. These include muscles that control the false vocal folds (which are the folds of tissue above the vocal folds), the pharyngeal (throat) muscles, the tongue, the neck muscles, the jaw muscles, the mouth muscles, the palatal (roof of the mouth) muscles, the shoulder muscles, the abdominal muscles, the back muscles, and the chest muscles. Inappropriate use of any of these muscles can place a significant strain on the laryngeal muscles, resulting in vocal fold trauma.

The goals of speech and voice therapy are to relearn how to relax the muscles of phonation and how to achieve optimal breath support dur-

ing both speaking and singing. Speech and voice therapy occur over the course of several sessions to ensure that the patient is practicing correct technique at home and work and to help reinforce healthy vocal patterns. For many patients, control of the reflux and speech and voice therapy result in resolution of granulomas. This may take several months to completely resolve, but improvement should be noted after six weeks of adequate therapy.^{5,8}

Management of Recurrent and Persistent Granulomas

In approximately fifteen to twenty percent of the patients with granulomas, the lesion continues to grow or cause symptoms after six to eight weeks of adequate voice therapy and reflux control. In these instances, excision of the lesion with either steroid injection directly into the granuloma or systemic administration of steroids via pills or shots is performed. Excision is performed in the operating room as an outpatient procedure in a manner similar to the procedure described for biopsy. This time, the entire lesion is removed and sent to the pathologist to confirm the diagnosis of granuloma. Sometimes, very small abnormal growths, such as the ones previously mentioned, can be associated with surrounding inflammation that looks like a granuloma and that may have been missed on the first biopsy. Excision of the entire lesion should give a definitive diagnosis.

Sometimes the granulomas are excised with a scalpel or scissors, a technique often referred to as the "cold technique," and sometimes they are excised with the laser, which is often referred to as the "hot technique." The laser is merely a knife

that uses light energy to vaporize and cut tissue. Because the laser uses light energy, heat is released by the laser as it cuts.^{15,16} On the one hand, the laser is advantageous in the excision of granulomas because they tend to bleed as they are cut, and the laser is able to cause clotting of blood as the heat energy is released. On the other hand, some surgeons believe that because the heat released from the laser results in a minor burn injury itself, the laser may actually predispose to further granuloma and scar formation.^{5,16} The presence of scar on the vocal fold or vocal process can interfere with the normal vibratory function of the vocal fold mucosa, thus producing a hoarse voice. For these reasons, some surgeons prefer to use the scalpel or scissors. Topical vasoconstrictors, which are medications that are applied directly to bleeding vessels to cause them to constrict and stop bleeding, are used with the cold technique as needed.

Once the granuloma is excised, the surgeon may inject steroids directly into the tissue where the granulomas were found. The steroids used are variations of substances found naturally in the body that decrease inflammation; these are different from the anabolic steroids sometimes used by athletes to enhance performance and do not have the same masculinizing effects on the voice and body that anabolic steroids have. Injection of steroids into the tissue where the granulomas were formed may help to prevent further inflammation and granuloma formation. Sometimes, steroids are given systemically (taken by mouth or given as a shot) over the course of up to several weeks to help prevent formation of the granulomas. The advantage of using systemic steroids over

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direct injections of steroids is that the systemic form of the steroid can be given over longer periods of time, yielding a longer anti-inflammatory effect. Excision is always followed by a reevaluation by the speech and/or voice therapists to ensure that proper vocal technique is being used to minimize trauma in the surgical area.

Reevaluation of the adequacy of voice rehabilitation involves assessment of the patient's compliance with the recommendations of speech/voice therapy. Sometimes, unknowingly, the patient incorrectly practices at home the vocal exercises that he or she has been given. This can result in more injury to the larynx and should be identified and corrected.

The use of speech and voice therapy, antireflux medications, anti-reflux behavior modification, excision, and steroid therapy when necessary is successful in resolving the granulomas in most patients. There are some patients in whom, despite adequate treatment, the granulomas still recur. This occurs in approximately five percent of the patients with granulomas. Sometimes this is directly related to vocal misuse that is not adequately corrected with conventional speech and voice therapy. In other patients, there is no identifiable cause for the recurrence. If the lesions are not symptomatic, no further treatment is needed and the lesions are monitored closely with serial examinations. Lesions that continue to be symptomatic may require repeated excision and steroid injection or ingestion. Some otolaryngologists have used botulinum toxin (Botox) injections into the muscles that most likely are responsible for the excessive trauma to the portion of the vocal fold with the granuloma.⁸ Botu-

linum toxin is a substance produced by the bacteria that cause botulism. Botulinum toxin works by causing a paresis of the muscles to which it is exposed. In patients with granulomas, it is thought that the lateral cricoarytenoid muscle of the larynx is hyperactive, causing forceful closure of the vocal folds at the level of the vocal process, the site most often involved with granulomas.⁸ Weakening of this muscle with the botulinum toxin injection prevents this forceful closure and limits the amount of trauma that can be caused to the vocal process. Speech and voice therapy are continued after botulinum toxin injections; without the forceful contractions of the lateral cricoarytenoid muscle, sometimes it is easier for the patient to learn healthy vocal technique.

SUMMARY

Granulomas are inflammatory lesions that can occur anywhere in the larynx, but typically occur in the posterior regions of the vocal folds on the vocal process of the arytenoid cartilage. Granulomas are caused by trauma, which can take the form of vocal abuse, vocal misuse, laryngopharyngeal reflux, intubation, or surgical or other trauma. The mainstay of treatment of granulomas involves identification and removal of the inciting irritant, speech and voice rehabilitation, and treatment of laryngopharyngeal reflux. The results of barium swallow studies, twenty-four-hour pH probe monitoring, and laryngeal electromyography may guide therapy. Excisional biopsy is considered for patients with atypical lesions and for patients with le-

sions that do not respond to treatment. Patients with recalcitrant, symptomatic lesions may require more aggressive treatment, including the use of steroids, repeated excision of granulomas, abdominal surgery for reflux, and botulinum toxin injections into the laryngeal muscles.

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