Radiology

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# ASSESSMENT OF THE IMPACT OF RADIOIODINE THERAPY OF THYROID CANCER IN POSTOPERATIVE CASES USING SCINTIGRAPHY

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**ABSTRACT:**

This study was carried out to assess the Impact of Radioiodine therapy of thyroid cancer in post-operative cases in King Khalid Hospital – Saudi Arabia using scintigraphy, it was a descriptive retrospective, and a prospective cross-sectional study was done during the period of June 2016 to February 2018 at King Khalid Hospital – Najran included 100 Saudi patients their age ranged (20-75) years old with differentiated thyroid carcinoma who underwent complete thyroidectomy and I131 ablation dose.Pre-therapy diagnostic whole body scintigraphy was done 48 hrs after administration of I131(3mci) to determine the ablation dose and post therapy whole body scintigraphy was performed 7 days after administration of iodine therapy dose (range 3.3-4.4 GBq) for detection and localization or exclusion of functioning thyroid remnants, persistent or recurrent local disease or distant metastasis in patients receiving I131therapy.

All patients came for follow –up after 6-12 months to assess the successful of ablation and to identify which patients may require repeat RAIT, the success rate of ablation is determined by negative whole body I131 scan.

The results of this study revealed that the mean age±SD of patients was 42.8±12.6 years (range 20–75) years; the most age frequently ranged from 31- 40 years. The most frequently histological type of thyroid carcinoma was papillary thyroid carcinoma. TSH level prior I131 dose was >30mIU/L. The mean ablation dose was 100.80 ± 11.9 mCi range from (3.33 to 4.44) GBq (90 to 120 mCi) of I131, with a median follow-up of 1 year (range 6months–18 months) with 185 MBq (5 mCi) of I131, from the study group it was seen that follow-up WBS was positive (there is recurrence) in 4 (4.0%) patients, the majority 96 patients (96.0%) had negative scans (success of Ablation). The correlation between whole-body scintigraphy finding and age showed that the mean age in the negative and positive scan was 43.06 years, 36.75 years respectively. Correlation between histological type of thyroid carcinoma and age group the papillary thyroid carcinoma was more in age group (31-40) years. The correlation between histological type and gender showed that the most histological type of female and male was papillary thyroid carcinoma repeated 58 and 18 times respectively. The mean ablation dose was 100.83mCi in the negative scan and 100.0mCi in the positive scan. Regarding T stage in T1 48 was negative scan and 3was positive, in T2 26 was negative scan, and there is no positive, in T3 22was negative, and one was positive. In nodal stage, the group with no lymph node invasion 96 was successfully ablated, and 2 with recurrence and group with lymph node involvement 2 with recurrence and there is no negative scan. There was no distant metastasis case in the study group. The mean tumor size was 2.69cm in the negative scan and 2.50 cm in the positive scan. It concluded that papillary thyroid carcinoma was highly response to radioiodine therapy, RT lobe of the thyroid gland was more affected than Lt Lobe and Most of the patients in the study sample were successfully ablated.

## INTRODUCTION

Iodine-131 has been used for over 60 years in the treatment of patients with DTC, to destroy both remaining thyroid cells and carcinoma foci. However, the indications for radioiodine therapy continue to be debated (Voutilainen PE, 2003).

$I^{131}$has a physical half-life of 8.05 days. It decays by high-energy gamma photon (364 keV) and particulate emissions (beta particle). The beta emission has an average energy of 192 keV (max energy 607 keV (90%), and 810 keV (7%)] and the beta particle will deposit its energy within 2.2 mm(90%) and 3.1 mm (7%), respectively of its site of origin (Bender JM,1993) with a mean tissue range of only 0.8 mm. The success of thyroid ablation with $I^{131}$depends mainly on the mass of remaining thyroid tissue in the neck and the initial dose rate to this tissue (DoiSA,et al ,2000).$I^{131}$ablation is not recommended in general (Samuel AM, 1994).Ablation with $I^{131}$is performed when the patient has a tumor with the potential for recurrence because it decreases both recurrence and death rates (Stocker DJ,2003). Retrospective data from multiple studies show that radioiodine ablation is associated with a 50% reduction in locoregional relapse and the longterm disease-specific mortality is probably reduced in primary tumors that are at least 1 to 1.5 cm in diameter, are multicentric, or have the soft-tissue invasion at presentation ( DeGroot LJ,1990). Although the debate about ablating the thyroid bed with $I^{131}$after total thyroidectomy continues ( Taylor T,1998), there are some compelling reasons to do this (Mazzaferri EL,1997): To destroy any residual microscopic foci of residual disease.To increase the sensitivity of subsequent $I^{131}$scanning for detection of recurrent or metastatic disease by eliminating uptake by residual normal tissue.High circulating TSH levels, necessary to enhance tumor $I^{131}$uptake, cannot be achieved with a large thyroid remnant. To improve the value of measurements of serum Tg as a tumor marker (Luster M.et al, 2005).Adjuvant radioiodine should be administered to all patients with differentiatedcarcinoma, when the

primary tumor is likely to relapse or cause death, andto patients who have evidence of extrathyroidal disease, either by direct invasion outside of the gland or loco regional metastases. In patients with residual disease following surgery, including extra cervical metastases, therapy with $I^{131}$ should be performed.( Ron E, Kleinerman.etal 1987).Treatment with radioiodine was the single most powerful prognostic indicator for a disease-free interval and increased survival.( Mattavelli F, et al.(2007). Those patients categorized as low risk also had significantly lower recurrence and death rates if they received $I^{131}$. ( Waxman A, et al 1981). Clinical members of the American Thyroid Association were surveyed regarding their treatment and long-term assessment of differentiated papillary thyroid carcinoma (Zhang, 1998).

This study aimed to assess the Impact ofRadioiodine therapy of thyroid cancer in post-operative cases in King Khalid Hospital – Saudi Arabia during period from 2016 to 2018 by using scintigraphy.

## MATERIAL AND METHODS

This was a descriptive qualitative hospital base studywith an aim to assess the impact of Radioiodine therapy in post-operative cases by using scintigraphy in Najran city during the period from June 2016 to February 2018.

**Subjects** The sample size of this study was 100 patients who their age ranged from 20-75years old with differentiated thyroid carcinoma who underwent complete thyroidectomy and $I^{131}$ ablation dose, Pre-therapy dxWBS was done 48 hrs after administration of $I^{131}$ (3mci) to determine the ablation dose and PTWBS was performed 7 days after administration of iodine therapy dose (range 3.3-4.4 GBq) for detection and localization or exclusion of functioning thyroid remnants, persistent or recurrent local disease or distant metastasis in patients receiving $I^{131}$ therapy.

### Technique

### Diagnostic whole-body $I^{131}$ scintigraphy (dx WBS):

Usually performed four to six weeks after thyroidectomy without any thyroid hormone replacement in the interval.

### Patient preparation

Explain the goal of the scan to the patient. Patients on thyroxine suppression need to stop the thyroxine for approximately four weeks before therapy to reach a hypothyroid state. Patients are given a low-iodine diet for a 1-2 week before therapy; alow-iodine diet shrinks the iodide pool in the body, increases the percentage of $I^{131}$ in the iodide pool and potentially increases the uptake of radio iodide by the thyroid remnant or tumor. No food for four hr. Before radioiodine administration, the patient may drink water but should not eat for 4 hrs before radioiodine administration because food may delay absorption of the radioiodine. Patients should not be scheduled for treatment if they have had intravenous contrast within the preceding 4-6 wk.The iodine in the contrast increased the iodide pool and decrease the uptake of $I^{131}$by the thyroid remnant or tumor.Exogenous iodine in diet or medications containing iodine will increase the iodide pool and decrease the uptake of $I^{131}$ by the thyroid remnant or tumor

The patient should be asked to discontinue any supplements containing iodine for several weeks before therapy.Patients are given a mild laxative the day before the scan to minimize gut activity

**Radio pharmaceuticals:** Oral $I^{131}$ capsule is administered in activities of 1–5mCi or less.

**Equipment Setup**: Gamma Camera: Dual-head whole-body camera. The collimator is High-energy parallel-hole. Energy Window: 364 keV with 20% window

**Patient Positioning**: Supine with arms at the side. For the spot images of the head and neck and the optional pinhole images, a pillow should be placed under the patient's shoulders to extend the neck.

**Routine whole-body imaging**: Image 48 hours after administration of the radiopharmaceutical. If $I^{131}$is administered on Tuesday, imaging may be performed instead on Thursday. The standard examination consists of anterior and posterior whole-body images (head to knees) (usually acquired at four cm/min—typically require 30 minutes) both lateral images of the head and neck and an anterior image of the head and neck with the head in the extended position. The patient should be asked to drink a glass of water before the spot images to clear activity from the esophagus. Collect the spot images for 10 min each.

Imaging after high-dosage $I^{131}$therapy generally will be performed at 72-120 hours. The standard examination consists of anterior and posterior whole-body images (head to knees) (usually acquired at 6 cm/min typically require 20 minutes), Collect the spot images for 5 min each. Optional imaging: Pinhole Images- If requested by the physicianobtains 10-min images of the neck at a distance of 14 cm with and without a sterna notch marker. SPECT or SPECT/CT Imaging- As requested by the physician.

**Follow-up:** All patients were followed up at three months, 6months and after one year and then six monthly. The first follow up scan was performed after 6 months with 185 MBq (5 mCi) of $I^{131}$ when TSH was >30 mIU/L. $I^{131}$whole body scan was usually done using a large field of view gamma camera with a medium energy, parallel-hole collimator, and the photo peak was 364 KeV with a 20% window. Continuous acquisition mode was used with a scanning ratio of 9 - 13 cm/s with a $512 \times 512$ or $1,024 \times 256$ matrix. Anterior and posterior views of the whole body can be obtained simultaneously. Spot views of suspected sites of metastasis can be done additionally using a $256 \times 256$ matrices for a total of500,000 counts. The additional image such as scanning after drinking a glass of water to washout physiologic uptake in the esophagus is sometimes needed TSH was achieved by prior withdrawal of thyroid hormone for 4-6 weeks**.**

Patients who have undergone thyroidectomy and radioiodine ablation requirelifelong thyroid hormone replacement Thyroid-stimulating hormone levels of 0.1 mIU/L or less are usually recommended minimizing the risk of tumor growth, In patients with an undetectable serum Tg concentration and negative neck ultrasound during follow-up, the risk of recurrence is so low.

The follow-up of thyroid cancer is based on the detection of residual andrecurrent thyroid carcinoma. This is traditionally performed by routine palpationand ultrasonography of the thyroid bed and loco regional lymph-node areas, andmeasurements of serum Tg combined with $I^{131}$whole-body scans after thyroidHormone withdrawal or administration of recombinant TSH**.**

### Low-Risk Patients with No Thyroglobulin Antibodies:

These patients were submitted to total thyroidectomy and $I^{131}$ablation. Therewas no evidence of disease on post-ablation whole-body scintigraphy (WBS) Six months to one year after therapy with I-131, the use of sensitive Tg assays can separate the patients with persistent disease from those free of disease that are unlikely to have recurrent disease, without the need for repeated whole-body radioiodine scans

### High-Risk Patients and Metastatic Disease:

After the administration of an ablative dose of $I^{131}$, further treatment is warrantedsurgery and $I^{131}$therapy) if the post-therapy whole-body scanshows uptake outside the thyroid bed. If no uptake is seen outside the thyroid bed, the combination of a diagnostic $I^{131}$whole-body scan, with 74 MBq (2 mCi) of $I^{131}$, and serum Tg measurement is recommended by many authors 6 to 12 months after thyroid ablation under withdrawal of L-thyroxin or rhTSH .

### Results

The results of this study represent in the following tables:

**Table 1: Show thecorrelation between T stage and age (years).**

| | | T Stage(cm) | | | Total |
|---|---|---|---|---|---|
| | | T1 | T2 | T3 | |
| Age group(years) | 20-30 | 14 | 2 | 1 | 17 |
| | 31-40 | 24 | 6 | 3 | 33 |
| | 41-50 | 5 | 13 | 3 | 21 |
| | 51-60 | 6 | 3 | 11 | 20 |
| | 61-75 | 2 | 2 | 5 | 9 |
| Total | | 51 | 26 | 23 | 100 |

T1: Tumor size <2cm, T2 Tumor >2cm <4cm, T3: tumor 4cm

**Table 2: Show the correlation between the independent variable and whole body scintigraphy findings.**

| Independent variable | | Negative Scan | Positive Scan |
|---|---|---|---|
| Age (mean years) | | 43.06 | 36.75 |
| Gender | M-20 | 19 | 1 |
| | F-80 | 77 | 3 |
| Histological type | Pap | 70 | 4 |
| | Foll | 20 | 0 |
| | Pap&Foll | 6 | 0 |
| Tumor size ( mean cm) | | 2.69 | 2.50 |
| TSH level (mean mIU/L | | 85.75 | 113.50 |
| Ablation dose (mean mCi) | | 100.83 | 100.0 |
| T stage | T1 | 48 | 3 |
| | T2 | 26 | 0 |
| | T3 | 22 | 1 |
| Nodal stage | N0 | 96 | 2 |
| | N1 | 0 | 2 |

**Table 3: Show the correlation between Follow up WBS finding and age**

| | | Follow up WBS findings | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| Age group(years) | 20-30 | 16 | 1 | 17 |
| | 31-40 | 31 | 2 | 33 |
| | 41-50 | 21 | 0 | 21 |
| | 51-60 | 19 | 1 | 20 |
| | 61-75 | 9 | 0 | 9 |
| Total | | 96 | 4 | 100 |

Negative scan: the success of Ablation, positive Scan: there is recurrence

**Table 4: Show the correlation between Follow up WBS finding and Gender.**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| Gender | Female | 77 | 3 | 80 |
| | Male | 19 | 1 | 20 |
| Total | 96 | 4 | 100 | |

Negative scan: the success of Ablation, positive Scan: there is a recurrence

**Table 5: Show the correlation between Follow up WBS finding and histological type of thyroid cancer**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| Histological type of thyroid cancer | papillary | 70 | 4 | 74 |
| | Follicular | 20 | 0 | 20 |
| | Pap &foll | 6 | 0 | 6 |
| Total | 96 | 4 | 100 | |

Negative scan: the success of Ablation, positive Scan: there is the recurrence

**Table 6: Show the correlation between Follow up WBS finding and T stage**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| T Stage | T1 | 48 | 3 | 51 |
| | T2 | 26 | 0 | 26 |
| | T3 | 22 | 1 | 23 |
| Total | | 96 | 4 | 100 |

T1: Tumor size <2cm, T2 Tumor >2cm <4cm, T3: tumor 4cm

**Table 7: Show correlation between Follow up WBS finding and Clinical stage.**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| Clinical stage | T1 N0 M0 | 46 | 1 | 47 |
| | T2 N0 M0 | 27 | 0 | 27 |
| | T3 N0 M0 | 23 | 1 | 24 |
| | T1 N1 M0 | 0 | 2 | 2 |
| Total | | 96 | 4 | 100 |

**Table 8: Show the correlation between Follow up WBS finding and Tumor size (cm).**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| Tumor Size (cm) | 1.3-2.0 | 2 | 0 | 2 |
| | 2.1-2.9 | 52 | 3 | 55 |
| | 3.0-3.9 | 16 | 0 | 16 |
| | 4 | 26 | 1 | 27 |
| Total | | 96 | 4 | 100 |

**Table 9: Show the correlation between Follow up WBS finding and me 131 Therapy dose (mCi).**

| | | Follow upWBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| I 131 Therapy doseGBq/mCi | 3.3/90 | 40 | 2 | 42 |
| | 3.7/100 | 32 | 1 | 33 |
| | 4.4/120 | 24 | 1 | 25 |
| Total | | 96 | 4 | 100 |

Negative scan: Absent of activity in thyroid bed, Positive scan: the present of activity in the thyroid bed

**Table 10: Show the correlation between Follow up WBS finding and TSH level (mIU/L).**

| | | Follow up WBS | | Total |
|---|---|---|---|---|
| | | Negative Scan | Positive Scan | |
| TSH level Group (mIU/L | >30< 50 | 4 | 0 | 4 |
| | 51-65 | 16 | 0 | 16 |
| | 66-75 | 10 | 1 | 11 |
| | 76-85 | 5 | 0 | 5 |
| | 86-99 | 16 | 1 | 17 |
| | >100 | 45 | 2 | 47 |
| Total | 96 | 4 | 100 | |

Negative scan: Absent of activity in thyroid bed, Positive scan: the present of activity in the thyroid bed

## DISCUSSION

This study was carried out on 100 Saudi patients (Male and Female) their age range between 20 to 75 years old with differentiated thyroid carcinoma who underwent complete thyroidectomy and $I^{131}$ ablation dose, from June 2016 to February 2018 in King Khalid Hospital – Najran.

Pre-therapy dxWBS was done 48 hrs after administration of $I^{131}$ (3mci) to determine the ablation dose and PTWBS was performed 7 days after administration of iodine therapy dose (range 3.3-4.4 GBq) for detection and localization or exclusion of functioning thyroid

remnants, persistent or recurrent local disease or distant metastasis in patients receiving $I^{131}$ therapy.

All patients came for follow –up after 6-12 months to assess the successful of ablation and to identify which patients may require further treatment, the success rate of ablation is determined by negative whole body $^{131}I$ scan.

Cross-tabulation for the tumor stage with age, the most frequently tumor stage was T1 in the age group (31-40) years with frequency 24.from T1 to T3 the maximum age group was (31-40) years repeated 33 times and the minimum age group was (61-75) years repeated nine times. Table 1.

The mean age in negative and positive scan was 43.06 ,36.75 years respectively, so the patients with age more than 40 years old were highly response to $I^{131}$ therapy, Table 2 , this disagreed with study of C. Durante ,et al (2016) .Male had 19 negative, and one positive, female had 77 negative and three positive, so female were more response to radioiodine therapy. Regarding histological type of thyroid carcinoma in papillary thyroid carcinoma 70 patients were negative scan and 4 was positive scan, in follicular thyroid carcinoma 20 patients were negative and there is no positive scan, in (papillary and follicular) 6 was negative scan and there is no positive scan, so papillary thyroid carcinoma was highly response to radioiodine therapy. The mean tumor size was 2.69cm in negative scan and 2.50cm in the positive scan. The mean TSH level was 85.75mIU/L in the negative scan and 113.50mIU/L in the positive scan However the mean TSH level of Md. Sayedur Rahman Miah,et al (2001) was 74.65 ± 12.47 mIU/L in negative scan and 77.95 ± 9.56 mIU/L in positive scan. The mean ablation dose was 100.83mCi in the negative scan and 100.0mCiin the positive scan. Regarding T stage in T1 48 was negative scan and 3was positive, in T2 26 was negative scan, and there is no positive, in T3 22was negative, and one was positive. In nodal stage, the group with no lymph node invasion 96 was successfully ablated, and 2 with recurrence and group with lymph node involvement 2 with recurrence and there is no negative scan.

The correlation between WBS finding and age group showed that age group (20-30) years had 16 negative scan and 1 positive, age group (31-40) years had 31 negative scan and 2 positive scan, group (41-50) years had 21 negative scan and 0 positive, group (51-60) years had 19 negative scan and 1 positive and group (61-75) years had 9 negative scan and there is no positive scan. Table 3

Regarding Table 4 and the successful of radioiodine therapy, it was seen that in negative scan female was 77 and male was 19, in positive scan female was 3and one male, so female had more successful of radioiodine therapy.

As seen in Table 5 and regarding the histological type of thyroid carcinoma study Showed that papillary thyroid carcinoma had70 with the negative scan, 4 was positive scan, and follicular thyroid carcinoma had 20 was negative scan and there is no positive and mixed had 6 negative, so most of the patient successfully ablation was papillary thyroid carcinoma.

The relation between tumor size and WBS findings showed that tumor size range (1.3-2.0) cm had 2 negative scans and there is no positive scan, size (2.1-2.9) cm had 52negative scans and 3 positive scans, size (3.0-3.9)cm had 16negative scan and there is no positive scan and size 4cm had 26negative scan and 1 positive scan, so the biggest distribution was observed in tumor size range (2.1-2.9) cm and negative scan. Table 6.

As seen in Table 7and regarding WBS findings showed that T1 had 48 negative scan and 3positive scan, T2 had 26 negative scans and no positive scan, T3 had 22 negative scan and 1positive scan, so most of patient with tumor size less than 2cm were successfully ablated.

As seen inTable 8in this study achieved that T1 N0 M0 was negative in 46 patients and positive 1, T2 N0 M0 was negative in 27 patients and there no positive scan, T3 N0 M0 was negative in 23 patients and 1 in positive, T1 N1 M0 was positive in 2 patients and there is no negative, so the stage one group were highly response to iodine therapy.

Regarding ablation dose of radioiodine therapy, it was seen that dose 3.3 GBq had 40 negative scans and 2 positive, dose 3.7GBq had 32 negative and 1 positive scan, dose 4.4 GBq had 24 negative scans and 1 positive scan, so the group dose of 3.3 GBq had the biggest distribution, as seen in Table 9

As seen in Table 10 in the present study Showed that TSH level more than 30 mIU/L and less than 50mIU/L had 4 negative scans and there is no positive, TSH level range (51-65) mIU/L had 16 negative scan and there is no positive, TSH level range (66-75) mIU/L had 10 negative scans and 1 positive, TSH level range (76-85) mIU/L had 5 negative scan and there is no positive, TSH level range (86-99) mIU/L had 16 negative scans 2 positives, TSH level >100 mIU/L had 45 negative scans and 2 positives, the mean TSH level was 85.75 in negative scan and 113.50 in positive scan, so patient with TSH group more than 100 had the biggest distribution.

## CONCLUSION

This study concluded that: Radioiodine therapy is highly recommended in patients with differentiated thyroid carcinoma and follow-up should be done every six months by scintigraphy.The follow-up diagnostic whole-body scintigraphy with I-131 Na I (4 mCi) is very important to show pathological uptake of radioiodine in the patient's body.

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