Calculation of Thyroid Dose with Planner System and Evaluation of Thyroid Function after Radiotherapy for Patients with Breast Cancer

Dorri Giv M.1, Bahreini Toosi M. H.2*, Aghamiri S. M. R.1, Akbari F.2, Taeb S.3

ABSTRACT

Background: Much research has widely been conducted into thyroid hormones levels following radiotherapy for breast cancer. Consequently, in this study, we evaluated to relate the rate of thyroid hormones levels with the dose distribution among breast cancer patients.

Material and Methods: Thirty patients were treated with 4-field breast cancer radiotherapy. The dose volume histograms, the volume percentage of the thyroid absorbing respectively 20, 30, 40 and 50 Gy were then estimated (V20, V30, V40 and V50) together with the individual average thyroid dose over the whole gland derived from their computed tomography-based treatment plans. Then, in serum samples triiodothyronine [T3], thyroxine [T4], thyroid-stimulating hormone [TSH] of the patients were measured before and after radiotherapy.

Results: There were no significant differences in thyroid hormones levels before and after radiotherapy for patients with breast cancer (P value >.05).

Conclusion: On the balance, we understood that thyroid stimulating hormones levels did not change before and after cancer breast radiotherapy.

Keywords
Thyroid, Breast Cancer, Radiotherapy

Introduction

Nowadays, early breast cancer is widely increasing and it can involve node-positive disease and local lymph nodes. One of the most important procedures for its therapy is surgery. However, it is possible that after surgery the remaining deposits of neoplastic disease locally or at distant sites are present [1, 2]. Therefore, radiotherapy plays a major role in the local deposit of breast cancer. Even though, radiotherapy greatly reduced the incidence of local deposits [3, 4], it has side effects on the rest of organs particularly on the sensitive organs such as thyroid gland, testes, etc. [5, 6]. Since thyroid gland is very sensitive, important and the largest pure endocrine gland in our body [7] and more importantly its hormones (triiodothyronine [T3] and thyroxine [T4]) play a very significant role in metabolism, development, growth, overall energy expenditure and a large number of body organs functions [7-9], an endless list of studies have been conducted so that these show incidence of hypothyroidism, Graves’ disease, thyroid can-
Dorri Giv M., et al

Cancer and benign adenoma after surgery and radiotherapy for patients with various cancers particularly head and neck cancer [5, 10-16]. Overall, these studies have been done but yet we witness unrecognized correlation between thyroid hormones levels after cancer radiotherapy [17]. As a result, we performed this study with the objective of defining the association between breast cancer radiotherapy and thyroid hormone level changes.

Material and Methods

Patients
This study was conducted in Reza treatment center at Mashhad University Medical of Sciences. We chose 30 patients with cancer breast. All characteristics of the patients and their treatment are summarized in Table 1.

Radiation Therapy
Before receiving dose patients, all patients were treated by using a three-dimensional computer-based treatment planning system and computed tomography (CT) scans. Then, dose delivery was performed using ETAR (Equivalent Tissue to Air Ratio) algorithm with a dose voxel size of 2 _ 2 _ 2 mm³. Radiotherapy technique is explained elsewhere. The breast received a dose of 60 Gy in 30 fractions and radiation dose was 1.8 or 2.0 Gy/d. Radiation delivered with a Linac accelerator 6- MV photons. Regional lymph nodes (supraclavicular, axillary, or internal mammary nodes or a combination of these) (Figures 1 and 2) were irradiated to a maximal dose of 60 Gy at the discretion of the radiation oncologist. Treatment procedures and received dose were the same in all patients.

Measurement of Thyroid Hormone Level
Serum samples were obtained from blood patients to determine levels of thyroid-stimulating hormone TSH, T3 and T4 levels before and after cancer breast radiotherapy. Then, we compared thyroid hormone levels before and after its therapy. In addition, this study was done during a 3 month therapy.

Statistical Analysis
Results of this study were analyzed by a T-

Table 1: Characteristics of patients and their treatment

| Characteristic                                      | Value                      |
|----------------------------------------------------|----------------------------|
| No. of patients                                    | 30                         |
| Range of age                                       | 25-38                      |
| Range of weight                                    | 70-83                      |
| sex                                                | Female                     |
| Stage                                              | III                        |
| Range of total radiation volume (cGy)              | 600 - 900                  |
| Volume Total of thyroid (cc)                       | 9.5 - 10.5                 |
| Range of dimension of the radiation in supraclavicular field (cm²) | 15.2 x 9.0 |
| Range of dimension of the radiation in axillary field (cm²) | 18.6 x 7.0 |
| With surgery                                       | 30                         |
| With chemotherapy                                  | 30                         |

Figure 1: Regional lymph nodes in the supraclavicular and axillary
test and compared thyroid hormone level.

**Results**

According to Figures 3, 4 and 5, there was no significant relation for TSH, $T_3$, and $T_4$ levels before and after cancer breast radiotherapy during 3 months of therapy. Also, Dose Volume Histogram received by thyroid is shown in Figure 6.

**Discussion**

Before and after study dates, thyroid hormones were almost the same in this study. A wide variety studies shows that glandular cells of the thyroid gland are considered resistant to radiation [18], but there is a possibility that extensive radiation over the permissible dose enhances the aberrant production of thyroid hormone or the generation of neoplasms and cysts [10]. Scientists are conducting research...
Figure 4: Mean of T₃ level before and after breast cancer radiotherapy

Figure 5: Mean of T₄ levels before and after breast cancer radiotherapy
into changes of thyroid hormone levels during radiotherapy from kinds of various cancers to show the incidents of hypothyroidism after cancer radiotherapy [10, 19, 20] and other scientists do not believe that incidents of hypothyroidism after radiotherapy and also say that hypothyroidism is categorized as a late disturbance of radiation [21]. Thus, patients who have a long interval after radiotherapy are at high risk of hypothyroidism. In addition, our results did not reveal any changes of TSH, T3 and T4 levels before and after radiotherapy. As a result, we can say that one of the most important factors for their changes is the number of months that we follow up patients after radiotherapy. Moreover, Garcia-Serra et al. offered a suggestion that serum TSH levels can be checked every 6 months for the first year [22]. It is well known that primary radiation induces thyroid hormonal changes and may enhance different damages [23]. Also, we can say that thyroid is prone to secondary radiation in breast cancer radiotherapy. Therefore, receiving dose is low.

Conflict of Interest
None

References
1. Cardoso LJSF, Martine J, Piccart–William C, Wood–Chie-Mien Hung. Breast Cancer and Molecular Medicine. Switzerland: Springer; 2006.
2. Weinberg R, Hahn W, Watnick R, et al., editors. Rules governing the creation of human tumor cells. I Int J Cancer. 2002;100:1.
3. Clarke M, Collins R, Darby S, et al. Effects of radiotherapy and of differences in the extent of surgery for early breast cancer on local recurrence and 15-year survival: an overview of the randomised trials. Lancet. 2005;366:2087-106. doi: 10.1016/S0140-6736(05)67887-7. PubMed PMID: 16360786.
4. Favourable and unfavourable effects on long-term survival of radiotherapy for early breast cancer: an overview of the randomised trials. Early Breast Cancer Trialists’ Collaborative Group. Lancet. 2000;355:1757-70. PubMed PMID: 10832826.
5. Ozawa H, Saitou H, Mizutari K, et al. Hypothyroidism after radiotherapy for patients with head and neck cancer. Am J Otolaryngol. 2007;28:46-9. doi: 10.1016/j.amjoto.2006.06.011. PubMed PMID: 17162132.
6. Hermann RM, Henkel K, Christiansen H, et al. Testicular dose and hormonal changes after radiother-
apy of rectal cancer. *Radiother Oncol.* 2005;75:83-8. doi: 10.1016/j.radonc.2004.12.017. PubMed PMID: 15878105.

7. Hancock SL, McDougall IR, Constine LS. Thyroid abnormalities after therapeutic external radiation. *Int J Radiat Oncol Biol Phys.* 1995;31:1165-70. doi: 10.1016/0360-3016(95)00019-U. PubMed PMID: 7713780.

8. Bassiri RM, Utiger RD. Thyrotropin-releasing hormone in the hypothalamus of the rat. *Endocrinology.* 1974;94:188-97. doi: 10.1210/endo-94-1-188. PubMed PMID: 2849564.

9. Beck-Peccoz P, Amr S, Menezes-Ferreira MM, et al. Decreased receptor binding of biologically inactive thyrotropin in central hypothyroidism. Effect of treatment with thyrotropin-releasing hormone. *N Engl J Med.* 1985;312:1085-90. doi: 10.1056/NEJM198504253121703. PubMed PMID: 2984564.

10. Cannon CR. Hypothyroidism in head and neck cancer patients: experimental and clinical observations. *Laryngoscope.* 1994;104:1-21. doi: 10.1288/00005537-199411001-00001. PubMed PMID: 7968176.

11. Kumpulainen EJ, Hirvikoski PP, Virtaniemi JA, et al. Hypothyroidism after radiotherapy for laryngeal cancer. *Radiother Oncol.* 2000;57:97-101. PubMed PMID: 11033194.

12. Turner SL, Tiver KW, Boyages SC. Thyroid dysfunction following radiotherapy for head and neck cancer. *Int J Radiat Oncol Biol Phys.* 1995;31:279-83. doi: 10.1016/0360-3016(93)E0112-J. PubMed PMID: 7860801.

13. Illés A, Bíró E, Miltényi Z, Keresztes K, Váróczy L, András C, Sipka S, Bakó G. Hypothyroidism and thyroiditis after therapy for Hodgkin’s disease. *Acta Haematol.* 2003;109(1):11-7. PubMed PMID: 12486317.

14. Thomas O, Mahe M, Campion L, et al. Long-term complications of total body irradiation in adults. *Int J Radiat Oncol Biol Phys.* 2001;49:125-31. PubMed PMID: 11163505.

15. Hancock SL, Cox RS, McDougall IR. Thyroid diseases after treatment of Hodgkin’s disease. *N Engl J Med.* 1991;325:599-605. doi: 10.1056/NEJM199108293250902. PubMed PMID: 1861693.

16. Bonadonna G, Bonfante V, Viviani S, et al. ABVD plus subtotal nodal versus involved-field radiotherapy in early-stage Hodgkin’s disease: long-term results. *J Clin Oncol.* 2004;22:2835-41. doi: 10.1200/JCO.2004.12.170. PubMed PMID: 15199092.

17. Tell R, Lundell G, Nilsson B, et al. Long-term incidence of hypothyroidism after radiotherapy in patients with head-and-neck cancer. *Int J Radiat Oncol Biol Phys.* 2000;60:395-400. doi: 10.1016/j.ijrobp.2004.03.020. PubMed PMID: 15380571.

18. Hall E. Dose-response relationships for normal tissues. *Radiobiology for the radiologist.* 1994:45-74.

19. Einhorn J, Wilkholm G. Hypothyroidism after external irradiation to the thyroid region. *Radiology.* 1967;88:326-8. doi: 10.1148/88.2.326. PubMed PMID: 6016932.

20. Jereczek-Fossa BA, Alterio D, Jassem J, et al. Radiotherapy-induced thyroid disorders. *Cancer Treat Rev.* 2004;30:369-84. doi: 10.1016/j.ctrv.2003.12.003. PubMed PMID: 15145511.

21. Hall E, Cox J. Physical and biologic basis of radiation therapy. Radiation Oncology: Rationale, Technique, Results Ed Stamathis G. 1989;6:1-11.

22. Garcia-Serra A, Amdur RJ, Morris CG, et al. Thyroid function should be monitored following radiotherapy to the low neck. *Am J Clin Oncol.* 2005;28:255-8. PubMed PMID: 15923797.

23. Colevas AD, Read R, Thornhill J, et al. Hypothyroidism incidence after multimodality treatment for stage III and IV squamous cell carcinomas of the head and neck. *Int J Radiat Oncol Biol Phys.* 2001;51:599-604. PubMed PMID: 11597798.