Title page

Title: Agreement Between Face-to-Face and Tele-assessment of Upper Limb Disability in Lung cancer survivors during COVID-19 era.

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Abstract.

Introduction: Upper limb disability can limit the quality of life of lung cancer survivors. The COVID-19 era has required a finding of alternatives to attend the monitoring of presented disturbances with the minor risk of spread. Tele-assessment offers new possibilities for clinical assessment demonstrating good reliability compared to traditional face-to-face assessment in a variety of patients. No previous study has been applied this type of assessment in lung cancer survivors. For this reason, the aim of this study was to evaluate the level of agreement between upper limb disability assessment using tele-assessment and the face-to-face method in lung cancer survivors.

Methods: A reliability study was conducted with 20 lung cancer survivors recruited from the Oncological Radiotherapy Service of the "Hospital PTS" (Granada). Patients attended a session for clinical face-to-face and real-time online tele-assessment. The main outcome measurements of the study included upper limb function (shirt task) and musculoskeletal disturbances (active range of movement and trigger points), and these outcomes were recorded by two independent researchers.

Results: The outcomes measures showed good agreement between both assessments. The active range of movement presented heterogeneous results, being excellent reliability ($\rho > 0.75$) in extension, internal rotation, homolateral adduction, and contralateral abduction, good ($0,4 < \rho < 0,75$) for flexion, homolateral abduction, contralateral adduction and contralateral external rotation, and poor ($\rho < 0,4$) for homolateral external rotation. The measure evaluating upper limb function and Trigger Points show the highest interrater reliability with confidence interval lower limits ≥ 0.99.

Discussion: The tele-assessment of upper limb function and musculoskeletal disorders of lung cancer survivors present a good interrater reliability compared to face-to-face assessment. It could be useful for monitoring the disability presented by cancer survivors whose access is difficulted by the residential situation, physical limitations or the risk of COVID-19 spread.
Keywords: e-Health, Agreement, Lung cancer, Covid-19 era, Upper Limb, Disability.

Introduction

Lung cancer is one of the most prevalent diseases worldwide, with an incidence of 2.206.771 cases in 2020 and a 5 years survival rate of 15%, this cancer ´s entity is the deadliest cancer [1]. The main treatment includes a combination of surgery and coadjutant treatment where radiotherapy treatment is often presented as the last step along with the treatment [2,3].

These treatments use to be accompanied by different side-effects at cardiorespiratory and musculoskeletal systems as fatigue, thoracic pain [4], or loss of peripheral muscle mass [5]. Frequently, accompanied by the pain and limitations that appeared after oncology treatment, usually appears shoulder impairments that affect the functional capacity and quality of life of lung cancer survivors in a directly [6].

Lung cancer-related impairments in upper limbs have been already reported [7], highlighting limitations in the active ranges of movement (AROM) and upper limbs exercise capacity [8]. These AROM limitations, accompanied by arm pain, are more frequent in the homolateral side after the application of surgery and radiotherapy but not sole, therefore the functionality of the homolateral upper limb is particularly impaired [9].

The COVID-19 has changed the day-to-day functioning of healthcare systems throughout the world. The number of face-to-face appointments has been reduced due to the growing spread of the virus, which affects people with chronic illnesses, such as hypertension and diabetes, among others. In the case of people with cancer, medical and rehabilitative care has been changed, from suspending their treatment to changes in care protocols [10,11].

It has been mentioned that people with cancer are at high risk during the COVID-19 pandemic [12]. However, lung cancer survivors need to continue their care with the medical staff to monitor their symptoms and impairments [13], this is why alternative ways must be sought to provide the best possible assistance while reducing the risk of being infected [14].

Communication and information technologies offer new possibilities for clinical assessment and treatment. Specifically, these systems may address issues of accessibility and cost as a potential solution for assessment and monitoring of those patients who nowadays prefer home-based care, and/or experience a loss of their independence [15]. Different studies [16,17,18] have demonstrated that the use of telehealth systems can increase overall survival in lung cancer patients because its use was shown to increase disease detection, lead to pursuit of earlier medical care, and increase medication and treatment compliance, and even earlier detection of relapse.

In this line, videoconferencing could reproduce a traditional in-person assessment or treatment using a computer, tablet, or mobile device with access to high-speed Internet. Tele-rehabilitation systems have demonstrated good reliability and feasibility that can be comparable to traditional face-to-face assessment in a variety of patients profile and impairments [19,20].

But, to our knowledge, no previous study has been developed on the assessment of upper limb disability in lung cancer survivors using videoconferencing software. The objective of this study was to determine the level of agreement between upper limb disability assessment using tele-assessment and the face-to-face method in a population of lung cancer survivors. We hypothesized that the results of assessments of upper limb disability in lung cancer survivors would not differ between telerehabilitation and face-to-face systems.

Materials and Methods

Design

A descriptive crossover design was used for the purpose of testing interrater reliability. Participants provided verbal voluntary informed consent before participation in the study. This study was conducted in accordance with the Declaration of Helsinki 1975, revised in 2013. All procedures and protocols followed were reviewed and approved by the local institutional review board.

Participants

Lung cancer survivors were recruited from the Oncological Radiotherapy Service of the "Hospital PTS" (Granada), between September 2020 and March 2021. Inclusion criteria were as follows: diagnosis of lung cancer, completion of adjuvant therapy, age 18 years or older, Spanish-speaking ability, access to the Internet and at less a basic ability to use computers or living with a relative who has this ability. Exclusion criteria were impaired cognition or comprehension deficits (screened by Montreal cognitive assessment [21]); visual or acoustic limitations; diagnosis of a neurologic condition that limited the evaluation; injuries or conditions affecting the musculoskeletal system including nerves, muscles, and tendons of the upper limbs; and/or previous trauma or fracture of the upper extremities.

Procedure

Patients underwent two physical assessments in an appointment: a face-to-face and a real-time online assessment. Both evaluations were carried out by two physiotherapists with more than 2 years' experience in assessing lung cancer survivors with different cancer-related symptoms in rehabilitation programs for cancer survivors. Each one was blinded to the assessments of the other. The order of the assessments was randomly assigned by a random sequence generator for each patient and examiner, and they were separated by 20 minutes. Due to the prevalence of cancer-related fatigue in cancer subjects, the fatigue was measured during the assessment with a fatigue Numeric Rating Scale (NRS) [22] in order to include resting time periods when fatigue was clinically significant.

Before conducting the measurements, anthropometric data, comorbidities and tumor location were obtained. Comorbidities were assessed by the Charlson Index, one of the most widely used scoring systems for assessing comorbidities that has been validated in several disorders [23]. The data collection was conducted at a laboratory of the Faculty of Health Sciences of the University of Granada when the clinical face-to-face interview was conducted.

Outcome Measures

Those outcomes included upper limb function and musculoskeletal disturbances. Musculoskeletal outcomes measured included an active range of movement and trigger points, both measured bilaterally. The online assessment was carried out by videoconference (WhatsApp) [24], reproducing a traditional in-person assessment using a computer, tablet or mobile device with access to high-speed Internet.

Upper limb function was assessed by the Shirt Task [25]. The shirt task was adapted from the t-shirt test used in spinal cord injury research [26,27]. The standing participant was instructed to pick up a folded unbuttoned long sleeve shirt placed on a table directly in front of them and put it on as fast as possible. The test was completed when all six buttons (not including the collar and sleeve buttons) were done-up in their corresponding holes. The sex of the participant determined whether a male or female shirt was used (as the buttons and holes are on opposite sides for each gender). The time taken to complete the task (seconds) was recorded as the participant's test score.

AROM was evaluated in the online assessment through photogrammetry. The motions were first shown by the examiner and then copied by the patient. Patients were asked to wear a vest so that their shoulder and the outline of their trunk were visible. A snapshot was taken to measure the exact angle. Kinovea version 0.8.15 software, a free and open-source video analysis package, was used to quantify the range of movement. It has been previously reported to be reliable for ensuring accurate measurements [28,29]. In the face-to-face assessment, the range of movement was evaluated through goniometer. Flexion, extension, abduction, adduction, and rotations of both upper limbs were included. Patients were placed standing, and the researcher asked them to perform the active movements, monitoring and correcting postural compensation [30]. This variable has been measured with this tool in previous cancer populations [31,32].

Trigger points (TrPs) were bilaterally explored in the face-to-face assessment by a blinded assessor in muscles described to refer pain to the shoulder in response to compression, performing the assessment following the criteria described by Simons et al [33]. This exploration has been also realized in other thoracic cancer entities [34,35]. The exploration included the follow muscles: trapezius, pectoralis major and minor, deltoids, supraspinatus, elevator scapulae, subscapularis, and latissimus dorsi. The order of points was randomized between subjects with a two-minute rest period between muscles, as previously used [36], in order to avoid the referred pain interfering with the patient's response. Total number of active TrPs were collected.

In the online assessment, the physiotherapist applied to the patient for a self-exploration of the different trigger point explored during the face-to-face assessment. It has been previously reported to be reliable for ensuring measurements [37].

Previous to online assessment, participants attended one of two scheduled group training during which each participant self-explored their own trigger points. The training was proposed at least one week before the clinical assessment and have a maximum duration of 30 minutes. The training was delivered on a large urban university campus in dedicated flexible spaces used for gatherings, weight management meetings, or study groups. Those trainings were conducted by a certified myofascial trigger point therapist and were accompanied by a leaflet with images of trigger point locations, associated referral pain pattern(s), and self-management instructions of particular trigger points. The self-explored trigger points were different to the self-explored trigger points of the study in order not to disrupt the assessment of the study.

Statistical Analysis

A sample size of 20 patients was estimated to provide 90% power to detect a correlation coefficient of 0.75 between face-to-face and tele-assessment methods in upper limb function of the most affected arm with a type 1 error (α) of 5%. This sample size was similar in previous studies that carried out an agreement between face-to-face and telerehabilitation methods [38,39].

The agreement between face-to-face and tele-assessment was analyzed applying the two-way random-effects intraclass correlation coefficient (ICC) (ρ) for the remainder of variables, and their confidence intervals were calculated for the interrater reliability trials. A value of $\rho < 0.4$ was considered poor reliability; 0.4 to 0.75, fair to good reliability; and > 0.75, excellent reliability. SPSS version 20.0 (IBM Corporation, Armonk, NY) was used for the statistical analyses.

Results

Of 35 potential patients, a total of 20 patients completed the study. The distribution of participants is shown in Figure 1. The descriptive data of participants are in Table 1 (80% male, mean ± SD age 62.45 ± 8.91 years). The patients presented a mean of comorbidities of 2.59 ± 2.62 in Charlson Index. The tumor locations of the patients were 45% in the right side, 45% in the left side, and the 10% present a center or bilateral location.

Please, insert figure 1

Please, insert table 1

The mean ± SD of degrees presented in the different active movement of both shoulders are detailed in Table 2. The interrater reliability of the measures was heterogeneous, presenting an excellent reliability ($\rho > 0.75$) in movements of extension, internal rotation, homolateral aduction, and contralateral abduction. Movements of flexion, homolateral abduction, contralateral aduction and contralateral external rotation had a fair to good reliability ($0,4 < \rho < 0,75$). And homolateral external rotation presented a poor reliability ($\rho < 0,4$).

Please, insert table 2

Table 3 show the results of Trigger Points and Shirt Task. The mean of Trigger Points was 1 ± 1.94 in the contralateral side to the tumor location, and 1.72 ± 3 in the homolateral side to the tumor location. The time resulted of Shirt Task was 33.49 ± 11.95 seconds in face-to-face assessment and 33.44 ± 11.80 in tele-assessment. The measure evaluating upper limb function show high interrater reliability with confidence interval lower limits ≥ 0.8. The Trigger Points presented in both sides show the highest interrater reliability (1; 1.00-1.00).

Please, insert table 3

Discussion

The objective of this study was to evaluate the level of agreement between face-to-face and tele-assessment of upper limb disability in a population of lung cancer survivors. The results show high interrater reliability comparing tele-assessment and face-to-face evaluation.

The technology brings a great potential to facilitate cancer care and reduce the risk of COVID-19 spread, for this reason cancer services are looking for being brought together with a mix of in-person and virtual options [40]. The increased use of tele-medicine is associated with improved cost efficacy and patient satisfaction [41,42], so the tele-oncology [43] use is increasing now that is improving in recent decade [44,45].

Most research in tele-oncology have focused on the feasibility and efficacy of remote monitoring or site-to-site tele-medicine consultation [46,47], but to date, few studies had tele-assessed the cancer-related impairment after oncologist treatment. Galiano-Castillo N. et al [20] have obtained similar reliability than ours, observing a high interrater reliability comparing face-to-face and tele-assessment with a web-based system when they reproduced a clinical assessment of lymphedema in breast cancer survivors. Nevertheless, no previous studies have explored videoconferencing assessing lung cancer-related impairment at home.

Implementation of these systems requires the validation of their reliability with respect to traditional assessments of health problems and the development of an adequate regulatory framework [48]. In our study, the results show a good agreement between face-to-face and tele-assessment for the assessed outcomes (Trigger Points, Upper Limb Function and Range of Motion). In this way, the correlation between the systems was similar to that obtained in previous studies that have evaluated the upper limb functioning and impairments in other populations [19,49]. Other studies in different musculoskeletal disorders also have observed similar reliability of our study for range of motion [50] and clinical tests [38,49].

Treatments for lung cancer survivors can lead to the assessed upper limb impairments [51]. In the study of Rodríguez-Torres J et al. [7], patients undergoing lung resection have shown significant dysfunction in both shoulders that remained one month after surgery, with decreased range of motion, an increase in the number of active trigger points with a high severity and interference of pain and poor quality of life. Radiotherapy treatment also increases pain and upper limb disability, producing nerve toxicity and decreasing the shoulder mobility in the short-term [52]. Ohmori et al. [53] studied a sample undergoing lung resection patients and showed that 43.2% presented trigger points with shoulder pain. Miranda et al.[6] also analyzed a sample of 37 lung cancer survivors, showing an important reduction of bilateral shoulders' range of motion associated to musculoskeletal disability as our study.

The ability to monitor upper limb functioning via the Internet gives patients a better follow-up through the therapeutic process that may help to increase their adherence to home exercise programs [54]. In this way, the present results give preliminary support to the implementation of tele-assessment for evaluating upper limb impairments of lung cancer survivors. One strength of the study lies in the use of real telerehabilitation conditions with the professionals using free videoconferencing software, thus reducing the costs of this type of procedure and the risk of COVID-19 spread.

Our study had some limitations that need to be reported. We were not able to establish with certainty whether the differences between face-to-face and tele-assessment were attributable to assessment procedure, memory, inter-rater bias or changes in patient test performance. It is also likely that individuals who agreed to participate in the study were more motivated and familiar with the Internet than the general population. Additionally, the inclusion of health professionals in real-time Internet could be another limitation for the implementation of these types of health services.

In conclusion, this study demonstrates good interrater reliability of upper limb tele-assessment performed by therapists for assessing upper limb function and musculoskeletal disorders in lung cancer survivors compared to a face-to-face assessment. Based on our approach, future studies should evaluate the efficacy of a complementary home-based intervention focused on the upper limb.

Our study findings have direct implications for tele-assessment based oncology services. The applicability of the results to clinical practice may be useful for lung cancer survivors whose access is limited by the residential situation, physical limitations or the risk of COVID-19 spread. In this way, the ability for monitoring upper limb functioning via the Internet provide to clinicians the possibility to give patients a consistent follow-up through the therapeutic process that may help to increase their adherence. Furthermore, tele-assessment of upper limb impairments using an Internet application may be an alternative for addressing the growing demand for monitoring the disease progression, reducing health care costs, social isolation, and improving health outcomes, quality of care, and quality of life of patients.

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Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

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Table 1. Descriptive characteristics of patients.

Characteristic		**Mean ± SD**
Age (y)		62.45 ± 8.91
Gender (% male)		80%
BMI (kg/ m^2)		28.21 ± 4.06
Charlson		2.59 ± 2.62
Tumor Location	Right	45%
	Left	45%
	Center/bilateral	10%

Data are expressed as mean ± SD or Percentage (%); y: years; BMI: Body Mass Index; SD: standard deviation.

Table 2. Descriptive values of the Active Range of Movement of Shoulder.

Variable (º)		**Face-to-face Assessment**	**Tele-assessment**	**Intra-class correlation coefficient**
ROM				
Flexion	Contralateral	157.65 ± 11.4	162.1 ± 9.84	0.628 (0.257 , 0.836)
	Homolateral	157.85 ± 11.49	163.6 ± 9.25	0.422 (0.021 , 0.716)
Extension	Contralateral	45.3 ± 13.99	42.2 ± 14.87	0.811 (0.585 , 0.921)
	Homolateral	47.15 ± 15.64	44.3 ± 13.26	0.860 (0.677 , 0.943)
Abduction	Contralateral	166.21 ± 11.33	169.05 ± 10.12	0.794 (0.533 , 0.916)
	Homolateral	161.84 ± 12.18	167.36 ± 9.2	0.718 (0.211 , 0.897)
Aduction	Contralateral	30.68 ± 15.76	33.15 ± 16.85	0.731 (0.431 , 0.886)
	Homolateral	30.55 ± 16.21	33.55 ± 20.17	0.904 (0.761 , 0.963)
Internal Rotation	Contralateral	45.55 ± 19.09	50.61 ± 22.6	0.776 (0.501 , 0.909)
	Homolateral	52 ± 20.09	54.52 ± 23.5	0.847 (0.650 , 0.938)
External Rotation	Contralateral	77.45 ± 14.9	82.35 ± 12.66	0.747 (0.424 , 0.896)
	Homolateral	79.85 ± 11.93	89.9 ± 27.65	0.398 (0.003 , 0.701)

Data are expressed as mean ± SD or mean (95% Confidence interval);

Movement measures are expressed in degrees. ROM: Range of Movement.

Table 3. Descriptive values of the upper limb function and active trigger points presented.

Variable	Face-to-face Assessment	Tele-assessment	Intra-class correlation coefficient
Active TrPs Contralateral Side	1 ± 1.94	1± 1.94	1
Active TrPs Homolateral Side	1.72 ± 3	1.72 ± 3	1
Shirt Task (seconds)	33.49 ± 11.95	33.44 ± 11.80	0.99 (0.99 , 1)

Data are expressed as mean ± SD or mean (95% Confidence interval); TrPs: trigger points.

Figure 1. *Flow diagram of the distribution of participants.*