Review Article

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Archives in Cancer Research

2021
Vol. 9 No. 1: 1

Multimodality Imaging Based Treatment Volume Definition for Reirradiation of Recurrent Small Cell Lung Cancer (SCLC)

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Citation: Sager O, Demiral S, Dincoglan F, Beyzadeoglu M (2021) Multimodality Imaging Based Treatment Volume Definition for Reirradiation of Recurrent Small Cell Lung Cancer (SCLC). Arch Can Res Vol.9 No.1:1.

Abstract

Objective: Small cell lung cancer (SCLC) may be considered as a major health concern as a leading cause of cancer related mortality worldwide. Despite intensive management, SCLC may follow an aggressive disease course with recurrent and/or metastatic disease in a considerable proportion of the patients. Herein, we assess multimodality imaging based treatment volume definition for reirradiation of recurrent SCLC.

Literature Review: Definition of treatment volume by multimodality imaging with incorporation of positron emission tomography (PET) or by computed tomography (CT)-simulation images only has been evaluated with comparative analysis for patients reirradiated for recurrent SCLC.

Results: A multidisciplinary team of experts from surgery, medical oncology, radiation oncology, and pulmonology has been involved in individualized patient evaluation. Decision making for reirradiation of patients with recurrent SCLC has been performed after comprehensive assessment considering the lesion size, localization and association with critical structures, previously administered treatments at initial diagnosis, and time interval from initial RT. Treatment volume determination by CT-only imaging and by CT-PET fusion based imaging has been assessed with comparative analysis. Ground truth target volume has been found to be identical with treatment volume determination by CT-PET fusion based imaging as the primary result of this study.

Conclusion: Incorporation of PET in RT planning process may be considered for patients receiving reirradiation for recurrent SCLC. Clearly, further investigation is required to shed light on this issue.

Keywords: Cytotoxicity; VitaminsB; Amygdalin; HPLC; Chitosanl; Nanoparticles

Received: March 08, 2021; **Accepted:** March 24, 2021; **Published:** March 31, 2021

Introduction

Lung cancer is among the most common and deadliest of all cancers worldwide. A broad categorization of lung cancer includes Small Cell Lung Cancer (SCLC) and Non Small Cell Lung Cancer (NSCLC) as the major subtypes. Although SCLC constitutes a smaller proportion of all lung cancers compared to NSCLC, it is the most aggressive subtype with a typically worse prognosis. Within this context, SCLC may be considered as a major health concern as a leading cause of cancer related mortality worldwide. Median survival for SCLC is typically around 1 year, however, there is extensive effort for improving treatment outcomes with multidisciplinary management and contemporary therapeutic strategies [1-3]. Radiation therapy (RT) plays an integral role in multimodality management of SCLC [4-6]. Despite intensive management, SCLC may follow an aggressive disease course with recurrent and/or metastatic disease in a considerable proportion of the patients. Delivery of high radiation doses for recurrent disease management may be limited due to primary radiotherapeutic management and excessive radiation induced toxicity may be a critical concern for reirradiation of recurrent SCLC. Nevertheless, reirradiation offers an important therapeutic option for management of recurrent SCLC [7]. Radiotherapeutic approaches have improved over the years with introduction of contemporary irradiation strategies, adaptive RT methods, automatic segmentation techniques, molecular imaging methods, stereotactic irradiation, and modernized treatment delivery techniques including Intensity Modulated Radiation Therapy (IMRT), Image Guided Radiation Therapy (IGRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation

Therapy (BART) [8-44]. In the context of SCLC management, there has been progress with introduction of immunotherapeutic strategies and normal tissue sparing RT strategies [45]. However, improving the toxicity profile of radiation delivery remains to be a critical aspect of radiotherapeutic management particularly in the setting of reirradiation for SCLC. Herein, we assess multimodality imaging based treatment volume definition for reirradiation of recurrent SCLC.

Literature Review

In this original research article, definition of treatment volume by multimodality imaging with incorporation of positron emission tomography (PET) or by CT-simulation images only has been evaluated with comparative analysis for patients reirradiated for recurrent SCLC. Ground truth target volume used as the reference for actual treatment and comparison purposes has been meticulously outlined by the board certified radiation oncologists after comprehensive assessment, colleague peer review, collaboration, and ultimate consensus. Detailed evaluation has been performed on an individual basis regarding the lesion size, localization, symptomatology, comorbidities, performance status, previous therapies and time interval from initial RT, and contemplated outcomes of reirradiation. CT-simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) has been used for RT simulation for treatment planning at our tertiary referral institution. Planning CT images have been acquired and then sent to the delineation workstation (SimMD, GE, UK) for definition of treatment volumes and surrounding critical structures. Either CT-simulation images only or fused CT and PET images have been used for treatment volume definition for reirradiation. Adequate coverage of target volume with optimal normal tissue sparing has been prioritized in treatment planning. Treatment volume determination with CT only and with incorporation of CT-PET fusion has been evaluated with comparative analysis. Synergy (Elekta, UK) linear accelerator (LINAC) has been utilized for treatment delivery and IGRT techniques have been routinely incorporated in radiotherapeutic management of patients with recurrent SCLC.

Results and Discussion

A multidisciplinary team of experts from surgery, medical oncology, radiation oncology, and pulmonology has been involved in individualized patient evaluation. Decision making for reirradiation of patients with recurrent SCLC has been performed after comprehensive assessment considering the lesion size, localization and association with critical structures, previously administered treatments at initial diagnosis, and time interval from initial RT.

Available RT planning systems at our tertiary cancer center have been used for precise radiation treatment planning to improve the therapeutic ratio. Determination of ground truth target volume to be used for actual treatment and for comparative analysis has been performed by board certified radiation oncologists after detailed assessment, colleague peer review, collaboration, and ultimate consensus. Synergy (Elekta, UK) LINAC has been used for reirradiation. Treatment volume determination by CT-only imaging and by CT-PET fusion based imaging has been assessed with comparative analysis. Ground truth target volume has been found to be identical with treatment volume determination by CT-PET fusion based imaging as the primary result of this study.

SCLC is the most aggressive type of lung cancer with grim prognosis. Despite multimodality management, a considerable proportion of patients suffer from metastatic disease or recurrent SCLC. Therapeutic options are limited in the setting of recurrent disease. High RT doses delivered as part of initial management may limit the prescription of high radiation doses in the recurrent disease setting. Adverse effects of RT constitute important concerns since critical organs may be exposed to high cumulative radiation doses. Within this context, improving the toxicity profile of reirradiation becomes an indispensable component of recurrent SCLC management.

RT planning for SCLC is mostly based on CT simulation of patients in the treatment position. CT is utilized for dose calculations and RT planning, however, supplementary data from molecular imaging may aid in precise treatment volume determination. There has been extensive effort for optimization of treatment volumes for SCLC to improve the therapeutic ratio [46-48]. A major challenge in radiotherapeutic management of recurrent SCLC stems from the high delivered doses as part of initial therapy. There is a typical requirement for limiting the reirradiation doses for avoidance of adverse radiation effects. Contemporary strategies such as radiosurgical applications under rigid stereotactic immobilization and image guidance may improve outcomes of reirradiation, however, precise treatment volume determination becomes more important in the context of stereotactic reirradiation due to higher doses of radiation typically delivered in a single or a few fractions. While definition of larger than actual treatment volumes may cause substantial exposure of normal tissues and subsequent adverse effects, definiition of smaller than actual treatment volumes may lead to inadequate target coverage with consequent treatment failure. From this standpoint, optimization of treatment volume determination is an important aspect of reirradiation for recurrent SCLC. In this study, we addressed the role of molecular imaging for reirradiation of recurrent SCLC. Indeed, many studies have also addressed multimodality imaging for improved target definition for radiotherapeutic management of several tumors [49-71].

Conclusion

In conclusion, incorporation of PET in RT planning process may be considered for patients receiving reirradiation for recurrent SCLC. Within this context, our study supporting the role of multimodality imaging for target definition of recurrent SCLC may add to the existing literature. Clearly, further investigation is required to shed light on this issue.

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