Literature Review

Dysphagia after chemoradiation in nasopharyngeal carcinoma

Ika Dewi Mayangsari, Elvie Zulka Kautzia Rachmawati, Amira Az Zahra
Department of Otorhinolaryngology - Head and Neck Surgery, Faculty of Medicine, University of Indonesia / Cipto Mangunkusumo Hospital, Jakarta

ABSTRACT

Background: Dysphagia is one of the early and long-term consequences of nasopharyngeal carcinoma management. Chemotherapy with radiation may improve the local control and survival rate but also can lead to serious dysphagia caused by radiation damage, and chronic alteration of tissues leading to fibrosis that can happen during or soon after the radiation therapy. Dysphagia can result in dehydration and malnutrition, place people at risk of aspiration, and reduce the quality of life by increasing anxiety and depression. **Purpose:** Identifying causes, relevant factors, clinical presentation, and management of post chemoradiation dysphagia in nasopharyngeal cancer patients. **Literature review:** Structures demonstrating post-therapy changes were deemed as dysphagia aspiration-related structures (DARS). Management of nasopharyngeal carcinoma is radiotherapy with fibrosis found in 38.2% of the nasopharyngeal carcinoma patients on at least one side of the neck post-treatment. The presence of fibrosis in the pharyngeal and laryngeal muscles impacted hyoid bone anterior movement and upper esophageal sphincter relaxation contributed to dysphagia. Fiberoptic Endoscopic Evaluation of Swallowing (FEES) is utilised to detect dysphagia in these patients. The treatment algorithm for dysphagia after chemoradiation consists of history taking, clinical evaluation, instrumental examination, and management. The management options may be behavioral, medical, surgical, or combination. **Conclusion:** Identifying the cause, the components of the deficit, and the relevant patient factors has prime importance in managing dysphagia besides considering the options and weighing the risks versus benefits.

Keywords: dysphagia, chemoradiation, nasopharyngeal carcinoma, dysphagia aspiration-related structures, fiberoptic endoscopic evaluation of swallowing

ABSTRAK

Latar belakang: *Disfagia merupakan salah satu dampak jangka pendek dan jangka panjang dari tatalaksana kanker nasofaring. Kemoterapi dengan radiasi bertujuan mengontrol keganasan dan meningkatkan kesintasan, tetapi juga dapat menimbulkan disfagia akibat gangguan seluler dari radiasi dan perubahan jaringan yang menimbulkan fibrosis, baik segera ataupun dalam jangka lama setelah radiasi. Disfagia dapat menyebabkan dehidrasi dan malnutrisi, meningkatkan risiko aspirasi, dan mengganggu kualitas hidup akibat ansietas dan depresi yang ditimbulkan.* ***Tujuan:*** *Mengidentifikasi penyebab, faktor yang terlibat, presentasi klinis, dan tatalaksana disfagia pasca kemoradiasi pada pasien dengan kanker nasofaring.* ***Tinjauan pustaka:*** *Struktur yang mengalami perubahan pasca kemoradiasi disebut sebagai struktur terkait disfagia dan aspirasi/*dysphagia aspiration-related structures (DARS)*. Sebanyak 38.2% pasien dengan kanker nasofaring yang menjalani radioterapi mengalami fibrosis pada setidaknya satu sisi leher pasca terapi. Fibrosis pada otot faring dan laring mempengaruhi pergerakan anterior tulang hyoid dan relaksasi sfingter esofagus atas, yang akan menimbulkan gejala disfagia. Disfagia pada populasi pasien kanker nasofaring dideteksi menggunakan* Fiberoptic Endoscopic Evaluation of Swallowing (FEES)*. Algoritma penanganan disfagia pasca kemoradiasi tersusun atas anamnesis, pemeriksaan klinis, pemeriksaan dengan alat, dan tatalaksana yang dapat berupa modifikasi perilaku, penggunaan obat, pembedahan, atau kombinasinya.* ***Kesimpulan:*** *Identifikasi penyebab, komponen yang terganggu, serta faktor pasien yang relevan, penting dalam penatalaksanaan disfagia, selain mempertimbangkan berbagai pilihan terapi dan keuntungan-kerugiannya masing-masing.*

Kata kunci: *disfagia, kemoradiasi, kanker nasofaring,* dysphagia aspiration-related structures, fiberoptic endoscopic evaluation of swallowing

Correspondence address: Ika Dewi Mayangsari. Department of Otorhinolaryngology - Head and Neck Surgery, Faculty of Medicine, University of Indonesia / Cipto Mangunkusumo Hospital, Jakarta. Email: idmayang@yahoo.com

INTRODUCTION

Nasopharyngeal carcinoma (NPC) is a widely found malignancy of the head and neck region, particularly in South East Asia, including Indonesia. It is primarily treated with radiotherapy due to its high radiosensitivity. Chemotherapy may also be given along with radiotherapy as an induction, concurrent, or adjuvant. Chemotherapy with radiation is done to achieve local control and improve survival rate, while surgery is reserved for recurrent or persistent cases. Treatment using chemoradiotherapy is challenging because of the risk of damage to critical structures surrounding the tumor, including those essential for swallowing function.[1,2]

Dysphagia is one of the early and long-term consequences of NPC management with chemoradiotherapy. Various studies had reported its incidence in NPC post chemoradiation, with prevalence ranging from 13% to 93.5%.[2] Dysphagia or disordered swallowing might be caused by mechanical obstruction (esophageal cancer, rings or webs, external compression by lymphadenopathy or mediastinal masses), or neuromuscular dysfunction (central or peripheral nervous system disorders, degenerative, or skeletal muscle disorders). Studies suggest that in patients with NPC managed by chemoradiation, dysphagia might have multiple causes as the treatment given to control the tumor might affect many critical structures in the head and neck region.[1,2] Tamin et al.[1] found that the most common structural abnormalities in 39 patients post-NPC treatment were an upright and swollen epiglottis (89.4%), poor oral hygiene (56.4%), and inadequate velopharyngeal closure during swallowing (56.4%).

Dysphagia following chemoradiation has a number of negative impacts on a patient's physical, social and emotional state.[3] Impaired swallowing might result in dehydration and malnutrition, worsening conditions that might have existed pre-chemoradiation due to the malignancy itself. Dysphagia also places people at risk of aspiration and pneumonia, and reduces the quality of life by increasing anxiety and depression.[1,2] This review aimed to identify causes, relevant factors, clinical presentation, and management of post chemoradiation dysphagia in nasopharyngeal cancer patients, as understanding the basis of physiological changes post-NPC treatment might be the key to preventing and managing dysphagia in this specific population.

Pathophysiology of radiation injury

Radiation-induced cellular damage has long been the focus in studies regarding complications following cancer treatments involving radiotherapy. While the main objective of radiotherapy is to damage cancer cells and stop growth, adverse effects to surrounding structures is difficult to avoid. Exposure to radiation causes alteration to molecular pathways, disrupts cancer cell growth, and inhibits normal functions in the surrounding healthy cells.[4] Dysphagia, presenting as various swallowing-related complaints and findings, remains one of the most common radiation-induced complications following NPC treatment.[5]

At the cellular level, the effects of radiation exposure are classified into direct and indirect effects. Direct effects of irradiation are caused by high-energy rays delivered to the tumor bed and directly interacting with DNA of the cancer cells. DNA-damaging abilities of ionizing radiation is the basis of radiotherapy itself; exposure to ionizing radiation causes both DNA single-strand and double-strand breaks. The loss of genetic material due to many breaks in the DNA causes the cells to fail to divide, leading to cell death.[6]

Irradiation also causes indirect damage to cells through oxidative stress and activation of the inflammatory reaction. DNA-damaged cells generate reactive oxygen species (ROS) and nitrogen species which causes oxidation of protein and lipids, and induces cellular damage. ROS also damages mitochondrial DNA which are passed on to daughter cells and continues the cycle of oxidative stress. Exposure to radiation also initiates a pro-inflammatory reaction and induces the production of pro-inflammatory cytokines and chemokines, including interleukin-1, interleukin-6, tumor necrosis factor-α (TNF-α) and transforming growth factor-β (TGF-β). These cytokines and chemokines mediate long-term inflammatory reactions, causing chronic inflammation and eventually fibrosis. Irradiation also causes the decrease of stem cell proliferation rate, and further inhibits the resolution of inflammation and tissue regeneration.[4,6] Although these effects are beneficial for eradicating cancer cells, yet as exposure to surrounding structures is difficult to avoid, healthy tissues within proximity to the tumor bed are subject to adverse effects as well. Damage to DNA strands, oxidative stress and inflammation also mediates systemic effects of irradiation, with most effects observed in the haematopoietic and immune system.[6]

Radiation-related changes in the time scale

In literatures, radiation-related complications in head and neck cancer are sub-grouped in relation to the duration between radiation exposure and presentation of symptoms into various classifications. Clinically, radiation injuries are classified into acute (<3 months after exposure to radiation), subacute (3-6 months) and chronic (>6 months), while dysphagia rehabilitation literature groups acute and subacute injuries into early injuries, and chronic injuries are termed delayed or late injuries. It is important to note that, while the temporal relation might suggest a chronic injury to be a continuation of an acute one, it can also develop without ever showing clinical signs of an early radiation-induced tissue damage. Basic radiation literatures further classify late injuries into consequential and generic effects. Multiple factors related to radiotherapy influence the severity of inflammatory response and development of these radiation injuries, such as volume and dose concentration, fraction size, and optimum accumulated dose of radiation.[4]

Early radiation injuries are mainly observed in the epidermis and mucosa due to inflammation and cell depletion. Immediately after exposure to ionizing radiation, the inflammatory cascade is activated and cytokines and chemokines are released. Changes are observed in cell membrane permeability along with the release of histamines, while progressive epithelial breakdown develops leading to cell loss. As a consequence, mucositis and desquamation of epidermis are observed, along with erythema and edema. Most patients can still swallow without much difficulty, but oral mucositis might cause continuous pain leading to poor oral intake. These acute changes start showing within hours to several weeks of radiation exposure, are transient and usually resolve within 3 to 6 months, or persist and develop into chronic injuries.[4]

Late radiation injuries are classified into consequential and generic late effects. Consequential late effects are those occurring as a consequence of a delay in re-epithelization of severe early injuries of the mucosa, reducing barrier functions and allowing infection and trauma to the underlying layers. Severe oral mucositis with desquamation and loss of barrier functions predisposes to tissue necrosis and delayed ulcer. On the other hand, generic late effects are changes in the tissue directly caused by radiation and are irrespective of the degree of earlier tissue damage. Fibrosis formed due to cellular changes after exposure to radiation leads to abnormalities in muscle and nerve function.[4]

As explained above, fibrosis is a common long-term side effect of radiotherapy, particularly in the head and neck region. Fibrosis results from activation of fibroblasts and myofibroblasts due to chronic inflammation and cell death, causing an accelerated extracellular matrix deposition. In a large cohort study of 849 NPC patients conducted by Yeh et al.[7], 38.2% (324 patients) had post irradiation neck fibrosis in at least one side of the neck. They also found radiation dose more than 62 Gy to be associated with post irradiation neck fibrosis. Post irradiation neck fibrosis compromises the mobility and contractility of muscles in the neck region, including those important for swallowing function. Lin et al.[8] reported a presence of fibrosis in the pharyngeal and laryngeal muscles causing delayed pharyngeal contraction, impacting anterior movement of the hyoid bone, and causing aberrant upper esophageal sphincter (UES) relaxation. These findings might result in reduced oral intake, or retention of food bolus in the pharyngoesophageal segment leading to poor nutrition, or increased risk of aspiration pneumonia.[5]

Patients might also suffer damage to cranial nerve function post exposure to radiation therapy. Cranial nerves involved in swallowing exits the skull base, and innervates the structures critical to swallowing function. Exposure to radiation often affects these pathways as well, posing these nerves to radiation-related damage.[2] Cranial nerves (CN) may also be damaged due to progressive soft tissue fibrosis.[4] Lower cranial nerves are usually more affected in NPC patients post radiotherapy, such as the glossopharyngeal nerve (CN IX), the vagus nerve (CN X) and the hypoglossal nerve (CN XII). Damage to the glossopharyngeal nerve causes loss of sensation in the pharynx and decreased salivation, while damage to the vagus nerve causes pharyngeal sensory and motoric deficits, in addition to impaired parasympathetic functions of almost all organs. Palsy of the hypoglossal nerve causes complete paralysis of the ipsilateral side of tongue. Although the mechanism is not yet fully understood, it is safe to assume that the loss of nerve functions also plays an important role in the development of dysphagia post NPC treatment with radiotherapy.[2,9]

Clinical presentation of swallowing-related problems post radiation therapy

Most patients undergoing radiotherapy have normal swallowing function, and only experience swallowing-related problems once there are major changes in anatomy and functionality of related structures. Dysphagia usually results as a combination of multiple defects in swallowing-related structures, such as reduced retraction of the posterior third of the tongue, incompetent retroflexion of the epiglottis, defective or reduced laryngeal elevation, delay in the pharyngeal transit, and poor coordination of the swallowing muscles. Patients presenting with oral mucositis and pain experience impaired oral phase of swallowing, causing decreased oral intake, leading to weight loss and malnutrition.[4,10] Oral mucositis in these patients is usually related to factors such as oral hygiene, smoking, nutritional status, and

infections. Patients might also experience systemic fatigue and nausea as side effects of therapy or due to the disease itself, which further diminishing their motivation to eat.[4] Patients with decreased oral intake needing gastric tubes might develop disuse atrophy of swallowing muscles. The muscles themselves undergo progressive replacement of muscle fibers with fibrotic tissue causing weakening and limited range of movement, which eventually leads to a prolonged feeding tube dependence.[10]

Normal swallowing function relies on the integrity of each responsible structure, and defect to these structures causes dysphagia. Eisbruch et al.[11] identified the structures responsible for causing post-radiation therapy dysphagia, termed dysphagia aspiration-related structures (DARS). These structures include the pharyngeal constrictors, upper esophageal sphincter, epiglottis, supraglottic larynx, and base of the tongue. Changes to DARS happen during chemoradiotherapy as they are usually in the middle of the treatment field. Early after chemoradiation, DARS become edematous and the structures develop varying degrees of muscle edema, subcutaneous fibrosis, and disuse atrophy, causing complaints of dysphagia. Over time, the structures stiffen and develop fibrosis, causing further difficulties in swallowing. Dysphagia developing later in the course of disease usually has underlying delayed mononeuropathy or polyneuropathies of the cranial nerves involved in swallowing, and commonly presents with silent aspiration and pharyngeal paresis.[12]

Normal swallowing function is divided into four phases: 1) oral preparation phase, in which food is ground and mixed with saliva, forming a bolus; 2) oral phase, in which the bolus is transported to the pharynx; 3) pharyngeal phase, where the swallowing reflex is initiated and moves the bolus into the esophagus; and 4) esophageal phase, where the peristalsis moves the bolus into the stomach. Murphy et al.[11] identified common swallowing abnormalities found in patients post radiation therapy according to the swallowing phases. Abnormalities in the oral preparation and oral-pharyngeal phase include limitations in lip closure resulting in drooling, loss of cheek muscles, trismus (impacts opening of the mouth and bite range), tongue weakness and decreased elevation and lateralization, spillage into vallecula and pyriform sinuses, and a decreased sensory input resulting in delayed swallow initiation. Abnormalities in the pharyngeal phase include edema of the epiglottis with decreased motion and inversion, decreased tongue base retraction, decreased contraction of pharyngeal constrictors, decreased anterior movement and elevation of the larynx, and decreased cricopharyngeal opening.[11]

It is also important to understand the differences in dysphagia experienced by patients with head and neck cancer, and patients with a neurologic problem. Patients with a neurologic problem experience dysphagia due to a direct damage to the nervous system, resulting in a “weak” swallow. On the other hand, patients with head and neck cancer experience swallowing problems due to fibrosis and atrophy of the swallowing muscles. These patients have reduced movement of swallowing-related structures, leading to reduced bolus movement and clearance and increased residue in the oropharynx. This residue increases the risk of aspiration, which can be managed by teaching the patients to swallow in a brisk and timely manner. Patients can also help move the food bolus by drinking water afterwards, which a neurologic patient will find harder to do as they struggle more with liquids. Summary of the differences found in a neurologic and head and neck cancer patient is listed in Table 1.[13]

Table 1. Differences in swallowing-related problems of a neurologic and head and neck cancer patient.[13]

Parameters	Neurologic patient	Head and neck cancer patient
Anatomy	Normal, unless paresis	Fibrotic and atrophied
Saliva	Excessive, often drooling	Dry, often with xerostomia
Taste	Intact	Reduced
Mastication	Clumsy and weak	Limited due to having teeth extracted prior to radiotherapy (most patients)
Oral containment	Problematic	Intact
Initiation of swallow	Slow and delayed	Intact
Trouble with consistency	Mostly with liquids	Mostly with food, harder consistencies
Structural movements	Delayed and reduced	Reduced, not delayed
Aspiration	Before or during swallow	After swallow (residue)

Detecting risk of dysphagia in NPC patients

Considering its prevalence, it is important to recognize the particular set of population at risk of developing dysphagia after treatment with chemoradiation in NPC patients. Causes of dysphagia in cancer patients might be multifactorial. Some might already have some degree of swallowing dysfunction before undergoing treatment, which predisposes them to develop dysphagia after treatment. Patients with oral cavity or pharyngeal cancer might have poor swallowing function, while hypopharyngeal and laryngeal cancer has higher risk of aspiration due to impairment of swallowing muscles. Bigger and higher-stage tumors are more likely to cause dysphagia before treatment, which could be due to infiltration of swallowing muscles inhibiting normal movement or causing pain, or simply altering the anatomical organization due to the size and location of the tumor.[14]

Patient characteristics and functional status affect the outcome of treatment, including dysphagia as an adverse outcome. Elderly patients experience decreased muscle strength, including those responsible for masticatory and swallowing functions, and decreased sensation leading to a delay in phases of swallowing and increased risk of aspiration. Other patient factors include comorbidities, weight loss and malnutrition, performance status, and psychological state. Choice of treatment type (surgery vs. no surgery, chemoradiation vs. radiation alone) directly correlates to the risk of dysphagia post treatment. All curative treatments in head and neck cancer have varying degrees of risk of causing an adverse effect on swallowing. Prior recognition of these pretreatment factors is important to mitigate the incidence of dysphagia after treatment in these patients.[14]

Evaluation of swallowing functions in patients with NPC should be done pre and post treatment. Dysphagia might already exist prior to treatment due to the size of the tumor itself. Starmer et al.[15] analyzed Pretreatment Penetration Aspiration Scores (PAS) in 204 patients with head and neck cancer, and found higher PAS in patients with advanced stage laryngeal/hypopharyngeal tumor compared to other sites. Pretreatment dysphagia assessment aimed at determining baseline swallowing function in patients before undergoing treatment, while also providing insight for predicting post treatment outcomes. This assessment requires collaboration and involves a multidisciplinary team of head and neck surgeons, speech pathologists, radiation oncologists, medical oncologists, radiologists, and nutritionists.[14]

The first step in dysphagia assessment is a clinical swallowing evaluation (CSE). Swallowing evaluation is carried out using the Eating Assessment Tool (EAT-10) or

The M.D. Anderson Dysphagia Inventory (MDADI).[16,17] While it is important to evaluate swallowing function in all NPC patients, a set of trigger symptoms helps identify patients who might already be experiencing dysphagia. These trigger symptoms include: inability to control food, liquids or saliva in the oral cavity, pocketing of food in cheek, excessive chewing, drooling, coughing, choking, or throat clearing before, during, or after swallowing, abnormal vocal quality after swallowing with "wet" or gurgly voice, build up or congestion after a meal, complaint of difficulty swallowing, complaint of food "sticking" in throat, nasal regurgitation, and weight loss.[14]

CSE is done throughout the course of treatment, from pre-treatment, during and post treatment. Information necessary to evaluate swallowing function in each stage are summarized in Table 2, 3 and 4. Components of CSE include reviewing the patient's chart, observation and oral motor evaluation, carrying out oral trials as indicated, and forming a recommendation.[14]

Table 2. Questions to ask prior to treatment.[14]

What is the TNM (tumor-node-metastasis) stage?
Is the patient on an oral diet? What type of a diet?
What foods/liquids are easy to swallow?
What types of foods/liquids are most difficult to swallow?
Is there pain with swallowing?
Is there weight loss?
Are there episodes of coughing or choking?
Is there any difficulty with breathing?

Table 3. Questions to ask during treatment.[14]

Does the patient have weight loss?
What types of consistencies and textures are tolerated orally?
Is an alternative form of nutrition required? Is there a need for nutritional supplement?
Does the patient have oral mucositis, xerostomia, or pain?
Is the patient continuing their swallowing exercises and attending therapy?
Do the patient and caregiver attend a support group?
Does the patient have a depressed mood which affects oral intake?

Table 4. Questions to ask post treatment.[14]

Is the patient tolerating an oral diet?
Is the patient using an alternative method for nutrition and hydration?
Has there been any weight loss?
Any hospitalization due to malnutrition, dehydration or weight loss?
Is the patient on a swallowing treatment program?

After the initial evaluation using CSE, the evaluating team form recommendations for the patient going forward. Recommendations might include diet and supplements, proper postures and positioning of the patient, maneuvers, compensatory strategies and swallowing exercises. The team might also recommend carrying out additional evaluations using instruments. FEES is one of the main modalities of evaluating patients with complaints of dysphagia, with findings including standing secretion, pre-swallowing leakage, residue, penetration, and aspiration. Other modalities may include Videofluoroscopic Swallow Study (VFSS), Transnasal Esophagoscopy (TNE), or esophageal manometry. Dysphagia is measured in Penetration-Aspiration Scale (PAS), an eight-point scale which takes consideration of depth of penetration or aspiration, and patient's response to airway invasion. PAS score of more than two indicates the presence of dysphagia. Additional consultations with other specialists outside the multidisciplinary team might also be recommended as needed.[14]

Management of post treatment dysphagia

Treatment for post chemoradiation dysphagia consists of medical, surgical, and behavioral options. Medical treatment options comprise dietary modifications: including diets and feeding route, and pharmacological treatments: including anti-reflux drugs, prokinetic agents, and salivary management. Surgical management aims at improving glottal closure, protecting the airway, and improving pharyngoesophageal segment opening. Behavioral interventions include food modifications, compensation, or rehabilitation strategies. Compensation strategies improve swallowing function without changing the physiology, such as adjustments in posture, diets or swallowing pattern without any muscle strengthening, while rehabilitation strategies improve swallowing mechanisms by application of certain techniques, changing the physiology and strengthening the muscle with exercises.[14]

Other nonsurgical treatments include prevention with food or liquid restriction, avoiding infection and dehydration, and prophylactic exercise programs.[14] Preradiation prophylactic swallowing therapy might improve swallowing outcomes on the basis that swallowing exercises cause upregulation of antioxidant enzymes and enhancement of mitochondrial activity, increasing the muscles' capabilities in fighting off oxidative stress induced by radiation therapy. Swallowing therapy is reported to be most beneficial when combined with maintaining a fully oral intake.[18]

Methods involving electrical stimulations such as surface electromyography (EMG) biofeedback and neuromuscular electrical stimulation might also be used as adjunctive modalities.[14] Lymphedema therapy using massage, stretching, or other manipulation is also reported as a potential treatment. No standard guideline on dysphagia treatment for NPC patients has been established yet, but most clinicians recommended 10-20 minutes of treatment time per day. Teaching hospitals with cancer centers are reported to start swallow therapy earlier and more agressively .[13]

Kotz et al.[19] assessed functional swallowing outcomes in patients undergoing prophylactic swallowing exercises prior to and during chemoradiotherapy. There were 5 exercises prescribed to each patient, performed 3 times a day, 10 repetitions each time. The 'effortful swallow' is squeezing hard with swallowing muscles as the patient swallows, increasing tongue base retraction and pharyngeal pressure to improve bolus clearance. The 'super supraglottic swallow' is holding breath and bearing down while swallowing followed by coughing, closing the airway before and during swallowing, and avoiding aspiration. The two tongue

base retraction exercises are the 'tongue hold maneuver' (holding the tongue between the front teeth and swallowing saliva) and the 'tongue retraction' (pulling the back of tongue to the back of mouth) which improves contact between tongue base and posterior pharyngeal wall and facilitates bolus propulsion. Lastly, the 'Mendelsohn maneuver' is holding the Adam's apple high while swallowing for a few seconds, increasing the duration of laryngeal elevation. These exercises aim at promoting bolus transport and decreasing post-swallow residue. The study reported significantly better Functional Oral Intake Scale (FOIS) at 3 and 6 months post chemoradiotherapy, but not immediately after or at 9 and 12 months.[19] Another compensatory maneuver also useful in patients post chemoradiotherapy in the head and neck region is the 'shaker' exercise, in which the patient is instructed to lie supine, raise their chin to their chest and maintain for 60 seconds before lowering the head back to supine position. This exercise is thought to strengthen the suprahyoid muscles.[14]

In conclusion, dysphagia remains one of the most common adverse outcomes of NPC treatment, including with chemoradiation. It has a number of negative impacts on a patient's life, placing them at risk of malnutrition and infections, and reduces their quality of life. All NPC patients undergoing chemoradiation are at risk of developing post-treatment dysphagia, and some pretreatment factors might place a subset of patients at even higher risk. Evaluation of swallowing functions are done prior to, during, and following chemoradiation to detect the presence of dysphagia. Additional instrumental examinations might be considered as needed. Management includes medical, surgical, and behavioral options. Prevention using prophylactic swallowing exercises and other strategies are proven to be beneficial, and results in better swallowing outcomes.

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