ORIGINAL ARTICLE

THE EFFICACY OF COMPUTED TOMOGRAPHY GUIDED PERCUTANEOUS CORDOTOMY ON INTRACTABLE PAIN IN PATIENTS WITH LUNG CANCER

Bilgisayarlı Tomografi Eşliğinde Yapılan Perkütan Kordotomi Uygulamasının Akciğer Kanserli Hastalardaki İnatçı Ağrı Üzerine Etkisi

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ABSTRACT

Objective: This study was carried out to evaluate the efficacy of Computed tomography (CT) guided percutaneous cordotomy(PCC) and postoperative complications in the treatment of intractable pain associated with lung cancer.

Material and Methods: CT – guided cordotomy was performed on 10 lung cancer patients unresponsive to medical and interventional pain management methods.

Results: The mean pretreatment and post treatment visual analog pain scale (VAS) scores of the patients were determined as 10 ± 0.0001 and 1.00 ± 0.67, respectively. Additionally, the mean pretreatment and post treatment Karnofsky Performance Scale (KPS) scores of the patients were calculated as 40± 9.42 and 73±10.59, respectively. Accordingly, there was a statistically significant difference between the pretreatment and post treatment VAS and KPS scores. Furthermore, the mean pretreatment and post treatment morphine equivalent dose of the patients were found as 860.2±199.8 mg and 220.7±69.08 mg, respectively.

Conclusion: The findings of this study suggest that CT guided PCC is a valuable treatment option for intractable pain problems in patients suffering from lung cancer.

Keywords: *CT Guided; Cordotomy; Pain, Cancer*

ÖZET

Amaç: Akciğer kanserine bağlı dirençli ağrı tedavisinde, BT kılavuzluğunda perkütan kordotominin etkinliğini ve işlem sonrası komplikasyonları değerlendirmeyi amaçladık.

Gereç ve Yöntemler: Medikal ve girişimsel ağrı tedavi yöntemlerine yanıt vermeyen 10 akciğer kanser hastaya bilgisayarlı tomografi (BT) eşliğinde kordotomi uygulandı.

Bulgular: Hastaların tedavi öncesi ve tedavi sonrası görsel analog ağrı skalası (VAS) puan ortalamaları sırasıyla 10±0,0001 ve 1±0,67 olarak belirlendi. Ayrıca hastaların tedavi öncesi ve tedavi sonrası ortalama Karnofsky Performans Ölçeği (KPS) puanları sırasıyla 40± 9,42 ve 73±10,59 olarak hesaplandı. Buna göre tedavi öncesi ve tedavi sonrası VAS ve KPS skorları arasında istatistiksel olarak anlamlı fark vardı. Ayrıca hastaların tedavi öncesi ve tedavi sonrası ortalama morfin eşdeğer dozları sırasıyla 860,2±199,8 mg ve 220,7±69,08 mg olarak bulundu.

Sonuç: Kordotominin akciğer kanserinden muzdarip bazı hastalarda inatçı ağrı sorunları için en iyi çözüm olduğuna inanıyor ve öneriyoruz.

Anahtar Kelimeler: *BT Kılavuzluğu; Kordotomi; Ağrı; Kanser*

INTRODUCTION

Lung cancer was the second most frequently diagnosed cancer worldwide in 2020 and the leading cause of cancer-related deaths. The diagnosis of lung cancer is usually made in the late stages (1). Pain associated with lung cancer depends on the localization of the primary tumor and the presence of metastases. Pain in primary lung cancer is usually observed in patients with pleura, and chest wall involvement characterized by pain in the arm and shoulder or classic Pancoast's Syndrome (2). There are a wide variety of treatment options available for clinicians in the treatment of cancer pain, ranging from pharmacological therapies to invasive interventions. Interventional pain management techniques can be used to attempt to control refractory pain in patients for whom standard therapy cannot provide effective pain relief or cannot tolerate medication adjustments. In general, standard invasive treatment options should be preferred (sympathetic block, epidural drug applications). In cases where standard invasive interventional treatment options are insufficient, high-risk invasive procedures can be used. Cordotomy reportedly provides more benefits to patients with limited life expectancy (3). Computed tomography (CT)-guided percutaneous cervical cordotomy (PCC) is indicated for pain levels below C5. It is a useful procedure in patients with unilateral, localized, persistent, and somatic cancer-related pain which may not be adequately treated with other invasive methods (3). CT-guided PCC targets the lateral spinothalamic tract in the anterolateral region of the spinal cord. The spinothalamic tract carries nociceptive signals from the contralateral side of the body, heat, and non-discriminatory sense of touch (4). The percutaneous technique was developed by Mullan et al. in 1963 (5) and radiofrequency current was used by Rosomoff et al. to produce the lesion in 1965 (6). The introduction of CT-guided PCC, which was described by Kanpolat et al., has led to greater safety and efficacy (7). Complications related to the CT-guided PCC procedure may include motor weakness, dysesthesia, mirror pain, urinary dysfunction, respiratory failure, headache, hypotension, hemorrhage, infection, neural damages caused by damages inflicted on other pathways (reticulospinal, somatosensory or corticospinal), Horner's syndrome, and sensory-motor changes including death. Contraindications include a history of respiratory distress on the contralateral side the procedure performed or midline pain (8-9).

In light of the foregoing, the objective of this study is to evaluate the efficacy of CT-guided PCC and post treatment complications in the treatment of intractable pain associated with lung cancer.

MATERIAL AND METHODS

The study sample included 10 lung cancer patients unresponsive to invasive interventional methods other than medical treatment and PCC. All patients underwent CT-guided PCC at the Algology Department of Akdeniz Faculty of Medicine. Of the 10 patients, 4 had adenocarcinoma, 4 had squamous cell cancer, 1 had small cell cancer and 1 had Pancoast tumor. Written informed consent was obtained from each patient. The study was conducted in accordance with the principles set forth in the Declaration of Helsinki. The study protocol was approved by the Akdeniz University institutional ethics committee (KAEK 425-24/05/2023). Cancer type, disease duration, the localization of pre-processing pain symptoms and type, pain intensity and the quality of life of pre-processing and post processing, types of pain treatment applied before CT-guided PCC, morphine equivalent dose (MED) and the complications emerged after the procedure were recorded. Pain levels were recorded with Visual Analogue Pain Scale (VAS) before the procedure and on the 7th-day after the procedure.

Karnofsky Performance Scale (KPS) was used to evaluate the quality of life of the patients before and after the procedure. KPS assesses patient's symptoms, ability to perform daily activities, dependency status, and need for medical care (10). The total score that can be obtained from KPS ranges between 0 point and 100 points. 100 points indicate normal health, each ten-point reduction in the total score indicates a deterioration in functions, and 0 points correspond to death (10). According to the KPS scores, patients are divided into 3 categories: Category A consisted of patients who scored between 80 and 100 points, thus do not require special care, can continue their normal activities and work; Category B consisted of patients who scored between 50 and 70 points, thus can take care of themselves with assistance, but cannot work;

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and Category C consisted of patients who scored between 0 point and 40 points, thus cannot take care of themselves and the disease progresses rapidly towards death (11). Patients included in the study filled out the scales under the supervision of a physician according to the pretreatment KPS scores, of the 10 patients included in this study, 8 (80%) patients were in Category C, 2 (20%) patients were in Category B, and there was no patient that could be classified as Category A patient. The patients had pain in the shoulder and/or upper extremity and upper chest region due to unilateral cancer. In this context, unilateral and bilateral PCC procedures were performed in 9 patients and in 1 patient with intractable pain, respectively. The patient, who underwent cordotomy due to intractable pain in the left chest, armpit and shoulder region, and whose pain regressed in the left shoulder and chest pain after the procedure, yet re-emerged in the right chest and shoulder region, was performed left PCC procedure 1 month later. Cordotomy procedure was performed as per the instructions described by Yegül in the literature (12).

Processing Technique

Patients were placed in supine position. The head is placed in a head holder and fixed in a slightly flexed position in order to 'open' the C2 foramen. They were provided oxygen via nasal cannula. Their vital signs were constantly monitored during the procedure. The patient has to remain reasonably still and should not move head while taking CT scans. Movement of the head and neck will make the pictures blurred and it is going to be hard to identify the position of the needle tip. Patients who have suffered too much pain cannot be stayed calm. Therefore, adequate premedication with opioid analgesics is necessary. We have preferred 50 – 100 mcg of fentanyl intravenously 5 minutes before operation, if the patient have pain. The needle entry area was sterilized. The entrance is located near the mastoid process. The C1-C2 (first and second cervical vertebrae) range was determined based on CT-imaging, and the area that lie just below the mastoid protrusion was marked. Local anesthesia was applied to the marked area using 2% lidocaine with an injection needle 21G (0.8mm x 25mm) (Figure-1a). Under the guidance of CT, Crawford type 20 G spinal needle was perpendicularly inserted to the apex of C2 foraminal opening. (Figure-1b). After puncturing the dura-mater membrane and cerebrospinal fluid was observed (Figure 1c). The spinal cord was visualized by injecting 7 mL of water-soluble contrast Omnipaque® (350 mg/mL) and 3 mL of saline mixture into the subarachnoid space using the barbotage method. The injection was done slowly doing barbotage to avoid increasing intracranial pressure and patient discomfort. If barbotage is performed the dye evenly spreads around the spinal cord. A disposable insulated radiofrequency cordotomy electrode with adjustable active tip (Minta) was inserted through the needle and connected to the generator (Neurotherm® NT1100) to start impedance monitoring. With continuous impedance monitoring, the needle was advanced and when its tip reached the anterolateral borderline of the spinal cord, the electrode was quickly, short (0.1 - 0.2 mm), and precisely inserted into the pia mater (Figure 1d). Once the electrode enters the anterolateral quadrant of the spinal cord and electrical impedance monitoring reaches intramedullary levels (Impedance is in the range of 200 ohms (CSF) to 1435 ohms), electrostimulation is performed. Electrostimulation was performed, 2 Hz to identify if there is motor response and 50 Hz to identify the region of original pain. Sensory test was performed to identify the region of original pain, also motor tests to search for motor response each response was documented with an axial CT scan. Sensory changes and motor contractions were recorded during stimulation. In the sensory testing coldness or hotness was felt in the site of original pain and in the motor testing neck muscles fasciculation. After it was verified that the patients felt the stimulus in the targeted area, they were administered radiofrequency current at 80 °C for 10, 20 and 30 seconds, respectively. Patients were kept under observation for 5 hours after the procedure, considering the possible complications that might arise.

Statistical Analysis

The research data were analyzed using the SPSS 21 (IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp) software package. Descriptive statistics were expressed using mean, standard deviation, minimum, and maximum. Shapiro-Wilk test was used to determine whether the variables

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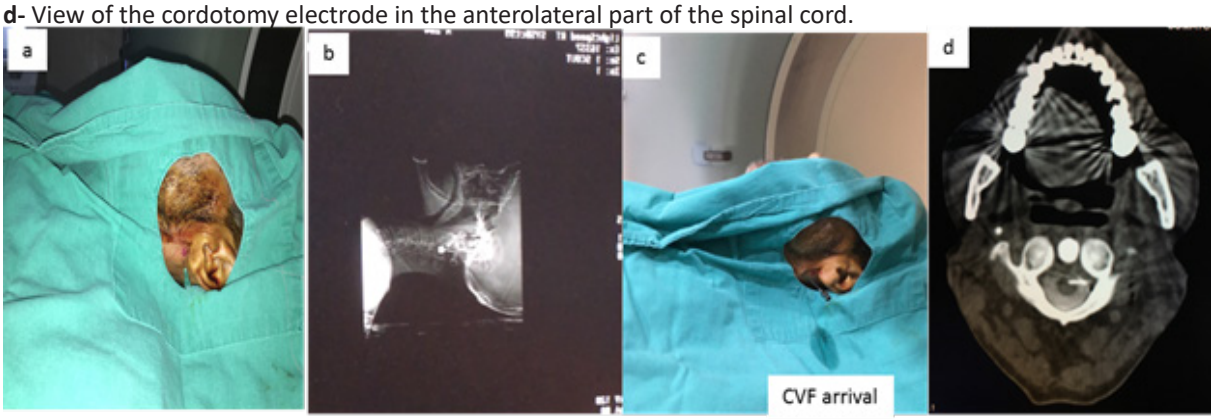
Figure 1.
a- Use of local infiltration anesthesia between the first and the second cervical vertebrae
b- CT image of the needle while between the C1 and C2
c- As the needle passed through the dura, CVF discharge has occurred
d- View of the cordotomy electrode in the anterolateral part of the spinal cord.



CVF: cerebrospinal fluid

conform to normal distribution. Subsequently, Wilcoxon test were used for statistical analyses. The significance level was set at 0.05.

RESULTS

The study sample consisted of 10 lung cancer patients with intractable pain who did not respond adequately to medical treatments or invasive interventional treatments other than cordotomy or who could not be administered higher opioid doses (more than 100 mg morphine equivalent dose) due to side effects and thus underwent CT-guided PCC at the Algology Department of Akdeniz Faculty of Medicine. Demographic characteristics, pain localizations, pain types and types of pain treatment applied before cordotomy of the patients are given in Table 1. The mean age of the patients, of whom 7 (70%) were male and 3 (30%) were female, was 60.1±10.3 years. Of the 10 patients, 4 had adenocarcinoma, 4 had squamous cell cancer, 1 had small cell cancer and 1 had Pancoast tumor. All patients had metastases to peripheral tissue and bone metastases or distant organs and were using high-dose narcotic analgesics (more than 100 mg morphine equivalent dose). Unilateral and bilateral PCC procedures were performed in 9 patients and in 1 patient with intractable pain, respectively. The mean disease duration was 4.9 months. The electrostimulation data of the patients and the cordotomy application side are given in Table 2. PCC was applied through the left C1-2 and right C1-2 spaces in 5 (50%) and 4 (40%) patients, respectively. One (10%) patient was performed bilateral C1-2 PCC. The mean VAS scores of the patients before and after the cordotomy were 10 ± 0.0001 and 1.30 ± 0.67, respectively. All patients experienced significant pain relief after PCC (Table 3). Additionally, the mean KPS scores of the patients before and after cordotomy were determined as 40± 9.42 and 73±10.59, respectively. There was a statistically significant difference between the pretreatment and post treatment VAS and KPS scores (Table 4) ($p<0.05$). Furthermore, the mean pretreatment and post treatment opioid dose equivalences of the patients were calculated as 860.2±199.8 mg and 220.7±69.08 mg, respectively (Table 4) ($p<0.05$). There was a statistically significant difference between the pretreatment and post treatment MED (Table 3). Analysis of the complications related to the PCC procedure revealed mirror pain in 10% of patients, head and neck pain in 90%, opioid withdrawal in 40%, walking imbalance in 30%, and urinary retention in 10%. One complication was observed in 20% of the patients, and two complications were observed in 80% (Table 3). Mirror pain complication occurred in one patient two days after the procedure and completely resolved spontaneously after 5 days. Walking imbalance complication occurred in 3 patients. In one of these patients, walking imbalance started 2 days after the procedure and completely resolved spontaneously in 5

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Table 1. Clinical Characteristics of the Patients who underwent Percutaneous Cervical Cordotomy

	Gender	Age	Cancer Type	Disease duration (Month)	Metastasis	Pain Localization	Pain type	Types of Pain Treatment Applied Before Cordotomy	Treatments For Cancer
1st Patient	Male	60	Small cell	6	Peripheral tissue, distant organ and bone metastases	Right chest, right upper extremity, lumbar region and right leg irradiation	Mixed	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	CT
2nd Patient	Male	65	Adenocarcinoma	4	Peripheral tissue and bone metastases	Right chest, right shoulder	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT
3rd Patient	Male	67	Squamous cell	4	Peripheral tissue, distant organ and bone metastases	Left chest, left upper extremity and lumbar region	Mixed	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	CT
4th Patient	Male	64	Squamous cell	3	Peripheral tissue, distant organ and bone metastases	Left chest, left upper extremity, lumbar region and right leg irradiation	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	CT
5th Patient	Male	65	Squamous cell	4	Peripheral tissue and bone metastases	Left chest, left shoulder	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT
6th Patient	Male	69	Pancoast	5	Peripheral tissue and bone metastases	Left chest, left upper extremity	Mixed	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT
7th Patient	Female	71	Adenocarcinoma	6	Peripheral tissue and bone metastases	Left chest, left shoulder	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT
8th Patient	Male	55	Adenocarcinoma	5	Peripheral tissue and bone metastases	Left chest, left upper extremity	Mixed	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT
9th Patient	Female	41	Adenocarcinoma	6	Peripheral tissue, bone and distant organ metastasis	Right shoulder and right chest before the 1st procedure and left chest, armpit and shoulder region before the 2nd procedure	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	CT
10th Patient	Male	44	Squamous cell	6	Peripheral tissue and bone metastases	Right chest, right shoulder	Nociceptive	Oral opioid + Transdermal fentanyl + Sympathetic block + Epidural drug applications	RT+CT

CT: Chemotherapy, RT: Radiotherapy

days. In another patient, walking imbalance started 3 days after the procedure and completely resolved after 1 week. In the third patient, walking imbalance started 2 days after the procedure and resolved after 8 days. Urinary retention occurred in one patient 1 day after the procedure and resolved after 4 days. Mild head and neck pain was reported in 90% of all patients, however, did not require any additional treatment in any patient, including the patients who developed opioid withdrawal.

DISCUSSION

Pain is reportedly experienced by 47% of the lung cancer patients. Lung cancer is one of the cancers that inflicts the most pain (1, 2). Pain affects the physical functions, daily activities, psychological-emotional status and social life of individuals. It is extremely important that the intractable pain is addressed not only as a health problem, but also as a humane problem. Patients with cancer differ from other patients in that they require their quality of life to be improved and the symptoms

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Table 2. Electrostimulation data of patients who underwent percutaneous cervical cordotomy.

	Procedure Side of the Body	Impedance	Motor Stimulation	Sensory Stimulation	Sensation During Motor Stimulation	Sensation During Sensory Stimulation
1st Patient	Left	217-1282 ohms	2 Hz / 1ms / 0.48 - 1V	50Hz / 1ms / 0.24V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
2nd Patient	Left	204-1167 ohms	2 Hz / 1ms / 0.42 - 1V	50Hz / 1ms / 0.25V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
3rd Patient	Right	208-1204 ohms	2 Hz / 1ms / 0.33 - 1V	50Hz / 1ms / 0.27V	Neck Muscles Fasciculation (Needle Site)	Hotness Sensation on Pain Site
4th Patient	Right	200-1235 ohms	2 Hz / 1ms / 0.37 - 1V	50Hz / 1ms / 0.23V	Neck Muscles Fasciculation (Needle Site)	Hotness Sensation on Pain Site
5th Patient	Right	211-1275 ohms	2 Hz / 1ms / 0.41 - 1V	50Hz / 1ms / 0.2V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
6th Patient	Right	223-1297 ohms	2 Hz / 1ms / 0.39- 1V	50Hz / 1ms / 0.24V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
7th Patient	Right	201-1232 ohms	2 Hz / 1ms / 0.32- 1V	50Hz / 1ms / 0.26V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
8th Patient	Right	225-1285 ohms	2 Hz / 1ms / 0.44 - 1V	50Hz / 1ms / 0.27V	Neck Muscles Fasciculation (Needle Site)	Hotness Sensation on Pain Site
9th Patient	Bilateral	209-1266 ohms	2 Hz / 1ms / 0.3- 1V	50Hz / 1ms / 0.25V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site
10th Patient	Left	211-1281 ohms	2 Hz / 1ms / 0.38 - 1V	50Hz / 1ms / 0.23V	Neck Muscles Fasciculation (Needle Site)	Coldness Sensation on Pain Site

that may develop as a result of primary treatment to be avoided.

The analysis of the VAS and KPS scores of ten lung cancer patients who underwent PCC included in this study revealed a significant difference between the pretreatment and post treatment scale scores. Accordingly, a significant reduction in pain was achieved in patients. In parallel, the daily MED decreased from 860 mg before PCC to 240 mg after PCC. All of the complications resolved within 10 days. No permanent deficit was observed in any patient. All of the patients stated their satisfaction with PCC outcomes 1 week after the procedure. CT-guided PCC is considered one of the useful procedures in patients with persistent pain due to unilateral cancer. As a matter of fact, it was reported that 95% of the patients who underwent CT-guided PCC had sufficient pain relief after the procedure (7). In this context, patients with unilateral cancer pain who do not respond to medical treatment and standard algological interventional procedures constitute the target patient group for cordotomy (12). It has been reported in the literature that patients with unilateral upper body pain due to lung cancer, mesothelioma or Pancoast tumors and unilateral lower body pain due to malignancies may benefit from CT-guided unilateral PCC (13). PCC is an effective procedure in reducing cancer pain, but its use has not increased in parallel with technological developments. The classical technique under fluoroscopy guidance is a blind technique and requires a fat-soluble contrast medium. For PCC we should use the CT guide because the active electrode can be easily detected by CT scanning. It is difficult to obtain such an image under fluoroscopy. CT-scan also allows localization of the electrode on the anteromedial and posterolateral sides of the lateral spinothalamic tract. When the procedure is performed under fluoroscopy, the dentate ligament should be visible, and the contrast medium used in this case should be fat-soluble. All contrast agents used today are water-soluble and it is not possible to visualize the dentate ligament with water-soluble contrast. Also, imaging of the dentate ligament is not necessary when using CT during the procedure. Kanpolat et al. reported that the success rate of CT-guided PCC was 92% in patients

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Table 3. Pre- and post-procedure; VAS, KPS scores, morphine equivalent doses and complications

	Pain type	BP-VAS	AP-VAS	BP- KPS	AP-KPS	BP- Category KPS	AP- Category KPS	BP- Morphine Equivalent Dose	AP- Morphine Equivalent Dose	Type of Complication
1st Patient	Mixed	10	2	40	70	C	B	1320	360	Mirror Pain + Walking Imbalance
2nd Patient	Nociceptive	10	1	40	70	C	B	858	198	Opioid Withdrawal+ Head and Neck Pain
3rd Patient	Mixed	10	2	30	50	C	B	960	300	Opioid Withdrawal+ Head and Neck Pain
4th Patient	Nociceptive	10	2	60	90	B	A	618	138	Walking Imbalance+ Head and Neck Pain
5th Patient	Nociceptive	10	1	50	80	B	A	840	180	Head and Neck Pain+ Urinary Retention
6th Patient	Mixed	10	1	40	70	C	B	738	198	Head and Neck Pain
7th Patient	Nociceptive	10	0	30	70	C	B	778	258	Opioid Withdrawal+ Head and Neck Pain
8th Patient	Mixed	10	1	40	80	C	A	1020	240	Opioid Withdrawal+ Head and Neck Pain
9th Patient	Nociceptive	10	2	30	70	C	B	720	180	Walking Imbalance + Head and Neck Pain
10th Patient	Nociceptive	10	1	40	80	C	A	750	155	Head and Neck Pain

VAS: Visual analogue scale, KPS: Karnofsky Performance Scale, BP: Before Procedure, AP: After procedure

Table 4. Before and after the procedure; Statistics of VAS, KPS scores and morphine equivalent doses

VARIABLES	BEFORE PROCEDURE		AFTER PROCEDURE		
	Mean ± SD	**Min-Max**	**Mean ± SD**	**Min-Max**	**p value**
VAS	10 ±0.0	10 -10	1.3 ± 0.67	0-2	0.004
KPS	40 ± 9.4	30 – 60	73 ± 10.59	50-90	0.004
MORPHINE EQUIVALENT DOSE	860.2±199.8	618-1320	220.7±69.08	138-360	0.005

Wilcoxon test was used for statistical analyses. VAS: Visual analogue scale, KPS: Karnofsky Performance Scale

with intractable pain, including patients with malignancies such as pulmonary malignancies, mesothelioma, gastrointestinal tumors, and Pancoast tumor (4). In another study by Kanpolat et al., the success rate of CT-guided PCC was reported as 98% in patients with excruciating pain due to lung tumors (14). In the study of Raslan et al., 98% and 80% procedural success was found in patients with persistent cancer pain who underwent CT-guided PCC at the end of one-month and six-month follow-up, respectively (15). In a study by Kanpolat et al. conducted with lung cancer patients, the mean VAS score decreased by 98% and the mean KPS score increased by 75% after the procedure (4). On the other hand, in another study, the mean VAS score decreased by 66% and the mean KPS score increased by 22% after the procedure (15). In comparison, in this study, which was conducted with lung cancer patients as in the study of Kanpolat et al., the mean VAS score decreased by 90% and the mean KPS score increased by 82.5% after the procedure. Therefore, pain palliation was achieved in lung cancer patients with severe pain, and it was concluded that cordotomy is effective in this patient group. According to the pretreatment KPS scores, 8 (80%) patients were in Category C, whereas 2 (20%) patients were in Category B. According to the posttreatment KPS scores,

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on the other hand, 6 (60%) patients were in Category B, and 4 (40%) patients were in Category A. Thus, the normal activity levels and the independence of patients had increased. Furthermore, the mean MED of patients decreased by 76% after the procedure. In addition, there was a decrease in the frequency of the side effects of high-dose opioid analgesic drugs such as constipation, loss of appetite, nausea and drowsiness which were more frequent before the procedure. Therefore, the increase in the KPS scores is due not only to the reduction of pain but also to the reduction of side effects. Nevertheless, further studies which feature reduced analgesic doses and assess patient survival times in larger patient groups would reveal more concrete results on the cost effectiveness of the procedure. The patients included in this study could not be followed up for extended periods. However, the research data suggest that cordotomy is effective for intractable lung cancer pain, since a significant reduction in pain was achieved in all patients included in this study. The most common complications associated with PCC are mild neck and headache, urinary retention, arterial hypotension, sensory ataxia, hypotonia, opioid withdrawal, and ipsilateral hemiparesis. Motor and sphincter or sexual disorders occur in less than 10% of cases. Other less common complications associated with PCC include respiratory dysfunction and sleep apnea (Ondine's Curse). Of the two complications, the latter is more commonly associated with bilateral PCC (16). In addition, there is a risk of recurrence of other previously masked pains or "mirror pain", that is, emergence of pain on the contralateral side. New pain often reflects the original pain in the same region on the contralateral side of the body. The incidence of such pain syndromes ranges from 9% to 63% (17). The complications encountered after cordotomy in patients included in this study were mirror pain, headache, urinary retention, mild gait instability and opioid withdrawal. Head and neck pain, which was observed in 90% of the patients, was the most common complication. All complications were temporary and did not require additional treatment. Mirror pain developed in 1 patient two days after the procedure and spontaneously resolved 5 days later. All complications disappeared within 10 days after the procedure. Major complications reported in other studies might have stemmed from the use of fluoroscopy-guided procedure. In addition, the absence of major complications in this case series might be attributed to the fact that the procedure was performed under the guidance of CT and by experienced physicians. Recovery of the spinothalamic tract and recurrence of pain are likely after a certain period of time following cordotomy (18). This post-regeneration pain may present as dysesthetic symptoms or pain syndromes and be difficult to treat as in the case of neuropathic pain seen after spinal cord injury. Nevertheless, such cases were not mentioned in a case series with a follow-up period of 5 years after cordotomy (19). Similarly, there were no symptoms suggestive of neuropathic pain observed in the patients included in this study during the follow-up period after cordotomy. Studies involving bilateral PCC have revealed that both procedures have low complication rates, with the success rate on the second side similar to that on the first side (12-13). In comparison, there was one patient who developed contralateral pain after the procedure in this study. A significant regression was observed in the pain of the patient who underwent the second PCC procedure 1 month after the first PCC procedure. The bilateral PCC results reported by both Kanpolat et al. and Yegül et al. indicated that the procedures performed on different sides both had low complication rates and similar success rates. The VAS score of the patient who underwent bilateral PCC was found to be 0 after both procedures, and no complications related to either procedure were observed. CT-guided PCC continues to be an effective and safe method in the treatment of cancer pain resistant to medical treatments. In addition, considering that cancer is a systemic and progressive disease, CT-guided PCC can be repeated if pain reoccurs in the same area or in another part of the body. Bilateral PCC should be considered as one of the methods to be preferred at different times due to its positive effect on the quality of life of patients with refractory bilateral extremity pain associated with cancer.

CONCLUSION

It is extremely important that the intractable pain is addressed not only as a health problem, but also as a humane problem. In this context, CT-guided PCC offers the best solution for refractory pain problems

experienced by lung cancer patients. The safety of the CT-guided PCC procedure depends on the skill of the physician and choosing the patients suitable to the procedure. In conclusion, CT-guided PCC should be performed as soon as possible.in individuals who do not respond to standard algological interventional procedures and conservative treatment options.

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