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Unilateral Diaphragmatic Paralysis after Thyroid Surgery

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갑상선 수술 후 발생한 편측 횡격막 마비 1예

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= **국문초록** =

갑상선 암 진단과 치료기술이 발전하면서 최근 그 수술 건 수가 급격하게 증가하고 있다. 하지만이와 관련된 합병증과 부작용을 면밀하게 평가해야 할 필요 역시 점차 늘어나고 있다. 갑상선 암 수술 후 발생할 수 있는 드문 합병증의 하나로 횡격막 신경마비(phrenic nerve paralysis)가 있다. 이러한 횡격막신경마비는 대부분 증상이 경미하고 쉽게 호전되어 임상적으로 크게 중요하게 다루어지지 않았다. 하지만, 갑상선 수술 후 갑작스런 호흡곤란이 발생한다면 횡격막 신경마비에 의한 횡격막 마비(diaphragmatic paralysis)와 관련되었을 가능성을 놓치지 말아야 한다. 저자들은 최근 갑상선암 수술 후 발생한 호흡곤란으로 2년 동안 심각한 호흡곤란을 호소하던 73세 여자환자에서 투시촬영(fluoroscopy) 상 편측으로 상승되고 운동성이 저하된 횡격막을 확인하여 일측성 횡격막신경마비(Unilateral phrenic nerve paralysis)를 확진 하였다. 갑상선수술 후 발생하는 일측 횡경막 신경마비는 임상에서 드물게 관찰되는 수술 합병증이기에 환자는 상당기간 이에 대한 감별이 제대로 이루어지지 않았다. 우리는 횡격막 마비의 조기 진단과 적극적인 치료를 통하여 심한 호흡곤란을 호소하는 환자의 증상 및 병의 경과를 호전 시킬 수 있었다.

중심 단어 : 횡격막 마비 · 횡격신경 · 갑상선 유두암 · 갑상선 수술.

Introduction

In Korea, the incidence of thyroid cancer has increased continuously since 1996, becoming one of the most common types of cancer in 2010.[1)] As such, the number of operations to treat thyroid cancer is increasing annually.[1)] Accordingly, there has been a gradual increase in the need to evaluate complications and side-effects associated with thyroid cancer surgery. The typical complications of thyroid surgery are laryngeal nerve paralysis and hypoparathyroidism, with occurrences of 2−5% and 1−4%, respectively.[2)]

Approximately 0.4% of patients with isobilateral recurrent laryngeal nerve paralysis also experience acute respiratory distress due to adduction of the vocal cords.[3)] However, an additional report assessing clinical precautions for the occurrence of dyspnea-related damage of the phrenic nerve during thyroid surgery reported that the occurrence of unilateral phrenic nerve paralysis was 5.5%.[4)] Phrenic nerve paralysis is one of the reasons for dyspnea that is commonly disregard-

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ed ; therefore, it is necessary to determine whether phrenic nerve paralysis and inexplicable dyspnea are present.

In this study, we confirmed the diagnosis of unilateral phrenic nerve paralysis by identifying the unilateral increase and reduced mobility of the diaphragm, measured with fluoroscopy, in a 73-year-old female patient who had complained of severe difficulty breathing for 2 years following thyroid cancer surgery.

1. Patient

A 73-year-old female patient visited our hospital with a chief complaint of dyspnea. She had been diagnosed with thyroid papillary cancer(right thyroid, upper pole, 1 cm sized) with right lymph node metastasis in right level III(T3N1M0), 2 years previously and had been treated by thyroidectomy with right modified radical neck dissection (total thyroidectomy with both central neck dissection with lymph node dissection level II III IV) ; she was also taking 150 μg/day levothyroxine. After surgery, the patient had to sleep sitting upright due to exacerbated dyspnea when in the supine position. She was prescribed alprazolam 0.25 mg twice daily due to continuous anxiety syndrome caused by consistent sleep disturbance. There was no medical history of significant chronic illness, such as high blood pressure, diabetes, or tuberculosis, and no significant family medical history.

At presentation, the results of the physical examination of the patient were as follows : height 150 cm, weight 66 kg, blood pressure 130/80 mmHg, pulse 70 beats per minute, body temperature 36.5℃, respiration rate 20 times per minute, and 98% oxygen saturation, as measured by pulse oximetry. Examination by stethoscopy revealed that the pulmonary sound of the lower part of the right lung was decreased, yet not significantly. No other specific abnormalities were observed. The laboratory results were as follows : white blood cell count 5840×103/μL(seg 45.8%), hemoglobin(Hb) 12.3 g/dL, aspartate aminotransferase/alanine aminotransferase(AST/ALT) 28/23 U/L, blood urea nitrogen/serum creatinine(BUN/Cr) 14/0.5 mg/dL, C-reactive peptide(CRP) <0.3 mg/dL, thyroid stimulating hormone(TSH) 0.06 μU/mL, and free-T4 2.05 ng/dL.

A pulmonary function test was then performed to identify the reason for dyspnea. Forced vital capacity(FVC) was 1.64 L(73% of the normal predictive value) and forced expiratory volume in one second(FEV1) was 1.39 L(90% of the normal predictive value). The ratio between FVC and FEV1 was 72%, and no other abnormalities were observed other than a minor restrictive disorder. The results of a DLCO(carbon monoxide diffusing capacity) test were normal. Her 6 minute gait test result was 418 m, and Borg Scale was 4 points. No specific abnormalities were observed on gastroscopy, echocardiography, coronary angiogram CT scan, or chest CT scan, which were all conducted to rule out any other reasons for the dyspnea.

The symptom transition signs pre- and post-operation were identified in detail to determine the cause of dyspnea in the patient. Immediately after surgery, she showed symptoms of dyspnea, which remained constant without further deterioration or improvement. Therefore, we determined that dyspnea could be related to a surgical complication. As such, all of the previous radiology results associated with the chest were verified sequentially. Two weeks after the operation, a right diaphragmatic line was elevated significantly on a chest X-ray (Fig. 1B) compared with the pre-operative chest X-ray(Fig. 1A). Subsequent images obtained 1 year after surgery demonstrated the continual increase of the right diaphragmatic line(Fig. 1C). Chest CT scans performed 2 and 9 months after the operation also identified segmental atelectasis on the right middle lobe, which is located next to the right diaphragm and right lower lobe(Fig. 2). Therefore, we suspected that the patient had clinically significant diaphragmatic dysfunction

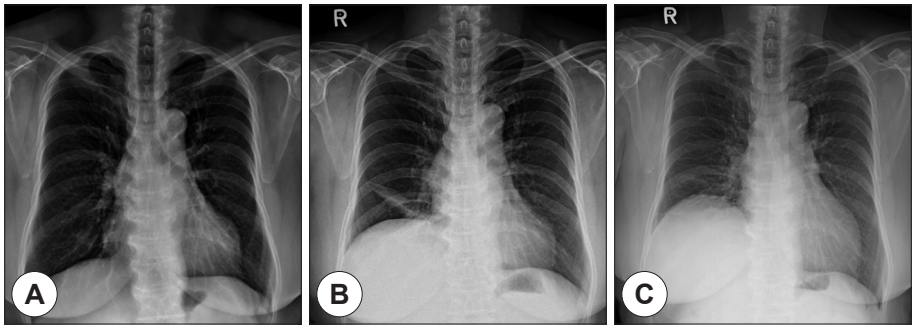

Fig. 1. A : Pre-operative Chest radiograph. B : Chest radiograph at 2 weeks. C : 1year after the surgery. Chest X-ray at 2weeks after operation shows an elevated hemidiaphragm compared with preoperative picture, and still elevated diaphragm is noted 1 year after the surgery.

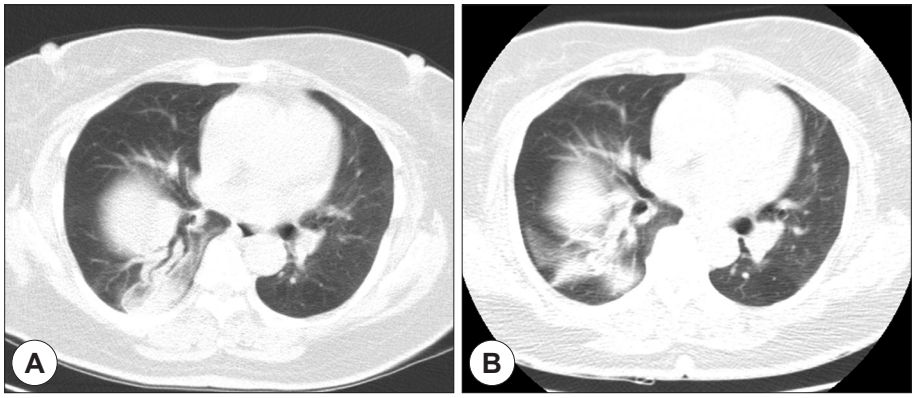

Fig. 2. A : Computerized tomography of the chest at 2 months after surgery. B : 9 months after surgery. Segmental atelectasis was identified on the right middle lobe, which was located next to the right diaphragm and right lower lobe.

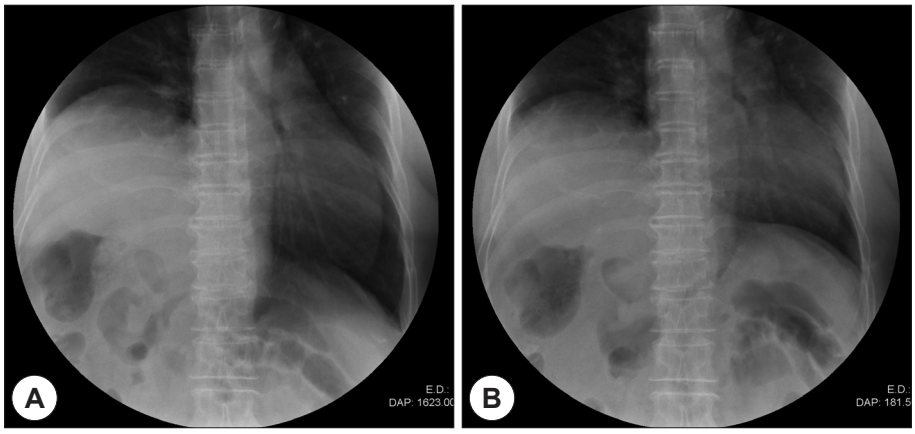

Fig. 3. Fig. 3 shows fluoroscopic "sniff" test, in which diaphragmatic movement is observed fluoroscopically while the patient sniffs forcefully. The sniff test showed paradoxically elevation of the paralyzed hemidiaphragm with inspiration compared with the rapid descent of the normal hemidiaphragm. A : Inspiration. B : Expiration.

based on the imaging studies. Imaging studies have previously suggested a close relationship between dyspnea and phrenic nerve dysfunction. A sniff test using fluoroscopic study was performed, and this confirmed unilateral phrenic nerve paralysis(Fig. 3).

Conservative treatment was performed in the patient based on life expectancy and physical status. We were able to identify phrenic nerve paralysis, but the abnormality of the diaphragm had not changed significantly.

Discussion

The diaphragm is a respiration-related muscle that plays a critical role in determining the inspiratory phase time, and it is responsible for 60−70% of the total tidal volume at rest.[5] Phrenic nerve paralysis can be caused by problems with several factors, such as the brain, spinal cord, phrenic nerve, neuromuscular junction, and the muscle itself.

Diaphragmatic dysfunction can cause dyspnea, hypokinesia, sleep disorders, reduced quality of life, atelectasis, and respiratory failure. The true prevalence of unilateral phrenic nerve paralysis is unclear, since it is frequently discovered incidentally by chest X-ray and is present without symptoms ; yet, it is more common than bilateral phrenic nerve paralysis. Many symptoms, including difficulty breathing during exercise, labored respiration, and asymmetry of chest exercises, occur during diaphragmatic paralysis due to impairment of the phrenic nerve. Depending on the posture change of the patient, respiratory distresses including dyspnea, wheezing, and sleep disorders can develop occasionally. These conditions can result in the misdiagnosis of phrenic nerve paralysis as heart failure, pulmonary artery embolism, chronic obstructive pulmonary disease, or interstitial lung disease. Therefore, unnecessary invasive test procedures are often performed on the patient.

Patients with phrenic nerve paralysis exhibit diaphragmatic elevation on chest X-rays, as well as paradoxical movement of the diaphragm and mediastinum on fluoroscopy. The diagnosis of phrenic nerve paralysis can be confirmed based on these observations. Pulmonary function tests can also be

performed to evaluate the deterioration of diaphragm function. As a result, the FVC of our patient was 70−80% of the expected level, which was reduced due to bilateral phrenic nerve paralysis.

During bilateral phrenic nerve paralysis, FVC measured in the supine position is commonly reduced by 15−25% compared with in the sitting position.[6] Phrenic nerves branch off from C3, C4, and C5 vertebrae, and the anterior portions of the nerves protrude between the scalene muscle and its covering fascia, which originates from the anterior neck. The nerves then spread on the same side as the diaphragm by localizing to the back of the subclavian vein and entering the thoracic cavity from the neck. They also spread to the pericardium, pneumomediastinum, pleura, and peritoneum. Impairment of the hemidiaphragm is caused mainly by the pulling and cooling of the phrenic nerve during cardiac surgery, cervical spondylosis, or nerve compression on the cervical spine due to cancer, injury, surgery, and pneumonia.[7] There are also many reports of nerve damage due to nerve compression caused by iatrogenic impairment, which can occur during surgery, or it can develop on the trachea or mediastinum.[8]

There are no official statistics analyzing the development of phrenic nerve paralysis after thyroid surgery. However, when we performed follow-up monitoring of 82 patients that had been diagnosed and treated for thyroid cancer at a tertiary hospital from 1996−2000 for 1−10 years, nine patients exhibited surgical complications, and one developed permanent impairment of the phrenic nerve.[9] In addition, two cases of unilateral phrenic nerve paralysis after thyroid surgery were reported in male patients, aged 70 and 54 years, who had suffered cervico-mediastinal goiters.[10]

A previous study reported that −40−60% of patients diagnosed with thyroid papillary carcinoma develop cervical lymphadenopathy.[11] In this study, modified or selective radical neck dissection were performed. Modified radical neck dissection removes each lymph node from levels 1−5, similar to radical dissection, but one or more of the accessory nerves, internal jugular veins, and sternocleidomastoid muscles are left intact.

The phrenic nerve can be dissected from the outside to the inside, taking special care to avoid damage while performing radical neck dissection from levels 2−4. This process can damage the phrenic nerve, for example if the nerve is dissected together with fibroid adipose tissue, the prevertebral fascia region is detached too deeply, or a cut is too close when cervical plexus dissection is performed. To reduce these potential damages, it is recommended to dissect at least 1 cm from the lateral part of the nerve.

Phrenic nerve paralysis also occurs rarely in benign thyroid disease, and some cases are due to compression of the phrenic nerve when a thyroid goiter invades into the pleural cavity. An additional case report described the disappearance of paralysis symptoms following partial thyroidectomy.[12] However, the occurrence of phrenic nerve paralysis due to benign thyroid disease was recently reduced because most surgical dissections are now performed prior to enlargement of thyroid goiters.

Phrenic nerve damage can also occur during surgery for head and neck tumors or during cardiothoracic surgery. Diaphragm nerve damage was reported in 16% of patients who underwent extensive lymphadenectomy and in 1.9% of patients with esophageal cancer.[13] Phrenic nerve damage was also reported in 14(8%) out of 176 patients with head and neck tumors that underwent modified radical neck dissection in 1991,[14] as well as in two out of 26 patients with cervical lymphadenopathy.[15] It can also occur during relatively non-invasive procedures ; for example, it occurred in 10(1.3%) out of 814 patients with radiofrequency ablation for pulmonary tumors[16] and in up to 61% of patients during cervical plexus-blocking anesthesia for carotid endarterectomy.[17]

Unilateral diaphragmatic paralysis typically appears temporarily and then disappears without any complications ; yet, severe respiratory distress was reported in a case of bilateral diaphragmatic paralysis due to bilateral phrenic nerve injury.[18] However, many cases are not reported due to lack of recognition of minor symptoms, which are easy for a clinician to miss if a patient complains of nonspecific symptoms. According to one study describing phrenic nerve paralysis, it can take several weeks to 15 years for diagnosis.[19]

The treatment of phrenic nerve paralysis is determined by the severity of the paralysis. If the paralysis is minor, it is recommended to use conservative and non-invasive treatments, such as artificial respiration or treatment of lung secretion. In contrast, diaphragmatic plication is required for patients with recurrent pneumonia and/or atelectasis, and those in need of long term mechanical ventilation. In general, phrenic nerve paralysis can be recovered 1−3 months after conservative or surgical treatment. Although the function of the diaphragm was not completely recovered, some report that diaphragmatic placation may help to diminish symptoms and improve pulmonary function.[20]

The prognosis of phrenic nerve damage varies according

to the mechanism that caused the injury, and it can be worse when the nerve is pulled or cut compared with cold injuries.[21] The mechanism of cold injury is considered to be axonal degeneration and demyelination of the nerve, which will regenerate in −3 years. In contrast, there is a high probability of permanent nerve damage if the nerve has been cut ; thus, surgical treatment should be considered at an early stage.

This case study presented a patient who developed unilateral diaphragmatic paralysis due to phrenic nerve injury, which occurred after thyroidectomy and modified radical neck dissection. This patient differed from other cases due to the presence of severe respiratory distress, which developed over 2 years. The importance of diagnosing phrenic nerve paralysis in this patient cannot be overemphasized, since the prolonged dyspnea of unknown cause improved with conservative treatment alone. If dyspnea occurs after thyroid surgery, the possibility that it is related to phrenic nerve damage should not be overlooked.

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