Peertechz®

CLINICAL GROUP

JOURNAL OF
Surgery and Surgical Research

ISSN: 2455-2968 DOI: https://dx.doi.org/10.17352/jssr

Review Article

Assessment of cardıac sparıng ın radıotherapeutıc management of medıastınal Hodgkın lymphoma (hl) durıng chıldhood and adolescence

Omer Sager*, Murat Beyzadeoglu, Selcuk Demiral, Ferrat Dincoglan, Hakan Gamsiz, Bora Uysal, Onurhan Colak, Fatih Ozcan and Bahar Dirican

Department of Radiation Oncology; University of Health Sciences, Gulhane Medical Faculty, Ankara, Turkey

Received: 09 June, 2020
Accepted: 30 June, 2020
Published: 03 July, 2020

***Corresponding author:** Dr. Omer Sager, Department of Radiation Oncology; University of Health Sciences, Gulhane Medical Faculty, Gn.Tevfik Saglam Cad. 06018, Etlik, Kecioren, Ankara, Turkey, Tel: +90 312 304 4683; Fax: +90 312 304 4680; E-mail: omersager@gmail.com

ORCID: https://orcid.org/0000-0001-7866-2598

Keywords: Hodgkin lymphoma (HL); Cardiac sparing; Heart; Radiation therapy (RT)

https://www.peertechz.com

Abstract

Lymphomas constitute the most frequent hematologic malignancies. HL is a rare type of B cell lymphoma featured with Reed Sternberg cells. Treatment of HL may be considered among the greatest success stories in oncology. Improvements in treatment of HL have rendered quality of life an important aspect of management given the long life expectancy of younger patients, particularly the children and adolescents.

The heart may be partly exposed to irradiation in radiotherapeutic management of mediastinal HL. Late effects of irradiation may include stenosis, regurgitation, and fibrosis of the cardiac conduction pathways which may result in late onset arrhythmias and conduction defects, angina pectoris, valvular disorders, coronary artery disease and myocardial infarction. Patients receiving RT to the mediastinum may suffer from adverse cardiovascular effects of irradiation due to coronary atherosclerosis formation which may occur despite the lack of any cardiovascular risk factors, and an asymptomatic period of several years may precede presentation with coronary heart disease given the slow process of intimal hyperplasia and collagen deposition. It may take several years after RT to diagnosis of these complications.

Normal tissue sparing Radiation Therapy (RT) techniques allow for improved targeting and normal tissue sparing in HL management. A relatively newer breakthrough has been the introduction of proton therapy with its unique characteristics. Herein, we provide a concise review of evolving RT techniques for management of mediastinal HL with focus on cardiac sparing.

Introduction

Lymphomas constitute the most frequent hematologic malignancies, and typically fare better than most solid cancers [1-3]. Hodgkin Lymphoma (HL) and Non Hodgkin Lymphoma (NHL) have distinct characteristics. HL is a rare type of B cell lymphoma featured with Reed Sternberg cells or lacunar histiocytes as giant malignant lymphoid cells which are typically positive for CD15 and CD30 but negative for CD20 and CD45. Reed Sternberg cells are considered to be diagnostic, however, the diagnosis should be based on the presence of the consistent cellular background and immunophenotyping results [4]. As an important cancer during the childhood and adolescence, HL may involve peripheral lymph nodes and rarely the liver, lungs, bone marrow, gastrointestinal or genitourinary tract. A bimodal age distribution s typical with one peak at

Citation: Sager O, Beyzadeoglu M, Demiral S, Dincoglan F, Gamsiz H, et al. (2020) Assessment of cardıac sparıng ın radıotherapeutıc Management of medıastınal hodgkın lymphoma (hl) Durıng chıldhood and adolescence. J Surg Surgical Res 6(2): 106-109.DOI: https://dx.doi.org/10.17352/2455-2968.000107

the age of about 20 years and the other at the age of about 70 years. HL may be subdivided into lymphocyte predominant HL and classic HL (CHL) with respect to genotypic, phenotypic, morphological, and clinical findings [4]. CHL subtypes include the nodular sclerosing CHL which is the most frequent type in children, lymphocyte depleted CHL, mixed cellularity CHL, and lymphocyte rich CHL [4].

Treatment of HL may be considered among the greatest success stories in oncology [5]. While the disease was considered as a lethal malignancy decades ago, contemporary management with irradiation and systemic treatment has provided excellent prognosis with long term survival outcomes in the millennium era [5-8]. Improvements in treatment of HL have rendered quality of life an important aspect of management given the long life expectancy of younger patients, particularly the children and adolescents. Normal tissue sparing Radiation Therapy (RT) techniques minimizing cardiac exposure have been introduced and adopted in clinical practice to achieve an improved therapeutic ratio for HL. Herein, we provide a concise review of evolving RT techniques for management of mediastinal HL with focus on cardiac sparing.

Cardiac sparing RT techniques for mediastinal HL management

RT is a principal modality of management for HL, utilized as the single treatment to achieve cure in selected patients [9]. Nevertheless, long life expectancy of children and adolescents with HL underscore the importance of quality of life of treated patients. While RT is an effective treatment modality, it is not devoid of adverse effects. Several authors have addressed the side effects of irradiation with focus on cardiotoxicity [10-25]. Systematic reviews and metaanalyses of long term risk of cardiovascular disease and mortality in lymphoma survivors revealed that risk of cardivascular events is increased in lymphoma survivors compared with the general population, which emphasizes the importance of cardiovascular screening for these patients [26-28].

The heart may be partly exposed to irradiation in radiotherapeutic management of mediastinal HL. Late effects of irradiation may include stenosis, regurgitation, and fibrosis of the cardiac conduction pathways which may result in late onset arrhythmias and conduction defects, angina pectoris, valvular disorders, coronary artery disease and myocardial infarction [29-31]. Patients receiving RT to the mediastinum may suffer from adverse cardiovascular effects of irradiation due to coronary atherosclerosis formation which may occur despite the lack of any cardiovascular risk factors, and an asymptomatic period of several years may precede presentation with coronary heart disease given the slow process of intimal hyperplasia and collagen deposition [29-31]. It may take several years after RT to diagnosis of these complications [32-34].

Over the years, there have been considerable advances in the discipline of radiation oncology including adoption of contemporary RT strategies such as Intensity Modulated Radiation Therapy (IMRT), Image Guided Radiation Therapy (IGRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation Therapy (BART), and radiosurgical applications to improve outcomes of management [35-41]. In the context of HL therapy, these strategies along with combination of precise RT approaches allowed for improved targeting and normal tissue sparing [42-52]. The recent expert consensus on the use of IMRT and IGRT for Hodgkin's lymphoma involving the mediastinum states that mean whole heart dose of < 5 Gy and mean left ventricle dose of < 2 Gy may be recommended as dose objectives for the heart, and contemporary techniques may aid in respecting critical organ dose constraints [42]. Nevertheless, a relatively newer breakthrough has been the introduction of proton therapy with its unique characteristics [53-63]. Studies with proton therapy consistently reported superior normal tissue sparing, particularly when combined with contemporary techniques. The study by Lautenschlaeger et al. focusing on pediatric patients and adolescents with HL reported significant reduction in doses to critical organs and integral body dose with proton therapy [63]. The authors concluded that these reductions could translate into decreased risk of late toxicities and secondary malignancies which is particularly important for children and adolescents [63].

While logistical issues, access to therapy, treatment costs and availability are still important considerations for proton therapy, pediatric patients and adolescents with mediastinal HL may benefit from the favorable characteristics of this treatment modality given their excellent prognosis and life expectancy.

Conclusion and future perspectives

Despite the significant advances in management of children and adolescents with mediastinal HL using RT, there still remains room for improvement for further achievements. Further studies are required to shed light on management of mediastinal HL with an improved toxicity profile and optimal cardiac sparing.

References

1. Siegel RL, Miller KD, Jemal A (2019) Cancer statistics, 2019. CA Cancer J Clin 69: 7-34. Link: https://bit.ly/3eU8jZk

2. Miller KD, Nogueira L, Mariotto AB, Rowland JH, Yabroff KR, et al. (2019) Cancer treatment and survivorship statistics. CA Cancer J Clin 69: 363-385. Link: https://bit.ly/2D1Qslo

3. Zhou L, Deng Y, Li N, Zheng Y, Tian T, et al. (2019) Global, regional, and national burden of Hodgkin lymphoma from 1990 to 2017: estimates from the 2017 Global Burden of Disease study. J Hematol Oncol 12: 107. Link: https://bit.ly/3eUB08v

4. Piccaluga PP, Agostinelli C, Gazzola A, Tripodo C, Bacci F, et al. (2011) Pathobiology of hodgkin lymphoma. Adv Hematol 2011: 920898. Link: https://bit.ly/2BYJJrX

5. Rathore B, Kadin ME (2010) Hodgkin's lymphoma therapy: past, present, and future. Expert Opin Pharmacother 11: 2891-2906. Linj: https://bit.ly/3inuw4f

6. Bonadonna G, Bonfante V, Viviani S, Di Russo A, Villani F, et al. (2004) ABVD plus subtotal nodal versus involved-field radiotherapy in early-stage Hodgkin's disease: long-term results. J Clin Oncol 22: 2835-2841. Link: https://bit.ly/3ioQGTS

Citation: Sager O, Beyzadeoglu M, Demiral S, Dincoglan F, Gamsiz H, et al. (2020) Assessment of cardiac sparing in radiotherapeutic Management of mediastinal hodgkin lymphoma (hl) During childhood and adolescence. J Surg Surgical Res 6(2): 106-109.DOI: https://dx.doi.org/10.17352/2455-2968.000107

7. Filippi AR, Franco P, Ciammella P (2012) Role of modern radiation therapy in early stage Hodgkin's lymphoma: A young radiation oncologists' perspective. Rep Pract Oncol Radiother 17: 246-250. Link: https://bit.ly/3eURAoR

8. Witkowska M, Majchrzak A, Smolewski P (2015) The role of radiotherapy in Hodgkin's lymphoma: what has been achieved during the last 50 years? Biomed Res Int 2015: 485071. Link: https://bit.ly/2YQmLfl

9. Wirth A, Yuen K, Barton M, Roos D, Gogna K, et al. (2005) Long-term outcome after radiotherapy alone for lymphocyte-predominant Hodgkin lymphoma: a retrospective multicenter study of the Australasian Radiation Oncology Lymphoma Group. Cancer 104: 1221-1229. Link: https://bit.ly/2YQ45fO

10. Mrotzek SM, Rassaf T, Totzeck M (2020) Cardiovascular Damage Associated With Chest Irradiation. Front Cardiovasc Med 7: 41. Link: https://bit.ly/2BYKD7P

11. Ratosa I, Ivanetic Pantar M (2019) Cardiotoxicity of mediastinal radiotherapy. Rep Pract Oncol Radiother 24: 629-643. Link: https://bit.ly/2NNlYWv

12. Lee Chuy K, Nahhas O, Dominic P, Lopez C, Tonorezos E, et al. (2019) Cardiovascular Complications Associated with Mediastinal Radiation. Curr Treat Options Cardiovasc Med 21: 31. Link: https://bit.ly/3dWLl2p

13. Armanious MA, Mohammadi H, Khodor S, Oliver DE, Johnstone PA, et al. (2018) Cardiovascular effects of radiation therapy. Curr Probl Cancer 42: 433-442. Link: https://bit.ly/3eSd3Pb

14. Raghunathan D, Khilji MI, Hassan SA, Yusuf SW (2017) Radiation-Induced Cardiovascular Disease. Curr Atheroscler Rep 19: 22. Link: https://bit.ly/3ilFxTG

15. Marmagkiolis K, Finch W, Tsitlakidou D, Josephs T, Iliescu C, et al. (2016) Radiation Toxicity to the Cardiovascular System. Curr Oncol Rep 18: 15. Link: https://bit.ly/3inPn7C

16. Moreira LA, Silva EN, Ribeiro ML, Martins Wde A (2016) Cardiovascular effects of radiotherapy on the patient with cancer. Rev Assoc Med Bras 62: 192-196. Link: https://bit.ly/3eTSWjQ

17. Yusuf SW, Howell RM, Gomez D, Pinnix CC, Iliescu CA, et al. (2015) Radiation-related heart and vascular disease. Future Oncol 11: 2067-2076. Link: https://bit.ly/2VBthoc

18. Santoro F, Tarantino N, Pellegrino PL, Caivano M, Lopizzo A, et al. (2014) Cardiovascular sequelae of radiation therapy. Clin Res Cardiol 103: 955-967. Link: https://bit.ly/3ioTUqs

19. Jaworski C, Mariani JA, Wheeler G, Kaye DM (2013) Cardiac complications of thoracic irradiation. J Am Coll Cardiol 61: 2319-2328. Link: https://bit.ly/2YPTgdC

20. Martinou M, Gaya A (2013) Cardiac complications after radical radiotherapy. Semin Oncol 40: 178-185. Link: https://bit.ly/3iklzrf

21. Travis LB, Ng AK, Allan JM, Pui CH, Kennedy AR, et al. (2012) Second malignant neoplasms and cardiovascular disease following radiotherapy. J Natl Cancer Inst 104: 357-370. Link: https://bit.ly/3dUdrLZ

22. Filopei J, Frishman W (2012) Radiation-induced heart disease. Cardiol Rev 20: 184-188. Link: https://bit.ly/38kgDiJ

23. Ng AK (2011) Review of the cardiac long-term effects of therapy for Hodgkin lymphoma. Br J Haematol 154: 23-31. Link: https://bit.ly/38mNRhC

24. Lee PJ, Mallik R (2005) Cardiovascular effects of radiation therapy: practical approach to radiation therapy-induced heart disease. Cardiol Rev 13: 80-86. Link: https://bit.ly/2VytdFZ

25. Adams MJ, Hardenbergh PH, Constine LS, Lipshultz SE (2003) Radiation-associated cardiovascular disease. Crit Rev Oncol Hematol 45: 55-75. Link: https://bit.ly/3eTCz6H

26. Stone CR, Mickle AT, Boyne DJ, Mohamed A, Rabi DM, et al. (2019) Treatment for lymphoma and late cardiovascular disease risk: A systematic review and meta-analysis. Health Sci Rep 2: e135. Link: https://bit.ly/2ZAQ9po

27. Boyne DJ, Mickle AT, Brenner DR, Friedenreich CM, Cheung WY, et al. (2018) Long-term risk of cardiovascular mortality in lymphoma survivors: A systematic review and meta-analysis. Cancer Med 7: 4801-4813. Link: https://bit.ly/3gkosYt

28. van Leeuwen-Segarceanu EM, Bos WJ, Dorresteijn LD, Rensing BJ, der Heyden JA, et al. (2011) Screening Hodgkin lymphoma survivors for radiotherapy induced cardiovascular disease. Cancer Treat Rev 37: 391-403. Link: https://bit.ly/3dU0ykO

29. Walsh MC (2010) Impact of treatment-related cardiac toxicity on lymphoma survivors: an institutional approach for risk reduction and management. Clin J Oncol Nurs 14: 505-507. Link: https://bit.ly/2AqRNkM

30. Heidenreich PA, Hancock SL, Lee BK, Mariscal CS, Schnittger I (2003) Asymptomatic cardiac disease following mediastinal irradiation. J Am Coll Cardiol 42: 743-749. Link: https://bit.ly/2CYZYpf

31. Orzan F, Brusca A, Conte MR, Presbitero P, Figliomeni MC (1993) Severe coronary artery disease after radiation therapy of the chest and mediastinum: clinical presentation and treatment. Br Heart J 69: 496-500. Link: https://bit.ly/2VDAhkq

32. Materazzo C, Massimino M, Schiavello E, Podda M, Gandola L, et al. (2017) Clinical and subclinical cardiac late effects in pediatric Hodgkin's lymphoma survivors. Tumori 103: 566-571. Link: https://bit.ly/3eS7pNf

33. Brusamolino E, Baio A, Orlandi E, Arcaini L, Passamonti F, et al. (2006) Long-term events in adult patients with clinical stage IA-IIA nonbulky Hodgkin's lymphoma treated with four cycles of doxorubicin, bleomycin, vinblastine, and dacarbazine and adjuvant radiotherapy: a single-institution 15-year follow-up. Clin Cancer Res 12: 6487-6493. Link: https://bit.ly/31B9jOk

34. Enrici RM, Anselmo AP, Donato V, Falchetto Osti M, Santoro M, et al. (1999) Relapse and late complications in early-stage Hodgkin's disease patients with mediastinal involvement treated with radiotherapy alone or plus one cycle of ABVD. Haematologica 84: 917-923. Link: https://bit.ly/2VFOpd5

35. Sager O, Dincoglan F, Demiral S, Uysal B, Gamsiz H, et al. (2020) Adaptive radiation therapy of breast cancer by repeated imaging during irradiation. World J Radiol 12: 68-75. Link: https://bit.ly/3dQ1TJG

36. Sager O, Dincoglan F, Demiral S, Uysal B, Gamsiz H, et al. (2019) Breathing adapted radiation therapy for leukemia relapse in the breast: A case report. World J Clin Oncol 10: 369-374. Link: https://bit.ly/2VC4wIC

37. Sager O, Dincoglan F, Uysal B, Demiral S, Gamsiz H, et al. (2018) Evaluation of adaptive radiotherapy (ART) by use of replanning the tumor bed boost with repeated computed tomography (CT) simulation after whole breast irradiation (WBI) for breast cancer patients having clinically evident seroma. Jpn J Radiol 36: 401-406. Link: https://bit.ly/2AnWFXL

38. Sager O, Beyzadeoglu M, Dincoglan F, Demiral S, Uysal B, et al. (2015) Adaptive splenic radiotherapy for symptomatic splenomegaly management in myeloproliferative disorders. Tumori 101: 84-90. Link: https://bit.ly/3eThjhj

39. Dincoglan F, Beyzadeoglu M, Sager O, Oysul K, Kahya YE, et al. (2013) Dosimetric evaluation of critical organs at risk in mastectomized left-sided breast cancer radiotherapy using breath-hold technique. Tumori 99: 76-82. Link: https://bit.ly/2VDfM7K

40. Sager O, Beyzadeoglu M, Dincoglan F, Oysul K, Kahya YE, et al. (2012) Evaluation of active breathing control-moderate deep inspiration breath-hold in definitive non-small cell lung cancer radiotherapy. Neoplasma 59: 333-340. Link: https://bit.ly/3ginaNB

Citation: Sager O, Beyzadeoglu M, Demiral S, Dincoglan F, Gamsiz H, et al. (2020) Assessment of cardıac sparıng ın radıotherapeutıc Management of medıastınal hodgkın lymphoma (hl) Durıng chıldhood and adolescence. J Surg Surgical Res 6(2): 106-109.DOI: https://dx.doi.org/10.17352/2455-2968.000107

41. Dincoglan F, Beyzadeoglu M, Sager O, Demiral S, Uysal B, et al. (2020) A Concise Review of Irradiation for Temporal Bone Chemodectomas (TBC). Arch Otolaryngol Rhinol 6: 016-020. Link: https://bit.ly/31AypwH

42. 42. Filippi AR, Meregalli S, DI Russo A, Levis M, Ciammella P, et al. (2020) Fondazione Italiana Linfomi (FIL) expert consensus on the use of intensity-modulated and image-guided radiotherapy for Hodgkin's lymphoma involving the mediastinum. Radiat Oncol 15: 62. Link: https://bit.ly/2VC5AfA

43. Meduri B, Gregucci F, D'Angelo E, Alitto AR, Ciurlia E, et al. (2020) Volume de-escalation in radiation therapy: state of the art and new perspectives. J Cancer Res Clin Oncol 146: 909-924. Link: https://bit.ly/2VCsyU3

44. Dewan A, Chufal KS, Tandon S, Ahmad I, Suresh T, et al. (2020) A case report evaluating combined effect of intensity-modulated radiotherapy and deep inspiratory breath-hold for mediastinal lymphoma: A dosimetric analysis. Lung India 37: 57-62. Link: https://bit.ly/2Bv1Plo

45. Dumane VA, Saksornchai K, Zhou Y, Hong L, Powell S, et al. (2018) Reduction in low-dose to normal tissue with the addition of deep inspiration breath hold (DIBH) to volumetric modulated arc therapy (VMAT) in breast cancer patients with implant reconstruction receiving regional nodal irradiation. Radiat Oncol 13: 187. Link: https://bit.ly/2VFaQPl

46. Tomaszewski JM, Crook S, Wan K, Scott L, Foroudi F (2017) A case study evaluating deep inspiration breath-hold and intensity-modulated radiotherapy to minimise long-term toxicity in a young patient with bulky mediastinal Hodgkin lymphoma. J Med Radiat Sci 64: 69-75. Link: https://bit.ly/2Zvx6MR

47. Besson N, Pernin V, Zefkili S, Kirova YM (2016) Evolution of radiation techniques in the treatment of mediastinal lymphoma: from 3D conformal radiotherapy (3DCRT) to intensity-modulated RT (IMRT) using helical tomotherapy (HT): a single-centre experience and review of the literature. Br J Radiol 89: 20150409. Link: https://bit.ly/3iphOlJ

48. Filippi AR, Ragona R, Piva C, Scafa D, Fiandra C, et al. (2015) Optimized volumetric modulated arc therapy versus 3D-CRT for early stage mediastinal Hodgkin lymphoma without axillary involvement: a comparison of second cancers and heart disease risk. Int J Radiat Oncol Biol Phys 92: 161-168. Link: https://bit.ly/2ZsFrAZ

49. Aznar MC, Maraldo MV, Schut DA, Lundemann M, Brodin NP, et al. (2015) Minimizing late effects for patients with mediastinal Hodgkin lymphoma: deep inspiration breath-hold, IMRT, or both? Int J Radiat Oncol Biol Phys 92: 169-174. Link: https://bit.ly/38lTlcr

50. Petersen PM, Aznar MC, Berthelsen AK, Loft A, Schut DA, et al. (2015) Prospective phase II trial of image-guided radiotherapy in Hodgkin lymphoma: benefit of deep inspiration breath-hold. Acta Oncol 54: 60-66. Link: https://bit.ly/38k3lgI

51. Koeck J, Abo-Madyan Y, Lohr F, Stieler F, Kriz J, et al. (2012) Radiotherapy for early mediastinal Hodgkin lymphoma according to the German Hodgkin Study Group (GHSG): the roles of intensity-modulated radiotherapy and involved-node radiotherapy. Int J Radiat Oncol Biol Phys 83: 268-276. Link: https://bit.ly/38jKbwZ

52. Paumier A, Ghalibafian M, Gilmore J, Beaudre A, Blanchard P, et al. (2012) Dosimetric benefits of intensity-modulated radiotherapy combined with the deep-inspiration breath-hold technique in patients with mediastinal Hodgkin's lymphoma. Int J Radiat Oncol Biol Phys 82: 1522-1527. Link: https://bit.ly/2VEZLOz

53. Scorsetti M, Cozzi L, Navarria P, Fogliata A, Rossi A, et al. (2020) Intensity modulated proton therapy compared to volumetric modulated arc therapy in the irradiation of young female patients with hodgkin's lymphoma. Assessment of risk of toxicity and secondary cancer induction. Radiat Oncol 15: 12. Link: https://bit.ly/2Zvdusj

54. Ricardi U, Maraldo MV, Levis M, Parikh RR (2019) Proton Therapy For Lymphomas: Current State Of The Art. Onco Targets Ther 12: 8033-8046. Link: https://bit.ly/2VBzbGc

55. Abbassi LM, Goudjil F, Arsène-Henry A, Dendale R, Kirova YM (2019) Protontherapy versus best photon for mediastinal Hodgkin lymphoma: Dosimetry comparison and treatment using ILROG guidelines. Cancer Radiother 23: 922-925. Link: https://bit.ly/2VFcjWe

56. Abbassi LM, Goudjil F, Arsène-Henry A, Dendale R, Kirova YM (2019) Protontherapy versus best photon for mediastinal Hodgkin lymphoma: Dosimetry comparison and treatment using ILROG guidelines. Cancer Radiother 23: 922-925. Link: https://bit.ly/2VFcjWe

57. Edvardsson A, Kügele M, Alkner S, Enmark M, Nilsson J, et al. (2019) Comparative treatment planning study for mediastinal Hodgkin's lymphoma: impact on normal tissue dose using deep inspiration breath hold proton and photon therapy. Acta Oncol 58: 95-104. Link: https://bit.ly/2ZsWNhf

58. Ho CK, Flampouri S, Hoppe BS (2014) Proton therapy in the management of lymphoma. Cancer J 20: 387-392. Link: https://bit.ly/3ipiMhx

59. Dabaja BS, Hoppe BS, Plastaras JP, Newhauser W, Rosolova K, et al. (2018) Proton therapy for adults with mediastinal lymphomas: the International Lymphoma Radiation Oncology Group guidelines. Blood 132: 1635-1646. Link: https://bit.ly/2Zxkuoq

60. Rechner LA, Maraldo MV, Vogelius IR, Zhu XR, Dabaja BS, et al. (2017) Life years lost attributable to late effects after radiotherapy for early stage Hodgkin lymphoma: The impact of proton therapy and/or deep inspiration breath hold. Radiother Oncol 125: 41-47. Link: https://bit.ly/3girfkT

61. Tseng YD, Cutter DJ, Plastaras JP, Parikh RR, Cahlon O, et al. (2017) Evidence-based Review on the Use of Proton Therapy in Lymphoma From the Particle Therapy Cooperative Group (PTCOG) Lymphoma Subcommittee. Int J Radiat Oncol Biol Phys 99: 825-842. Link: https://bit.ly/3dOQ4U5

62. Horn S, Fournier-Bidoz N, Pernin V, Peurien D, Vaillant M, et al. (2016) Comparison of passive-beam proton therapy, helical tomotherapy and 3D conformal radiation therapy in Hodgkin's lymphoma female patients receiving involved-field or involved site radiation therapy. Cancer Radiother 20: 98-103. Link: https://bit.ly/2YRDIpX

63. Lautenschlaeger S, Iancu G, Flatten V, Baumann K, Thiemer M, et al. (2019) Advantage of proton-radiotherapy for pediatric patients and adolescents with Hodgkin's disease. Radiat Oncol 14: 157. Link: https://bit.ly/31D7QHe

Citation: Sager O, Beyzadeoglu M, Demiral S, Dincoglan F, Gamsiz H, et al. (2020) Assessment of cardıac sparıng ın radıotherapeutıc Management of medıastınal hodgkın lymphoma (hl) Durıng chıldhood and adolescence. J Surg Surgical Res 6(2): 106-109.DOI: https://dx.doi.org/10.17352/2455-2968.000107