

## Retrospective Study of Tc-99m Thyroid Scan in Patients with Graves' Disease: Is There Significant Difference in Lobar Activity?

### Abstract

**Purpose:** Graves' disease (GD) is the most common cause of hyperthyroidism. It was reported that the right thyroid lobe is generally larger, and it is more likely to be affected by thyroid disorders. The aim of the current study is to verify preferential affection of one of the thyroid lobes and incidence of higher activity of either thyroid lobe in patients with GD through analysis of quantitative data of Tc-99m thyroid scan and possible relation of different thyroid lobar activity to gender, age, and total thyroid uptake (TTU) level. **Materials and Methods:** Retrospective analysis of quantitative data of Tc-99m thyroid scan in patients with GD was done. Total and lobar thyroid uptake levels were analyzed and correlated with age, gender, and TTU. **Results:** GD was reported in 222 patients, representing 76.6% of those with hyperthyroidism, women represent 70.3% of patients. The right thyroid lobe uptake (RLU) figures were significantly higher compared to the left in the whole group as well as in women and in young patients (<40 years). This significance was lost in men and in old patients. Equal lobar uptake was found in 11 patients. 138 patients (62.2%) had higher RLU, while the remaining 73 patients (32.8%) had higher left thyroid lobe uptake, with statistically significant difference. This significant difference was found in women and in young patients and was absent in men and old patients. There is an increase in the incidence of patients with higher RLU in association with an increase in TTU. All women with TTU >30% had higher RLU figures. **Conclusion:** There is significant preferential thyroid lobar affection in favor of the right thyroid lobe in patients with GD, with significantly higher RLU figures and significantly more incidence of patients with higher right lobar activity. This significance is maintained in women and in young patients and lost in men and old patients. The incidence of higher right thyroid lobe activity also increases in association with increase in TTU. Our results emphasize the value of Tc-99m thyroid scan in patients with GD, especially when surgery is the treatment of choice, helping to tailor suitable surgical procedure for each individual patient.

**Keywords:** Different lobar uptake, Graves' disease, Tc-99m thyroid scan

### Introduction

The important value of the thyroid gland comes from the fact that it plays a pivotal role in regulating body metabolism.<sup>[1]</sup> Imbalance in this regulation by alteration of thyroid hormonal profile can result in many disorders.<sup>[2]</sup> Hyperthyroidism is one of these disorders that can be attributed to different thyroid disease entities. Graves' disease (GD), an autoimmune disorder, is the most common cause of hyperthyroidism worldwide, accounting for 50%–80% of all causes of thyrotoxicosis. It frequently affects young women.<sup>[3-5]</sup>

GD diagnosis is based on clinical signs and symptoms of diffuse goiter, palpitation, nervousness, weight loss, and

ophthalmopathy together with laboratory findings including suppression of serum thyroid-stimulating hormone (TSH) concentration, elevation of serum levels of free T3, free T4, as well as thyroid receptor antibody positivity.<sup>[6,7]</sup>

Tc-99m thyroid scan has a great role in the assessment of thyroid function prior to therapy in GD. It was reported that Tc-99m scan is more important in preparation of radioactive iodine (I-131) therapy to assess gland size and to calculate dose of I-131. The characteristic scan features include diffuse thyroid gland enlargement with intense homogenous tracer uptake pattern together with depletion of background activity and salivary glands tracer handling. Furthermore, quantitative

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data are characterized by variable degrees of high total thyroid uptake (TTU) level, that becomes more elevated in association with increase severity of the disease process.<sup>[8,9]</sup>

It was reported that the right thyroid lobe is generally larger than the left. Besides, the right thyroid lobe is more likely to be affected by thyroid nodules. Furthermore, it was stated that the right thyroid lobe tends to enlarge more in diffuse goiter.<sup>[10,11]</sup>

The difference in thyroid lobe affection by thyroid disorders was also reported for patients with unilateral GD. It was postulated that it may be related to side-to-side differences in interaction of thyroid lobes with antibodies which is related to multifactorial origin. One reason might be local suppression of sodium iodide symporter (NIS) gene expression and function which may be responsible at least partially for the development of impaired uptake of radioactive iodine by thyroid tissue of either lobe, especially during early stages of hyperthyroidism, resulting in interlobar different tracer uptake figures. Another reason might be the isolated lymphatic drainage of each lobe, which may lead to variable autoreactivity against thyroid autoantigens and TSH receptors resulting in different thyroid lobar activity.<sup>[12,13]</sup> Assessment of this different lobar activity is going to be done in the current study through the analysis of quantitative data of Tc-99m thyroid scan, including total and individual lobar thyroid uptake figures.

### Aim

The aim of the current study is to verify possible significant preferential affection of one of the thyroid lobes in patients with GD and whether there is a significantly higher incidence of affection of either thyroid lobe in this disease entity through analysis of quantitative data of Tc-99m thyroid scan. Furthermore, we are going to correlate any resultant preferential lobar uptake and incidence of lobar affection in GD patients with gender, age, and TTU.

### Materials and Methods

This is a retrospective study in which data from all patients referred for Tc-99m thyroid scan to King Abdulla Medical City in the period from January 2010 to June 2019 were reviewed. Selected patients should have the following criteria:

1. Clinically established hyperthyroidism associated with laboratory results showing elevated serum levels of free T3 and free T4 with low-serum TSH level
2. Presence of signs and symptoms related to hyperthyroidism with low-serum TSH level associated with serum-free T3 and free T4 levels either within the normal or high normal range or with elevation of one of them, with the clinical diagnosis of subclinical hyperthyroidism
3. The thyroid scan was performed after excluding antithyroid medications and any sources of iodine

interference. The dose of free Tc-99m was 5 mCi (185 MBq) and imaging was performed 20–25-min post tracer injection

4. The region of interest of the thyroid gland as well as of both the right and left lobes were properly drawn as well as the background area to ensure having appropriate quantitative uptake figures of TTU as well as right thyroid lobe uptake (RLU) and left thyroid lobe uptake (LLU) figures, with the calculated TTU 3.5% or more
5. The scan reached an exact underlying etiological diagnosis of the patient clinical status of hyperthyroidism, with the final report clearly stating one of the following four diagnoses to be accused for the patient clinical status: thyroiditis, toxic nodular goiter, autonomous thyroid nodule, or GD.

The only exclusion criterion was the presence of a history of any form of previous thyroid surgical interference.

Data of included patients regarding age, gender, total, and individual thyroid uptake levels were tabulated and subjected to statistical analysis.

### Statistical analysis

Statistical data were analyzed using the Statistical Package of Social sciences (SPSS) -version21- (SPSS Inc. Chicago, IL). Numeric data were presented as the mean and the standard deviation or the median and were compared between any two groups by the independent *t*-test or the nonparametric Mann–Whitney test. The choice of the method of presentation or comparison was based on the type of data distribution. Categorical data were presented as percentages and were compared by the Chi-squared test. For all comparisons, a two-sided alpha was set at 0.05.

### Results

Patients with the aforementioned criteria who were referred for thyroid scan looking for an underlying etiological diagnosis of their clinical status were 290 patients. Tc-99m thyroid scan diagnosed thyroiditis, toxic multinodular goiter, and toxic adenoma as an underlying etiological factor in 34, 23, and 11 patients, respectively, representing 23.4% of patients. The remaining 222 patients proved to have GD were included in the current study, representing 76.6% of those with thyrotoxicosis.

GD was more commonly seen in women, representing 70.3% of the patient population (156 patients), while the remaining 66 patients were men (29.7%) [Table 1]. The age range of those with GD was from 15 to 80 years, with a mean age of  $38.7 \pm 14.7$  years. The latter figure was  $37.7 \pm 14.5$  and  $41.2 \pm 15$  for women and men, respectively, with no statistically significant difference between the age of both groups ( $P = 0.097$ ). Patients were divided according to age into two groups, those below 40 years and those above this age. 132 patients (59.5%) belong to the former group, while the remaining 90 patients (40.5%) were in the

older age group. Out of the former group, young women represent 76%, accounting for 45% of whole patients, with significantly higher number of women in the younger age group ( $P = 0.048$ ). Old women (>40 years) account for 25.2% of the whole group followed by old and young men with almost equal figures of 15.3% and 14.4% of included patients, respectively [Table 1].

The TTU level for the whole group was greatly variable, ranging from 3.8% to 55.4%. The uptake level of 3.8% was reported in a 31-year-old woman with subclinical hyperthyroidism and the 55.4% uptake level was found in a 17-year-old woman with overt hyperthyroidism.

The TTU for the whole group had a mean value of  $13.5 \pm 8.8$ . This figure was relatively higher in women compared to men, being  $14 \pm 9$  and  $12.3 \pm 8.2$ , respectively, with no statistically significant difference between TTU of both groups ( $P = 0.155$ ). On the other hand, the mean RLU and LLU for the whole group were  $7.1 \pm 4.7$  and  $6.2 \pm 4.3$ , respectively, with statistically significant difference between lobar uptake in the whole group ( $P = 0.037$ ). Yet, splitting by gender led to loss of statistical difference in the smaller group of males ( $P = 0.761$ ), but it was still retained in the larger female group of patients ( $P = 0.021$ ) [Table 2].

As regards age, the mean TTU for patients in the young group was  $14.4 \pm 9.8\%$  versus  $12.1 \pm 6.9\%$  for older patients, with significant difference between TTU figures ( $P = 0.031$ ). The mean value of RLU was  $7.6 \pm 5.4\%$  and  $6.1 \pm 3.7\%$ , respectively, with a significant  $P$  value ( $P = 0.016$ ). This significant correlation was absent for LLU ( $P = 0.089$ ) with mean figures of  $6.9 \pm 4.7\%$  and  $5.9 \pm 3.4\%$  for young and old groups of patients, respectively. On the other hand, the difference between uptake figures of RLU and LLU in young patients was significant ( $P = 0.033$ ), yet, for older group, the difference was statistically insignificant ( $P = 0.439$ ) [Table 2].

Around 80% (177/222) of patients had TTU <20%. Young patients (<40 years) represented 73.3% (33/45)

of patients with thyroid uptake level more than 20% and 55.9% (99/177) of those with thyroid uptake level below 20% versus 26.7% and 44.1% for patients more than 40 years of age, respectively [Table 3]. Figure 1 shows the older the patient, the lower the TTU level.

Patients were divided according to TTU into four groups, those with TTU level >3.5% up to 10%, from 10% to 20%, from 20% to 30%, and those with TTU more than 30%. These groups included 97, 80, 31, and 14 patients representing 43.7%, 36%, 14%, and 6.3% of patients, respectively. Women represent 65% (63/97), 72.5% (58/80), 80.6% (25/31), and 71.4% (10/14) of those groups, respectively. It is worth to mention that all women in the latter group with TTU figure more than 30% belong to the young age group (<40 years) [Table 4].

Both thyroid lobes had equal thyroid uptake figures (ELU) in 11 patients [Figure 2], with RLU-to-LLU ratio equals 1, representing 5% of the whole patients group. On the other hand, this ratio was more than 1 in 138 patients [Figure 3]. This group had uptake ratio range from 1.1 to 2.9, with a mean value of  $1.93 \pm 0.59$ . On the other hand, this ratio is <1 in the remaining 73 patients [Figure 4]. For the latter group, the RLU-to-LLU ratio range was 0.34–0.97, with a mean value of  $0.67 \pm 0.29$ . The number of patients with RLU: LLU >1 denoted higher incidence of right thyroid lobe activity with more number of patients with right lobar affection by the underlying disease process. This is also applicable to the left thyroid lobe in patients with RLL:LLU <1, denoting more involvement of the left thyroid lobe by the autoimmune disease process in GD. The difference in this ratio was statistically significant in the whole group, in women as well as in young age group with significantly more number of patients with higher right lobar activity and involvement by the autoimmune process of GD. For men and old age patients, still a higher incidence of right lobar affection is noted; yet, the difference is statistically not significant [Table 5].

In general, for the whole patients, there was significant increase in the incidence of higher RLU with increase in TTU. This increased from 50% to 70% , 67.7% and to 85.7% in the four groups of TTU, namely in those with TTU up to 10%,from 10-20% ,from 20-30% And more than 30% respectively. In women, this increase was more evident climbing from 55%,to 69.7% ,88.2% up to 100%, the latter figure is for those with TTU more than 30%. The situation is different in men with those figures ranging

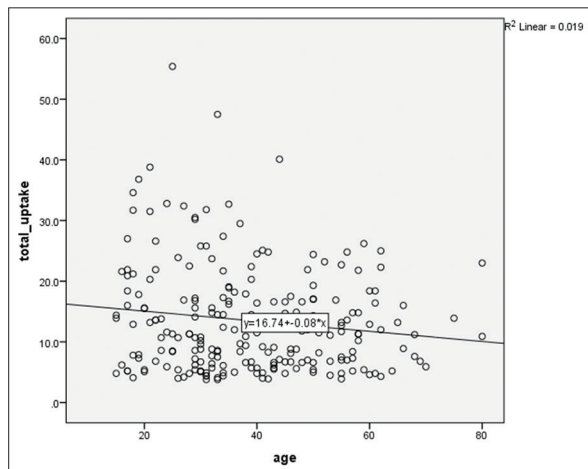


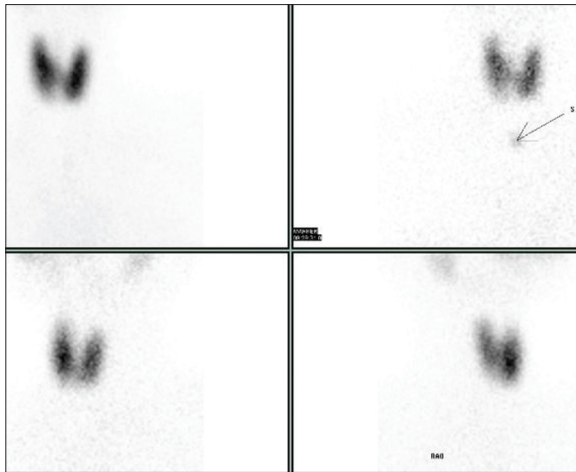
Figure 1: Correlation between total thyroid uptake and patients' age

Table 1: Gender and age of 222 patients with Graves' disease

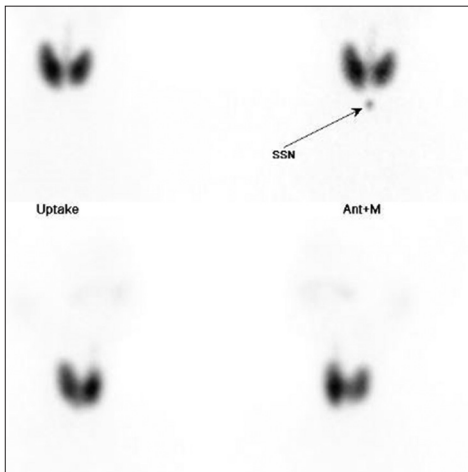
Age	<40 years	>40 years	Total
Females	100 (45%)*	56 (25.2%)	156 (70.3%)
Males	32 (14.4%)*	34 (15.3)	66 (29.7%)
Total	132 (59.5%)	90 (40.5%)	222 (100%)

\*Significant  $P < 0.05$

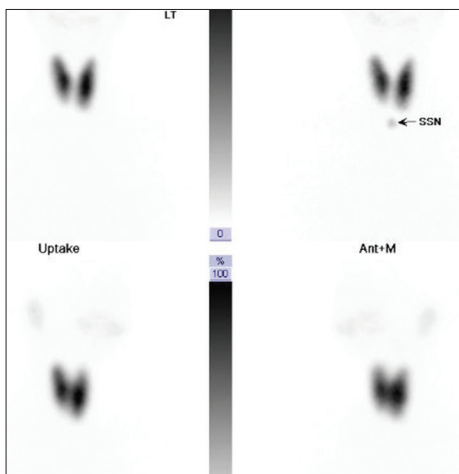




**Figure 2:** Equal right and left lobe uptake figures, with total thyroid uptake: 4.8%, right thyroid lobe uptake: 2.4%, left thyroid lobe uptake: 2.4%, and right thyroid lobe uptake: left thyroid lobe uptake ratio = 1



**Figure 3:** More active right thyroid lobe, with total thyroid uptake: 11.5%, right thyroid lobe uptake: 6.7%, left thyroid lobe uptake: 4.8%, and right thyroid lobe uptake: left thyroid lobe uptake ratio = 1.4



**Figure 4:** More active left thyroid lobe, with total thyroid uptake: 11.3%, right thyroid lobe uptake: 5.1%, left thyroid lobe uptake 6.2%, and right thyroid lobe uptake: left thyroid lobe uptake ratio = of 0.8

from 47.1% to 68.2%. This latter higher figure was reported for patients with TTU from 10% to 20% ,decreasing to 50% in the two groups with higher TTU with no significant increase in right lobar involvement in men in association with increase in TTU [Table6].

Out of 132 young patients, 90 patients (68.2%) had more RLU compared to 48 patients (53.3%) with higher RLU in old age group with a statistically significant difference ( $P = 0.04$ ). Young women had the highest incidence of higher RLU, found in 70% of this group of patients. This was followed by incidence of higher RLU of 62.5%, 57.1%, and 47% in young men, old women, and old men, respectively [Table 6].

## Discussion

The term hyperthyroidism is a form of thyrotoxicosis attributed to inappropriately high synthesis and secretion of thyroid hormones by the thyroid gland.<sup>[14]</sup> GD is the most common cause of hyperthyroidism, accounting for 50%–80% of cases of thyrotoxicosis.<sup>[3]</sup> In our study, GD accounts for 76.5% of all patients referred for thyroid scanning with established hyperthyroidism, confirmed by scintigraphic findings with the characteristic scintigraphic features associated with high figure of TTU.

Genetic, environmental, and endogenous factors have been attributed as possible etiological factors for GD.<sup>[15,16]</sup> It is an autoimmune disease associated with hyperthyroid clinical manifestations attributed to circulating autoantibodies named thyroid-stimulating immunoglobulin also called thyroid-stimulating antibody. These immunoglobulins bind with specific TSH receptors on the cell membrane of the thyroid gland, thus stimulating the action of the TSH. This occurs through mediated autoimmunity by B- and T-lymphocyte directed at the main well known four thyroid antigens. These are thyroglobulin, thyroid peroxidase, NIS, and thyrotropin receptors. The latter is considered the primary antigen of GD that is accused for stimulating thyroid hormone synthesis and thyroid gland growth, resulting in hyperthyroidism and thyromegaly.<sup>[17]</sup>

There is marked female preponderance in all types of thyroid diseases, more evident in toxic goiter.<sup>[18]</sup> It is well known that GD is generally more common in females, affecting females more than males.<sup>[3,19]</sup> This female preponderance in GD, may be related to the influence of estrogens on the immune system.<sup>[20]</sup> In the current study, women represented 70.3% of all patients with GD. It was reported that GD usually strikers women between 20 and 40 years, but it can occur in any age.<sup>[21]</sup> This group of young women accounted for 45% of all our patient population, representing the most commonly affected group. This was followed by old women, old men, and young men, respectively, accounting for 25.2%, 15.3%, and 14.4%, respectively,

The mean age in our patients with GD was  $38.7 \pm 14.7$  years. This figure was  $37.7 \pm 14.5$  and

**Table 2: Value of TTU, RLU and LLU figures in correlation to gender and age**

	Total (n=222)	Males (n=66)	Females (n=156)	P	<40 years	>40 years	P
TTU							
Mean	13.5±8.8	12.3±8.2	14±9	0.155	14.4±9.8	12.1±6.9	0.031
Median	11.3	9.2	12.0		11.8	11.15	
Min-Max	3.8-55.4	4.2-40.1	3.8-55.4		3.8-55.4	3.9-40.1	
RLU							
Mean	7.1±4.7	6.2±4.3	7.4±5	0.068	7.6±5.4	6.1±3.7	0.016
Media	6.1	4.1	6.3		6.3	5.6	
Min-Max	1.4-29.0	1.8-19.4	1.4-29.0		1.6-29	1.4-19.4	
LLU							
Mean	6.2±4.3	6.1±4.2	6.7±4.5	0.332	6.9±4.7	5.9±3.4	0.089
Median	5.5	5.0	5.7		5.8	5.2	
Min - Max	1.6-26.4	1.8-20.7	1.6-26.4		1.6-26.4	1.8-20.7	
P for comparing RLU&LLU	0.037	0.761	0.021	-	0.033	0.439	-

**Table 3: Correlation between age and TTU level**

Total thyroid uptake	Females <40 years (n,%)	Females >40 year (n,%)	Males <40 years (n,%)	Males >40 years (n,%)	Total <40 years (n,%)	Total >40 years (n,%)	Total patients (n,%)
Up to 20%	73 (41.2)	48 (27.1)	26 (14.7)	30 (16.9)	99 (55.9)	78 (44.1)	177 (100)
More than 20%	27 (60)	8 (17.8)	6 (13.3)	4 (8.9)	33 (73.3)	12 (26.7)	45 (100)

**Table 4: Age and gender of patients in different groups of TTU**

Total thyroid Uptake	Females <40 years (n,%)	Female >40 years (n,%)	Total females (n,%)	Males <40 years (n,%)	Males >40 years (n,%)	Total males (n,%)	Total patients (n,%)
Up to 10%	40 (40)	23 (41.1)	63 (40.4)	15 (46.9)	19 (55.9)	34 (51.5)	97 (43.7)
10-20%	33 (33)	25 (44.6)	58 (37.2)	11 (34.4)	11 (32.4)	22 (33.3)	80 (36)
20-30%	17 (17)	8 (14.3)	25 (16)	3 (9.7)	3 (8.8)	6 (9.1)	31 (14)
>30%	10 (10)	-	10 (6.4)	3 (9.4)	1n (2.9)	4 (6.1)	14 (6.3)
Total	100 (100)	56 (100)	156 (100)	32 (100)	34 (15.3)	66 (100)	222 (100)

**Table 5: Correlation between RLU: LLU ratio with patients' gender and age**

RLU: LLU ratio	Females (n,%)	Males (n,%)	Total (n,%)	<40 years (n,%)	>40 years (n,%)	Total (n,%)
More than (1)	102 (65.4)*	36 (54.5)	138 (62)*	90 (68.2)*	48 (53.3)	138 (62)*
ELU	8 (5.1)	3 (4.5)	11 (5)	6 (4.5)	5 (5.6)	11 (5)
Less than (1)	46 (29.5)*	27 (41)	73 (33)*	36 (27.3)*	37 (41.1)	73 (33)*
Total	156 (100)	66 (100)	222 (100)	132 (100)	90	222 (100)
P	0.017	0.331	0.013	0.011	0.287	0.013

\*Significant  $P < 0.05$ 

41.2 ± 15, for women and men, respectively. This is similar to that reported by Al-Shaikh, 2009,<sup>[22]</sup> who reported a mean age of 36.5 ± 10.64 in 216 patients with toxic goiter, and more or less comparable to other studies done on Saudi patients with toxic goiter by Malabu *et al* 2008<sup>[23]</sup> Sulimaini *et al* 1989.<sup>[24]</sup>

In our study, patients in the young age group (<40 years) had significantly more TTU figures compared to older group, with 73.3% of patients with total uptake level more than 20% in the younger age group versus 26.7% only of older patients. Furthermore, all women with TTU level more than 30% were in the young age group. This goes

with what was reported by Allahabadia *et al.*, 2000,<sup>[25]</sup> that patients <40 years at diagnosis had more severe hyperthyroidism. Furthermore, Alfadda *et al.*, in 2007,<sup>[26]</sup> reported that patients who are <40 years at presentation were more likely to have higher free T4 at presentation.

The right thyroid lobe was reported to be larger than the left lobe.<sup>[10,11]</sup> Furthermore, the right thyroid lobe was reported to be more affected than the left lobe by thyroid disorders.<sup>[11]</sup> Bolognasi and Rossi, 2006,<sup>[27]</sup> suggested that the right thyroid lobe is usually larger than the left and more frequently affected by nodular and nonnodular thyroid conditions. This more involvement of the right

**Table 6: Incidence of different lobar uptake in relation to age, gender and TTU**

	Females <40 years (n,%)	Females >40 years (n,%)	Total females (n,%)	Males <40 years (n,%)	Males >40 years (n,%)	Total males (n,%)	Total <40 years (n,%)	Total >40 years (n,%)
TTU <10%:								
Higher RLU	22 (55)	11 (47.8)	33 (52.4)	11 (73.3)	5 (26.3)	16 (47.1)	33 (60)	16 (38.1)
Higher LLU	14 (35)	10 (43.5)	24 (38.1)	3 (20)	13 (68.4)	16 (47.1)	17 (31)	23 (54.8)
ELU	4 (10)	2 (8.7)	6 (9.5)	1 (6.7)	1 (5.3)	2 (5.8)	5 (9)	3 (7.1)
Total number	40 (100)	23 (100)	63 (100)	15 (100)	19 (100)	34 (100)	55 (100)	42 (100)
TTU 10%-20%								
Higher RLU	23 (69.7)	18 (72)	41 (70.7)	7 (63.6)	8 (72.7)	15 (68.2)	15 (75)	26 (72.2)
Higher LLU	9 (27.3)	6 (24)	15 (25.9)	4 (36.4)	2 (18.2)	6 (27.3)	5 (25)	8 (22.2)
ELU	1 (3)	1 (4)	2 (3.4)	0	1 (9.1)	1 (4.5)	-	2 (5.6)
Total number	33 (100)	25 (100)	58 (100)	11(100)	11 (100)	22 (100)	20 (100)	36 (100)
TTU 20%-30%								
Higher RLU	15 (88.2)	3 (37.5)	18 (72)	-	3 (100)	3 (50)	15 (75)	21 (67.7)
Higher LLU	2 (11.8)	5 (62.5)	7 (28)	3 (100)	-	3 (50)	5 (25)	10 (32.3)
ELU	-	-	-	-	-	-	-	-
Total number	17 (100)	8 (100)	25 (100)	3 (100)	3 (100)	6 (100)	20 (100)	31 (100)
TTU >30% :								
Higher RLU	10 (100)	-	10 (100)	2 (66.7)	-	2 (50)	12 (92.3)	-
Higher LLU	-	-	-	1 (33.3)	1 (100)	2 (50)	1 (7.7)	1 (100)
ELU	-	-	-	-	-	-	-	-
Total number	10 (100)	-	10 (100)	3 (100)	1 (100)	4 (100)	13 (100)	1 (100)
Total :								
Higher RLU	70 (70)	32 (57.1)	102 (65.4)	20 (62.5)	16 (47)	36 (54.5)	90 (68.2)	48 (53.3)
Higher LLU	25 (25)	21 (37.5)	46 (29.5)	11 (34.4)	16 (47)	27 (41)	36 (27.3)	37 (41.1)
ELU	5 (5)	3 (5.4)	8 (5.1)	1 (3.1)	2 (6)	3 (4.5)	6 (4.5)	5 (5.6)
Total number	100 (100)	56 (100)	156 (100)	32 (100)	34 (100)	66 (100)	132 (100)	90 (100)

thyroid lobe was also observed in many reports in cases of the rare condition of unilateral GD.<sup>[13]</sup> In our study, the right thyroid lobe was found to be significantly more affected than the left lobe by the autoimmune process in the usual form of GD involving both thyroid lobes. This is deduced from significantly higher RLU figures and significantly higher incidence of patients with higher RLU in Tc-99m thyroid scan. This significant difference in favor of the right thyroid lobe was seen in the whole group as well as in women and in young patients. This difference in favor of the right thyroid lobe in both RLU figures and in incidence of patients with higher right thyroid lobe activity was also seen in men and in old age patients; yet, the difference is not statistically significant. Besides, this incidence of higher right thyroid lobe activity was found to increase with the increase in TTU. All women (10 patients) with TTU level more than 30% were <40 years, and all have relatively higher RLU and activity compared to LLU. This significant side-to-side difference seems to be of multifactorial origin. It may be due to acquired conditions as preceding unilateral bacterial or viral inflammation of the thyroid gland. This results in inhomogeneous alteration of thyroid tissue in either lobe, with resultant variable degrees

of difference between thyroid uptake level of both lobes, but the role of infection needs to be further investigated and evaluated by other studies.<sup>[13]</sup> The difference in thyroid lobes in patients with unilateral GD were also reported by Manthri *et al.*, 2019.<sup>[17]</sup> They reported that this lobar difference could be related to the presence of different sensitivity of right and left thyroid lobes to TSH stimulation that seems to be present in normal thyroid tissue without any pathological process in the thyroid gland. This was reported for patients with unilateral GD; yet, it can be also applied to other thyroid disease entities, including the usual form of GD that affects both thyroid lobes. They also reported that this clonal heterogeneity possibly involves differential expression of antigen triggers T-cell response resulting in different expression and function of iodine uptake mechanism as well as differences in growth and activity in response to TSH receptor stimulation. This goes with older reports stating that in GD, there is abundant NIS immunoreactivity at the basolateral aspect of most thyroid follicular cells consistent with diffuse increased uptake of iodine and free Tc-99m.<sup>[17,28,29]</sup> We can state that this interlobar difference in expression and activity of NIS can lead to the different lobar response to immunoreactivity

in favor of the right thyroid lobe in patients with GD. This difference is more apparent in the current study in women and young age patients as well as in association with higher TTU level compared to old age, male gender, and low TTU. The preferential right thyroid lobe activity in GD becomes more pronounced in young women with TTU figure more than 30%, seen in all ten patients with those criteria in the current study. Large-scale studies on more patients are advisable for further evaluation of these findings.

The results of the current study emphasize the value of performing Tc-99m thyroid scan in all patients with GD, especially in whom surgery is the treatment of choice. It can help in tailoring surgical procedures in this latter group of patients. There are two main different surgical techniques for treatment of hyperthyroidism, either total or subtotal thyroidectomy. In the latter, a small unilateral or bilateral remnant is left.<sup>[30]</sup> For patients going to undergo subtotal thyroidectomy, in whom Tc-99m thyroid scan is positive for evidently more active right thyroid lobe, a remnant can be left only on the left side with complete removal of the right lobe (Dunhill procedure). In this procedure, a unilateral total and contralateral subtotal thyroidectomy is performed with an impact on decreasing the incidence of complications compared to total thyroidectomy.<sup>[31]</sup> Besides, in a properly selected group of patients with GD, in whom there is significantly more active right thyroid lobe together with elevated RLU/LLU ratio, especially if associated with evidently larger right thyroid lobe, as found in some young women in the current study, our results may reraise the concept of performing hemithyroidectomy, removing only the significantly active right thyroid lobe, in a highly selected group of patients. Surgeons will be more happy if surgery needed in those patients with GD might be a hemithyroidectomy rather than total thyroidectomy, thereby preventing the complications of permanent hypoparathyroidism.<sup>[32]</sup> Our results will pave the way to perform further prospective studies to compare results and complications of right hemithyroidectomy versus the commonly employed total or subtotal thyroidectomy on a particular group of patients with GD who are going to be properly selected according to several factors including total and lobar thyroid uptake figures.

## Conclusion

Through the analysis of quantitative data of Tc-99m thyroid scan, we conclude that there are significantly higher RLU figures as well as significantly higher incidence of right thyroid lobe affection in patients with GD. This significant preferential thyroid lobar affection in favor of the right thyroid lobe in GD denotes more right thyroid lobar involvement by the autoimmune process of this disease entity. This significance is maintained in women and young patients and lost in men and old patients; still the latter two groups have higher RLU figures and higher incidence of

right thyroid lobar affection. The incidence of higher right thyroid lobe activity also increases in association with increase in TTU. Young women with high TTU have the highest incidence of more right thyroid lobar involvement in patients with GD. Clinically, our results can help to tailor surgical procedures in patients with GD, in whom surgery is the treatment of choice.

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## Conflicts of interest

There are no conflicts of interest.

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