CERVIFIT NECK STRENGTHENING AND CONDITIONING PROGRAM ON FORMER HEAD AND NECK SQUAMOUS CELL CARCINOMA PROTON THERAPY PATIENT.
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Introduction

Proton therapy is quickly becoming the preferred protocol when addressing invasive squamous cell carcinoma. According to MD Anderson, “proton therapy allows for the effective treatment of complicated head and neck tumors, while minimizing the radiation dose to vital structures such as the eyes, mouth and brain. Vital physical functions such as vision, smell, taste and swallowing remain virtually untouched when a patient is treated with proton therapy.” (1)

While mitigating some of the risk of side effects, proton therapy according to Penn State School of Medicine, “Damage to the muscles in the neck may also occur after radiation. Usually, damage to the muscles results in atrophy, or decrease in size of the muscles on one or both sides of the neck. The muscles and soft tissue may also develop a hard or “woody” texture. Some survivors will develop longer, thinner-appearing necks that are not as strong as they were before treatment due to muscle atrophy, resulting in difficulty holding their head up for long periods.” (2)

According to the article, A Comprehensive Review of Head and Neck Cancer Rehabilitation: Physical Therapy Perspectives, “isometric strengthening of the cervical extensors, and postural modifications with visual cuing, is beneficial. Manual fibrous release techniques are indicated when ROM is restricted by robust soft tissue fibrosis or tethering of the skin to subdermal tissues. Patients can be taught self-massage to augment the efficacy of ROM activities.” (3)

Currently, patients who undergo proton therapy are discharged with minimal home exercise instructions with no medical supervision. This can potentially increase the risk to the patient for mechanical injury to the cervical spine.

The CerviFit strengthening and conditioning program addresses the physician’s and patient’s concerns diagnostically and therapeutically. By establishing the subject’s baseline neck tensile strength and Range of Motion, the physician can objectively monitor an individual’s progress. The patient is seen by the physician or PA (Physician Assistant) bi-monthly insuring compliance, measuring tensile neck strength, ROM (Range of Motion) and modifying the program as needed. This approach has been shown to reduce pain, improve functionality, and return the subject’s quality of life. The CerviFit program utilizing the hand-held Dynamometer, an industry standard in diagnostic objectivity, removes any ambiguity in the objective diagnostic findings.

The Cervifit eight-week, Physician prescribed, and reviewed home rehabilitation and conditioning program results has been consistently reproduced in a multitude of patients with various underlining neuro-orthopedic conditions, which, were validated by the test results and clinical assessments. There is an emerging correlation between the strengthening of musculoskeletal system and the reduction of pain and headaches.
Patient Summary

Patient is a 55-year-old female attorney diagnosed in March 2016 with squamous cell carcinoma and completed proton therapy in June 2016. Patient was formally treated at MD Anderson in Texas and at the time of initial appointment while in remission, suffered from cervical muscular atrophy and weakness caused by the prolonged effects of Targeted Proton Therapy. In addition, patient complained of recurring Migraines, and persistent referred neuropathy.

The Cervifit Strengthening and Conditioning Program was initiated under medical supervision consisting of a 10-week isotonic neck exercise regimen.

Conclusion

When initially evaluated, the subject was unable to lift her head off of the pillow and unable to work. The subject had substantial significant positive results within the first two weeks as documented by the Dynamometer (reference graphs below), which measures a subject’s tensile strength. The progressive, sustained patient anecdotal and objective improvement during the course of the CerviFit program included, increased physical activity, reduction in headaches and neck pain.

At the conclusion of her 10-week home rehabilitation program, there was marked improvement of the subject’s cervical tensile strength and mobility allowing a return to her occupation as an Attorney without any neck weakness or complaints.

CerviFit Program:

CerviFit Device:
Method of Diagnostic Measurement, Handheld Dynamometer:
The dynamometer is an instrument for measuring the force of muscular contraction. The subject(s) tested using this dynamometer were fitted with a custom nylon “halo”. The “halo” or means of attachment was designed to firmly fit around the crown of the subject complete with a “D” ring which was attached on the “pull” side of the device. The device was held by the attending physician and the seated subject was asked to exert as much pulling force as possible. The readings were recorded on the chart below and upon completion of the protocol was entered into an excel spreadsheet with the calculations demonstratively illustrated on the proceeding graphs.
Patient Benchmark Progress Record:

<table>
<thead>
<tr>
<th>Patient:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice:</td>
<td>Attendant:</td>
</tr>
</tbody>
</table>

(Check One)
Session: INITIAL [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] MID [ ] 6 [ ] 7 [ ] 8 [ ] 9 [ ] 10 [ ] FINAL [ ] OTHER: ________________

Pain Cause Type: Traumatic Injury [ ] Posture [ ] Repetitive Activity [ ] OTHER: ________________

How would you describe your pain today?

[ ] Least Pain: ........................................................................................................ [ ] Most Pain: ...

Short Description Cause of Injury (Initial Survey Only - e.g. Car Accident):

________________________________________________________________________

CerviFit Neck Strengthening System

Neck Strengthening System

CerviFit Neck Strength and Conditioning Program on former head and neck squamous cell carcinoma proton therapy Patient. | Jeffery Steinberg, MD
CerviFit Neck Strength and Conditioning Program on former head and neck squamous cell carcinoma proton therapy Patient.

Dynamometer Results:

Cervical Flexion/Dorsal (expressed in Kgs)
CerviFit Neck Strength and Conditioning Program on former head and neck squamous cell carcinoma proton therapy Patient.
Cervical Flexion/Left (expressed in Kgs)
CerviFit Neck Strength and Conditioning Program on former head and neck squamous cell carcinoma proton therapy Patient. | Jeffery Steinberg, MD
Dr. Jeffery Steinberg is a board-certified Neurologist with over 25 years of clinical experience. Dr. Steinberg completed his residency at Kaiser Permanente, Los Angeles, an interventional pain fellowship at University of Louisville, (Veterans Administration) and neurophysiology/ sleep fellowship at Emory University. Professional accomplishments include: Created and former Medical Director of the Memory Center at Memorial Hospital Pembroke Pines, Fl; co-founded Leeza’s Place, a charitable organization supporting caregivers of those afflicted with Alzheimer’s, with TV Celebrity Leeza Gibbons.

Dr. Steinberg is the medical advisor for Anatomical Architects and oversees the rehabilitation protocol on the CerviFit program.

References

(2) Late Effects of Head & Neck Radiation; https://www.oncolink.org/frequently-asked-questions/cancers/head-and-neck/general-concerns/late-effects-of-head-neck-radiation

Proton Therapy for Head and Neck Cancers

Cancerous and non-cancerous tumors can occur in the skull base and neck, and even benign tumors in these areas may cause symptoms or threaten the health and well-being of a patient.

MD Anderson provides comprehensive care for patients who have benign or malignant head and neck tumors. Treatment options include surgery, radiation, chemotherapy, or any combination of the three.

The MD Anderson Proton Therapy Center treats cancers of the:

- Nasal and sinus cavities
- Oral cavity, including the salivary glands, tongue and tonsils
- Larynx
- Eye
- Skull base
- Spine

The power of protons

Proton therapy allows for the effective treatment of complicated head and neck tumors, while minimizing the radiation dose to vital structures such as the eyes, mouth and brain. Vital physical functions such as vision, smell, taste and swallowing remain virtually untouched when a patient is treated with proton therapy.

Many head and neck cancer patients can benefit from the precision of intensity modulated proton therapy, or IMPT, a treatment offered exclusively at MD Anderson. IMPT delivers protons to the most complicated tumors by focusing a narrow proton beam and essentially "painting" the radiation dose onto the tumor layer by layer.

The need to implant a feeding tube during head and neck treatment, which can occur in up to 60% of standard radiation patients, may be avoided in IMPT patients due to less collateral damage to the oral cavity.

Side effects such as nausea, damage to the salivary glands, loss of taste and endocrine disorders are also

This image demonstrates how proton therapy can be more beneficial in sparing important structures on the head and neck area in comparison to traditional radiation (IMRT). In this case proton therapy was able to spare the oral cavity, brain stem, larynx and spinal cord.
reduced with proton therapy. This enables patients to better maintain their weight and hydration, contributing to successful treatment outcomes and substantially improving quality of life both during and after cancer treatment.

**Proton Therapy Clinical Trials**

Clinical trials underway at the Proton Therapy Center are dedicated to understanding the advantages of protons for treatment of head and neck tumors. This includes the first randomized Phase II/III trial comparing IMPT to standard conformal radiation therapy in patients with oropharyngeal carcinoma, which occurs at the back of the throat.

The trial aims to measure proton therapy's ability to reduce a range of side effects common to head and neck cancers.

**EXPECATIONS**

Proton therapy treatment for head and neck cancer typically takes about 15-30 minutes each day and is delivered five days a week for 4-7 weeks. Most patients tolerate it extremely well and can continue to work and exercise during and immediately after treatment is complete.

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Late Effects of Head & Neck Radiation

Last Modified: June 23, 2009

Question:

Dear OncoLink "Ask The Experts," I had radiation for 8 weeks for nasopharangeal cancer that had also gone to a lymph node in my neck. Now over 4 years later, I have some problems with my voice and breathing. My tongue has recently started cramping up on me for 5 or so minutes at a time, and I can’t talk or swallow during this time. My right shoulder is weak, and I can’t lift my arm as I used to and the muscle is gone on top of the shoulder. Is this normal, and is there any treatment that can be done or any medication to stop the tongue from responding this way?

Answer:

Christine Hill-Kayser, MD, Assistant Chief Resident in the Department of Radiation Oncology at the Hospital of the University of Pennsylvania, responds:

Late effects from radiation to the head and neck may be complicated, and may involve several different structures in the regions that were irradiated. The most common late effect of radiotherapy for head and neck cancer is dry mouth. This can occur from damage to the glands that produce saliva. Dry mouth can cause difficulty with swallowing or eating certain types of food. Additionally, chronic dry mouth can cause dental decay that may occur faster than usual. Survivors of head and neck cancer should be followed closely by a dentist, and the dentist may recommend use of fluoride trays to promote dental health. Artificial saliva products may be helpful in relieving dry mouth, as may taking small, frequent sips of water. Radiation to the head and neck may alter the taste sensation, as well. In many cases, taste returns to normal with time, but this is not always the case. Difficulties such as dry mouth and taste alteration may affect a survivor’s ability to take in adequate food. Use of nutritional supplements, such as Ensure or Boost, may be helpful, and nutritional counseling is important for all survivors who may have difficulty eating.

Radiation to the neck may also cause damage to the vessels, nerves, and muscles. Damage to the vessels in the neck may cause increased risk of stroke from atherosclerosis (plaquing) inside the vessels. Because of this risk, survivors of head and neck cancer should be particularly careful to avoid other risk factors for stroke – this includes eating a low-fat, healthy diet and avoiding smoking. Damage to the lymph vessels, which drain fluid from the head and neck, may cause lymphedema. Lymphedema may cause swelling in the neck or face, which may be worse after lying down. Patients with lymphedema may be referred to a Lymphedema Therapist for therapy to address the problems associated with lymphedema.
Damage to the nerves within the head and/or neck is rare after radiation, but does occur in some cases. Damage to the nerves that control the throat may make swallowing difficult. If this occurs, a swallowing study may be performed (video swallow, barium swallow, or both). If a speech and swallow specialist observes swallowing abnormality on a swallow study, s/he may recommend dietary changes to assist with swallowing and prevent choking. Damage to the nerves that control the voice may cause hoarse voice, which may or may not be permanent. Damage to the nerves that control the arms can also occur from radiation to the head and neck. This may occur from damage to a nerve structure called the brachial plexus, and may result in weakness of one arm or shoulder. Patients who develop arm weakness should be referred to a Physical Therapist; they may also be referred to a Neurologist for testing of nerve and muscle function. Very rarely, the nerves that control the tongue may be damaged by radiation. This may cause uncomfortable “spasms” of the tongue. Patients who develop painful motions or spasms of the tongue should be evaluated by a speech and swallow specialist, and may also be referred to a neurologist for testing of nerve and muscle function.

Damage to the muscles in the neck may also occur after radiation. Usually, damage to the muscles results in atrophy, or decrease in size of the muscles on one or both sides of the neck. The muscles and soft tissue may also develop a hard or “woody” texture. Some survivors will develop longer, thinner-appearing necks that are not as strong as they were before treatment due to muscle atrophy, resulting in difficulty holding their head up for long periods. Some practitioners will prescribe a brace or physical therapy to help with this condition.

Some practitioners may recommend a combination of medicines to address hardening, or fibrosis, of tissues of the head and neck, including pentoxifylline (Trental) and vitamin E. Survivors interested in medical treatment for changes in the tissues of the neck may discuss these medicines with an oncology specialist with expertise in treating head and neck cancers.

You can learn more about late effects due to cancer treatment by creating your own OncoLife Care Plan (https://oncolife.oncolink.org).
A Comprehensive Review of Head and Neck Cancer Rehabilitation: Physical Therapy Perspectives

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Abstract

Rehabilitation in relation to cancer can be preventative, restorative, supportive, and palliative. It is recognized that patients may have rehabilitation needs throughout their care pathway. The role of physiotherapy in the cancer rehabilitation is less understood and particularly in the head and neck cancer (HNC) patients. This results in various residual deformities and dysfunctions for the patients with HNC. The objective of this review is to provide detailed information regarding the problems faced after the cancer treatments and rehabilitation of patients who suffered with HNC. The fact that cancer patients are facing several months of chemotherapy and/or radiotherapy and usually major surgery, as well as the direct effect of immobility due to pain, means that muscle wasting, joint stiffness, as well as de-conditioning and fatigue are inevitable. The absence of physiotherapy intervention would be detrimental to patient care and the ability of the patient/family to cope with the effects of the disease or its treatment on their functional capacity and quality of life. Following any treatment for HNC, physical therapy may play an essential role in preventing various complications and helping patients to mitigate impairments, and restoring function of the shoulder joint, neck, and face.
**Keywords:** Cancer rehabilitation, Head and neck cancer, Palliative care, Physical therapy

**INTRODUCTION**

Cancer is a leading health problem in India, with approximately 1 million cases occurring each year. Over 200,000 cases of head and neck cancer (HNC) occur each year in India versus 30,000 for the USA. Cancer accounts for 8% of the deaths in India. Incidence of HNC primaries has shown to increase with age. Although the functional and cosmetic deficits are very apparent in HNCs, this group of cancers accounts for only 5% of all malignancies.

Worldwide, it is considered to be the fifth most common cancer with the seventh highest cancer mortality. The most commonly listed causes of HNCs are tobacco and alcohol abuse. It is also suggested that use of alcohol in concert with smoking is among the most common etiologic factors of HNCs. Other reasons include exposure to different HNC-inducing agents, such as betel chewing, hot tea, smoking, alcohol consumption, and human papilloma viruses.

Yeole made an attempt to study the trends in the age-adjusted incidence rates for the sites of HNCs in Mumbai, Bangalore, Chennai, Delhi, Bhopal, and Barshi registries’ populations. He found the clear trend of cancer of the tongue, oropharynx, and larynx where bidi smoking is the dominant risk factor could be explained on the basis of available data.

Oncologists and scientists have made substantial progress in cancer treatment in the last few decades. As both the number of cancer survivors and the length of their survival are increasing, long-term health issues related to cancer and its treatment are becoming more important. To achieve such excellent outcomes many patients receive aggressive treatment, including surgery, chemotherapy, and radiation therapy.

**CANCER-RELATED PROBLEMS**

The problems that occur in relation to the cancer disease and its treatment vary with the type of cancer, disease stage, and type of medical treatment. Difficulties may develop in the period between diagnosis and primary treatment, during primary treatment, and during follow-up.

The shoulder disability and chronic neck pain occurs following radical neck dissection. In radical neck dissection the sternocleidomastoid and
omohyiod muscles, the spinal accessory nerve, the anterior, external, and internal jugular veins, and the external maxillary artery are excised, along with the lymphatic groups in the anterior and posterior triangles. In comparison, a modified radical neck procedure removes the same muscles and lymphatics and the internal jugular vein but spares the spinal accessory nerve. A functional neck dissection removes only the lymphatics and spares all muscles, nerves, and vessels.

Van Wilgen et al.[17] found that reduced shoulder abduction, shoulder pain, and neck pain are related to several domains of quality of life (QOL) at least 1 year after surgery. Acute complications are wound infections, chyle leakage, and postoperative morbidity, such as cardiac problems and thrombosis.[18,19] The most common late complications are shoulder disability, shoulder pain, reduced cervical mobility, and lymphedema.[17,20–22] Decreased cervical range of motion (ROM), lymphedema, swallowing, mouth opening, and shoulder disability are regarded as late complications. None of these parameters appear to be related to reduced survival, but most of them are considered to be associated with reduced QOL.[23–27]

Giuliano et al.[18] found the overall postsurgical complication rate of 50%. The death rate was 3.6%. Forty-seven patients (42.7%) were electively referred to the intensive care unit (ICU). The occurrence of postoperative complications was associated with extended clinical severity stage ($P = 0.02$), type of surgery ($P = 0.03$), ICU ($P = 0.03$), type of reconstruction ($P = 0.02$), Functional Severity Index ($P = 0.03$), neck dissection ($P = 0.002$), and Acute Physiology and Chronic Health Evaluation II (APACHE II) ($P = 0.008$).

**REHABILITATION**

The term “rehabilitation” refers to a process aimed at enabling persons with disabilities to achieve and maintain their optimal physical, sensory, intellectual, psychiatric, and/or social functional levels, thus providing them with the tools to adapt their lives toward a higher level of independence.[28] Rehabilitation does not focus on a prolongation of survival but rather on an improvement of the patient's QOL. This is also the goal of palliation. The difference between rehabilitation and palliation can be found in the fact that rehabilitation attempts to re-establish impaired functions), while palliation focuses on the alleviation of symptoms. Traditionally, once disease-modifying cancer treatment options have been exhausted, patients move to palliative care. Because of its initial ties to the
modern day hospice movement, palliative medicine has been loosely defined as hospice care, terminal care, and end-of-life care.\cite{29,30}

Interdisciplinary team\cite{18,31} involved in the Cancer Rehabilitation consists of Physician, Rehabilitation nurse, Physical therapist, Occupational therapist, Prosthetist-orthotist, Nutritionist, Speech therapist, Psychologist, Vocational counsellor, Social worker, and Recreational therapist.

The rehabilitation takes place in various stages in different forms,\cite{32} such as Preventive rehabilitation therapy is started early after the diagnosis of cancer is made, where no significant physical impairment exists, but therapy is started to prevent functional loss. Restorative rehabilitation therapy is directed at the comprehensive restoration of maximum function for patients who have a residual physical impairment and disability. Supportive rehabilitation therapy attempts to increase the self-care skills and mobility of the cancer patient with physical exercises to prevent the effects of immobilization, such as joint impairments, muscle atrophy, weakness, and pressure scores. Palliative rehabilitation therapy aims to increase or maintain the comfort and function of patients with terminal cancer by improving their wellbeing, giving pain relief, avoiding joint impairments and pressure sores, and to provide at least partial self-sufficiency.

An important finding was that rehabilitation was underused in the population studied.\cite{33} Reasons for underuse may include the failure of the acute care staff to identify functional impairments, lack of appropriate referral for rehabilitation, lack of awareness of rehabilitation services, and lack of knowledge among family members. These barriers can be overcome by providing education and by enlisting the cooperation of the clinical oncology staff, whose background in rehabilitation and functional issues may be limited or underemphasized.

Of importance, all practitioners must keep in mind that, after the patient's condition is stabilized and after he or she is discharged from the hospital, rehabilitation services must be considered on an outpatient or home-based basis to maintain gains and to prevent further deconditioning. At present, the vast majority of patients are never referred for rehabilitation follow-up after discharge.

**Role of physiotherapy**

Role of physiotherapy in the cancer rehabilitation is less understood and particularly in the HNC patients. This results in various residual deformities and dysfunctions for the patients with HNC. The role of the physiotherapist in palliative care include that they work with respiratory, neurologic, lymphatic,
orthopedic, musculoskeletal symptoms and complications, pain, and hemotologic conditions.[34] Common interventions they utilise are positioning for prevention of pressure sores; Trans-cutaneous electrical nerve stimulation (TENS) for pain control; neurologic rehabilitation in peripheral neuropathies; mobility training to enhance the exercise tolerance, maintenance, and independence; passive/active range of movement to prevention of contractures; and individual designed exercise programs for maintaining the general health of the patient.[35]

During the rehabilitation of these patients, it is of primary importance to unload the shoulder immediately postoperatively, reduce shoulder and neck pain, and prevent stretch fibrosis of the trapezius and contracture of the unopposed pectoralis muscles, as well as to provide strengthening exercises for the residual muscles in the neck and shoulder girdle to compensate for lost muscles.[36] Postoperative physiotherapy includes prevention and management of the respiratory complications, such as respiratory distress and excess secretions; cardiovascular complications, such as deep vein thrombosis and dependent edema; and musculoskeletal complications, such as joint and muscle tissue stiffness and weakness in the face, neck, and shoulder.[37]

Sufficient wound healing should occur in 10–14 days to allow patient to begin the exercise program for the shoulder and neck. Prior to this it is imperative that the patient be cognizant of proper positioning for the affected shoulder and neck areas. While the patient is seated, the shoulder and the upper arm should be supported on a pillow or the arm chair to prevent further stretching of the trapezius. The start of the exercise program may be delayed in patients with delayed wound healing or fistula formation and those in danger of carotid “blowout.” The risk of carotid blowout is critical approximately 2 weeks after surgery and is the result of arterial disease, radiation effects, or removal of the carotid sheath. This is, unfortunately, the time at which most ROM/strengthening exercises are scheduled to begin. The physical therapist must be ready to modify the exercise program to protect the patient during this critical period, as a blowout of the carotid is potentially fatal.

Thorsen et al.[38] observed the effect of physical activity shortly after chemotherapy and found VO2 max increased by 6.4 mL/kg/min in patients in the intervention group who received physical activity and by 3.1 mL/kg/min in patients in the control group ($P < 0.01$). The fatigue score decreased by 17.0 points in the control group compared with only 5.8 points in the intervention group ($P < 0.01$).
Therapeutic exercises are initially passive but gradually progress to active-assistive and eventually resistive exercises as tolerated by the patient. Strenuous physical activities, such as lifting, carrying, pulling, and pushing, should be avoided initially but may be resumed in the course of time as the physical condition improves.[16]

Additionally, the physical therapist can help by training other muscles to assist with shoulder function.[39–41] The levator scapulae, through their action as scapular elevators, can be trained to help maintain level shoulders. Patients are instructed to work on these exercises in front of a mirror. The action of scapular retraction can be assumed by the rhomboids, which results in a balanced counter pull to the action of pectoralis major. The serratus anterior should be strengthened to assist with scapular stabilization during shoulder flexion and abduction.

Training in Activities of daily living (ADL) is initiated approximately 1 week postoperatively. Prior to discharge, a decision is made as to whether the patient requires a permanent orthosis or other assistive devices to compensate for lost function. After discharge, most patients are referred for continued therapy and are given specific instructions for exercise and other activities at home.[40]

**Common complications and physiotherapy management**

Disorders of pain, weakness, debility, deformity, and dysfunction in persons with cancer result from the direct and indirect effects of cancer or its treatment. The common complications of HNC and its treatment which require physiotherapy assessment and rehabilitation are as follows:

**Spinal accessory nerve palsy** Some degree of weakness can be elicited in most patients on the side of the neck dissection. The spinal accessory nerve may be entirely spared or subject to neurapraxic, axonotmetic, or neurotmetic insult, all with different rates and degrees of recovery.[13,41] Additionally, electrocautery of blood vessels can undermine blood supply to the vasa nervorum, producing ischemic injury.[42] Specific deficits may include a painful shoulder, trapezius muscle paralysis resulting in a rotated scapula, and loss of range in the shoulder.

Martin *et al.*[43] assessed the scapular flip sign 20 subjects (13 male, 7 female) presented with pain and decreased shoulder function following head and neck surgery or posttrauma and found the symptoms, including trapezius atrophy, shoulder girdle depression, limited active shoulder abduction to less than 90°, shoulder pain, and shoulder weakness.
The timing and intensity of rehabilitation should be guided by patient's prognosis for recovery.[44] Spinal accessory nerve re-innervation can continue over 12 months following surgery. Important elements of spinal accessory nerve rehabilitation include the following[45]:

- Prevention of frozen shoulder through active ROM and active-assisted ROM;
- Prevention of anterior chest wall flexibility deficits through trunk mobility exercises;
- Strengthening of alternate scapular elevators and retractors[13];
- Instruction of compensatory techniques for activities requiring sustained shoulder abduction and forward flexion;
- Neuromuscular retraining of shoulder girdle muscles;
- Preservation of trapezius muscle tone through electrical stimulation[14] if reinnervation is anticipated;
- Postural modification and re-education; and
- Providing shoulder support[12] to allow recovery of the levator scapulae.

Susan et al.[46] proved that the patients undergoing neck resection with sparing of the nerve may experience a return of shoulder function and that physical therapy may play a role in recovery. They explained this with a 50-year-old man with a history of Burkitt's lymphoma presenting with right upper extremity weakness, treated in physical therapy with ROM and strengthening exercises who demonstrated an increase in shoulder strength, ROM, and function.

Patients with complete, persistent spinal accessory nerve palsy can be fitted with an orthosis. For patients plagued by levator scapulae fatigue and spasms, a “shelf” orthosis designed to encircle the waist, and to provide a ledge on which patients can rest their affected arms when not in use, reduces symptoms.[47]

**Cervical contracture** Progressive fibrosis of the anterior and lateral cervical soft tissue may be highly problematic for HNC patients, particularly those who receive external beam radiation.[41] Christine et al.[48] explained the complications of the radiation therapy, which results in imaging findings of tissue edema followed by fibrosis, scarring, and atrophy. Complications from radiation therapy can occur months to years after treatment.

Proactive ROM in all planes of neck motion should be initiated as soon as safely possible and can be continued throughout radiation therapy in the absence of significant skin breakdown. Irradiated patients should perform ROM twice daily during the first 2 years following cancer treatment and daily thereafter. After
surgery, the delicate balance between flexibility[25,49,50] and wound healing must be respected. For optimal results, patients should be taught to provide additional stretch during end-range lateral bending or rotation by exerting additional pressure with the contralateral hand. Stretches should be held for 5 deep breaths and repeated between 5 and 10 times per session.

Isometric strengthening of the cervical extensors, and postural modifications with visual cuing, is beneficial. Manual fibrous release techniques are indicated when ROM is restricted by robust soft tissue fibrosis or tethering of the skin to subdermal tissues. Patients can be taught self-massage to augment the efficacy of ROM activities. Compression garments, either off the shelf or customized, are a convenient means of applying compression. Custom-cut foam pieces strategically inserted can achieve greater focal pressure on stubborn areas. Constant vigilance must be maintained to ensure that friable, irradiated skin is not compromised.

**Pain** Up to 60% of patients at all stages of the disease process experience significant pain.[11] Most of this pain can be adequately relieved by oral analgesics. Unrelieved pain can be a risk factor for suicide in cancer patients.[49] Multiple pain disorders may be present simultaneously in a patient. Correct determination of the cause or causes of pain is essential to its successful treatment.[41]

Breivik *et al.*[50] found that 56% of the 5084 adult patients they contacted, suffered moderate-to-severe pain at least monthly. They found that out of 573 patients, 320(55%) were receiving prescription-only analgesics, with 192/437 (40%) taking strong opioids either alone or with other drugs for cancer-related pain. Of those prescribed analgesics, 281 (63%) experienced breakthrough pain. In all, 396 (69%) reported pain-related difficulties with everyday activities.

Treatment of pain disorders often involves a multimodality approach that may include physical or occupational therapy, medications, and interventional procedures.[51] Physiotherapy can include therapeutic exercises, active or passive mobilization techniques, graded and purposeful activity, relaxation, distraction, postural re-education, positioning, mobility, TENS, heat or cold, and massage therapy.[31] Massage for pain relief can have an effect on complex behavioral patterns as well as the simple perception of pain, although this is mainly derived from empirical work.[52] Exercises commonly increase the subject's awareness of posture, motion patterns and breathing and are designed to heighten the patient's perception of the areas where pain originates and are a basis for active processing of pain by the patient.[53]
**Shoulder disability** Shoulder disability refers both to impaired mobility in the shoulder joint and to pain in the shoulder region after neck dissection. This is a well-known and common morbidity,[54] leading to denervation of the trapezius muscle and neuropathic pain with secondary effects in the shoulder, such as adhesive capsulitis and myofascial pain in muscles around the shoulder.[20,55]

Shoulder analysis following neck reconstruction with the pectoralis major pedicled flap (PMPF) by Moukarbel *et al.*[56] showed a significantly reduced flexion angle ($P = 0.043$) and combined internal/external rotation angle on the operated side ($P = 0.027$) and a significant strength reduction for the flexion, external rotation, and adduction domains ($P < 0.05$). SPADI score analysis showed a significantly higher disability score ($P = 0.017$) and total score ($P = 0.009$) on the PMPF side.

This leads to problems in daily activities and a reduced QOL.[24] Lauchlan *et al.*, [57] found while investigating the impact of preventative rehabilitation to prevent shoulder disability in HNC population that out of 32 subjects, the patients received a course of early physiotherapy for a period of 3 months following surgery rated their physical wellbeing higher than those subjects not undergoing rehabilitation.

**Trismus/temporomandibular joint dysfunction** The temporomandibular joint (TMJ) dysfunction includes fibrosis[58] due to radiotherapy, scarring, weakness and atrophy of the muscles producing the movements after surgery, and intra-articular damage due to radiotherapy and surgery, which leads to the stiffness of the joint. So the patients may feel difficult in the mouth opening, mastication, and speech.[58,59] Other problems include headaches, usually at the temples and side of head, vague tooth soreness or toothaches, which often move around the mouth, pain and fatigue when eating hard or chewy foods, clicks, pops, or grinding sound in jaw joint, and cervical neck tension and pain.

Weber *et al.*[60] measured the maximal inter-incisal mouth opening (MIO) in patients treated with surgery and radiation/chemoradiation for HNC and found about 50% of the patients had a limited mouth opening (<36 mm); and patients with oropharyngeal cancer had a significant higher risk for trismus ($P = 0.024$) than patients with other HNCs.

The rehabilitation for preventing reduced mouth opening mainly concentrates on programs using different jaw-stretchers or mouth-opening exercises.[61–64] Different devices are available for jaw stretchers, such as Therabite, the TMJ exerciser, and the Acute Medic jaw trainer and stretcher.[65,66] Physical therapy
can help relax the muscles, increase joint flexibility, and the other oro-motor exercises[67] The occlusal splint will help to rest and should not chew gum, biting nails, clenching teeth together while awake, or any other nonfunctional jaw habits (eg, pencil chewing).

Diet should be fairly soft, and chewy and crunchy foods should be avoided during treatment. Moist heat is very helpful for the sore muscles of TMD. Jaw and neck exercises, which will help the muscles stretch. Passive joint mobilization, re-education of the jaw movement, scar mobilisation, and strengthening exercises to the jaw muscles play vital part after the surgery or chemoradiotherapy.[68]

Van der Molen et al.[58] compared the effects of two rehabilitation programs on pre- and post-treatment MIO, and found significant decrease over time (from 50 to 47 mm, respectively; \( P < 0.01 \)), but not in occurrence of trismus (MIO 35 mm; from 5 to 7 patients; \( P = 0.70 \)). Even the pain scores (no, mild, moderate, and severe pain) did not vary much (\( P = 0.42 \)).

Some therapies may be preventative and may begin prior to and continue throughout treatment. For example, the patient who receives radiotherapy and chemotherapy needs oral ROM exercises to maintain movement of the lips, tongue, and jaw. Initiate these exercises prior to radiation therapy and advise the patient to continue doing the exercises 4–6 times daily, if possible, for 5–10 min each time throughout the course of radiation and for at least 3 months thereafter. [68]

**Fatigue** Fatigue is the most common symptom experienced by the cancer patients.[41] The prevalence of fatigue ranges from 70% to 100% contingent on the type and stage of cancer and is related to whether patients are receiving antineoplastic therapy.[69–73] Fatigue reduces the energy, mental capacity, functional status, and psychologic resilience of cancer patients. Anemia has received the greatest attention as a source of fatigue.[74]

Janaki et al.[75] evaluated the magnitude of fatigue in cancer patients receiving radiotherapy and its relative impact on QOL. Fatigue was present in 87.8% of patients initially and increased gradually over the course of radiotherapy and peaked in the last week. There was significant reduction in the functional scores \( (P < 0.001) \) of QOL, impairment of cognitive function \( (P = 0.059) \) along with significant reduction of social function \( (P < 0.001) \) and global health status \( (P < 0.001) \).

Rehabilitation exercises including physical and occupational therapy may be of help along with mild exercises or walking to overcome fatigue.[76,77] Mild to
moderate exercise to help promote energy are a boost for QOL even though they may feel tired.[78]

Dimeo et al.[78] found that all the patients experienced a clear reduction of fatigue and could carry out normal daily activities again without substantial limitations with an improvement in maximal physical performance (from $6.4 \pm 0.4$ km/h to $7.5 \pm 0.9$ km/h, $P < 0.05$) and maximal walked distance (from $1640 \pm 724$ m to $3300 \pm 953$ m, $P < 0.05$). Heart rate and lactate concentration by an equivalent submaximal workload (5 km/h) were significantly reduced (from $138 \pm 21$ beats/min to $113 \pm 20$ beats/min, $P < 0.05$, and from $2.6 \pm 1.4$ mmol/L to $1.3 \pm 0.6$ mmol/L, $P < 0.05$).

An important thing is to avoid too much rest and overexercise, which may cause fatigue by using important energy stores, lack of exercise can also cause fatigue through physical deconditioning and deterioration. In general, patients with anemias characterized by hemoglobin lower than 8 g/dL should not participate in physical or occupational therapy unless cleared to do so by a physician.[79,80]

Knols et al.[81] reviewed the evidences systematically from 34 randomized clinical trials and controlled clinical trials examining the effectiveness of physical exercise in improving the level of physical functioning and psychological wellbeing of cancer patients during and after medical treatment and summarized that cancer patients may benefit from physical exercise both during and after treatment. However, the specific beneficial effects of physical exercise may vary as a function of the stage of disease, the nature of the medical treatment, and the current lifestyle of the patient.

**Lymphedema**

Because surgery, radiation, and/or chemotherapy disrupt lymphatic structures, damage soft tissue leading to scar tissue formation and fibrosis, and further affect lymphatic function, patients with HNC may be at a high risk for developing secondary lymphedema.[82]

Deng et al.[82] found 75.3% (61 of 81) of the patients with HNC who were 3 months or more posttreatment had some form of late-effect lymphedema. Of those, 9.8% (6 of 61) only had external, 39.4% (24 of 61) only had internal, and 50.8% (31 of 61) had both types.

Edema in the head and neck region causes a dull pain and facial disfigurement, and in extreme cases lips and eyelids can be so swollen that vision and eating is impaired.[83] Lymphedema therapy consists of sequential manual lymphatic
drainage of the edematous region according to Vodder's technique.[84,85] This can be combined with compression garments.[86]

Conservative therapy of lymphedema involves a two-stage treatment program. [87,88] The first phase consists of skin care, manual lymphedema treatment, remedial exercises, and compression applied with multilayered bandage wrapping. The bandaging achieves high tissue pressures during exercise but low pressures at rest.[89] Simple elevation of a lymphedematous limb reduces swelling. Patients should be instructed to avoid heat, cold, local compression or excessive exercise of the affected arm. A specific exercise program performed once a day is aimed at augmenting muscular contraction, enhancing lymphatic flow and joint mobility, strengthening the limb and reducing the muscle atrophy. Phase 2 (initiated immediately after phase 1) consists of compression by low-stretch elastic stockings or sleeves, skin care, remedial exercises, and repeated manual lymphedema treatment as necessary.

Piso et al.[85] tested a series of 10 manual lymphatic drainage, which were initiated and completed early after surgery in 12 cancer patients for 6 weeks and suggested that sequential therapy of manual lymphatic drainage and compression garments can significantly reduce early postoperative edema after curative surgery for orofacial tumors.

A prescription for low-stretch garments (custom made with specific measurement as needed) worn during the day to preserve the results of manual lymphedema treatment is essential. In principle, the highest compression level (usually 40–60 mmHg) tolerated by the patient is likely to be the most beneficial.[90] Compliance is essential in maintaining subsequent lymphedema reduction following conservative therapy.[91,92] Psychological support and QOL improvement program is an integral component of any treatment of lymphedema. [93]

**Chemotherapy-induced neuropathy** Patients receiving specific types of neurotoxic chemotherapeutic agents may develop peripheral neuropathy that can result in sensory, motor, and/or autonomic deficits. While some patients’ deficits will resolve quickly after cessation of chemotherapy, others have a persistent peripheral polyneuropathy that may impact strength, balance, and function.[94,95]

Currently, numerous drug therapies are being tested to prevent and treat chemotherapy-induced peripheral neuropathy (CIPN).[96] but rehabilitation professionals lack a body of evidence to guide their intervention in individuals with CIPN. Exercise and occupational therapy can restore function in extremities,
but studies of their effectiveness have mostly been done in the early treatment phase. Exercise can also enhance balance, strength, and safety, and braces can be used to support weak muscles.[97]

**Swallowing difficulty** Dysphagia due to the trauma to the upper aerodigestive tract during treatment of HNC is associated with aspiration with an increased risk of pneumonia[98,99] and a reduced QOL.[100] The main reasons for swallowing problems in HNC patients after radiotherapy are thought to be reduced tongue strength, reduced laryngeal elevation, reduced tongue base retraction during swallowing, and fibrosis of the muscles involved in swallowing.[101,102]

Weber et al.[60] measured the MIO in patients treated with surgery and radiation/chemoradiation for HNC and found about 50% of the patients had a limited mouth opening (<36 mm). Patients with oral cancer report about problems with opening the mouth (73%), eating (65%), drinking (73%), xerostomia (92%), speech disorders (68%), and voice (62%).

Most rehabilitation programs concentrate on maintaining tongue strength, tongue mobility, and the mobility of the larynx.[103] In the rehabilitation program, the exercises consisted of tongue mobility and stretching and the Mendelson's maneuver (holding the larynx in its most supine position during swallowing, for 2–3 s during each swallow).[104,105]

**Exercise and cancer**

Physical activity seems to be useful in the rehabilitation process for cancer patients. Impaired physical capacity can be explained by several factors, such as tumor toxicity and the treatment of cancer, including surgery, chemotherapy, and radiotherapy, which may induce cardiorespiratory and musculoskeletal deconditioning.[81]

Weert et al.[106] made a 15-week rehabilitation program, including individual exercise, sports, psychoeducation, and information for cancer survivors (n = 63) and found significant improvements on health-related QOL with effect sizes varying from 0.38 to 0.99 RAND-36 (a 36 item survey tool to assess the Health-Related Quality of Life, created by RAND Corporation) and from −0.34 to −0.57 Rotterdam Symptom Check List (RSCL), most persistent at 3-month follow-up. Furthermore, significant improvements in exercise capacity and muscle force of upper and lower extremities and 80% of the patients prior to start and 58% of the patients after completion of the program indicated that they preferred the entire multidimensional program.
The role of exercise in oncologic rehabilitation programs has far been mostly limited to physical treatment addressing specific impairments caused, by disease or surgery. Moreover, recent studies have shown that physical activity may improve both the quality of life and mood and the physical performance of cancer patients during and after treatment.[107]

Dimeo et al.[108] observed a significant increase of physical performance (workload at the anaerobic threshold pre 61.6 ± 26 W, post 78.6 ± 31 W, \( P < 0.0001 \)) and reduction of global fatigue (Functional Assessment of Cancer Therapy: pre 45.7 ± 13.4, post 52.6 ± 12.4, \( P < 0.0001 \); Brief fatigue inventory (BFI): pre 37.9 ± 18.3, post 31.2 ± 17.1, \( P < 0.001 \)) due to the effects of an endurance and resistance exercise program on persistent cancer-related fatigue.

Physical exercise is perhaps the most important therapeutic modality in the rehabilitation management of physical disabilities.[109] Muscle-strengthening exercises may be either isometric, isotonic, or isokinetic. Isometric exercise does not involve joint motion, and so is prescribed for painful or unstable body parts, whereas isotonic exercise involves joint motion against variable resistance.[15] Isokinetic exercise, a most effective strengthening exercise, involves the use of specific devices (e.g., the Cybex apparatus) to maintain constant speed of motion independent of the force applied.[110] Task-oriented exercises, such as ambulation or training in self-care, may improve function and safety by repetition and prolonged therapy. Aerobic exercise has been shown to increase the performance status in breast cancer patients treated with conventional chemotherapy.[111–117]

Dimeo et al.[118] found significantly higher maximal physical performance at discharge in the trained cancer patients receiving high-dose chemotherapy (\( P = 0.04 \)). Duration of neutropenia (\( P = 0.01 \)) and thrombopenia (\( P = 0.06 \)), severity of diarrhea (\( P = 0.04 \)), severity of pain (\( P = 0.01 \)), and duration of hospitalization (\( P = 0.03 \)) were reduced in the training group. They suggested that aerobic exercise can be safely carried out immediately after high-dose chemotherapy and can partially prevent loss of physical performance.

Furthermore, a reduction of treatment-related complications has been observed in cancer patients participating in exercise programs during cancer treatment.[118] Finally, preliminary evidence suggests that regular physical activity may improve immune function. Therefore, exercise could play a potential role as complementary therapy for cancer patients during and after treatment.

**CONCLUSION**
Management of cancer appropriately focuses on prevention, early diagnosis, and cure, but following effective treatment, most cancer patients experience some physical impairment that results in a physical disability or a handicap. As the prognosis for most types of cancers improves, it becomes more important to ensure that all cancer patients regain maximum function in the broadest sense to ensure return to all former roles. Multidisciplinary rehabilitation, therefore, is an integral part of the total management of the cancer patient. The exact functional deficits need to be identified for each patient and proper rehabilitation interventions should started promptly or at the same time as other treatments.

Footnotes

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REFERENCES


53. Willick SE, Herring SA, Press JM. Basic concepts in biomechanics and musculoskeletal rehabilitation. In: Loeser JD, Bugler SH, Chapman CR, Turk DC,


801. [PubMed: 14584059]


**Figures and Tables**
Table 1

<table>
<thead>
<tr>
<th>Disease</th>
<th>Chemotherapy</th>
<th>Radiotherapy</th>
<th>Surgery</th>
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<tbody>
<tr>
<td>Pain</td>
<td>Nausea, vomiting, fatigue, malaise, myalgia, neutropenia, thrombocytopenia, anemia, osteoporosis, and neurotoxicity</td>
<td>Can damage bone, ligament, tendon, muscle, nerve, blood and lymphatic vessels. The damage may be acute or develop and progress many years after treatment</td>
<td>Lead to medical debility, damage to the central or peripheral nervous systems, deficits of swallowing, and other musculoskeletal disorders</td>
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Vision, hearing, balance, taste, respiration, swallowing and smell can be altered or impaired.