QUALITY ASSESSMENT OF THYROID ULTRASOUND AND IMPLEMENTATION OF A STANDARD REPORTING TEMPLATE TO BE USED IN TRAINING HOSPITALS

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Diagnostic Radiology

Johannesburg, 2017

DECLARATION

I, Sunette Claassens, declare that this research report is my own work. It is being submitted for the degree of Masters of Medicine in the branch of Diagnostic Radiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

_____ Signature

_____ Day of_____2017

DEDICATION

To Arend. Without you my dreams would have stayed just that, dreams.

PUBLICATIONS AND PRESENTATIONS

This research was presented in poster format at the 2nd RSSA/ SASPI congress, November 2016; and won first prize.

The abstract of the above-mentioned poster will be published in the South African Journal of Radiology.

ABSTRACT

Ultrasound is the conventional and best imaging modality used to visualize the thyroid and thyroid-related disease. An adequate ultrasound report can significantly influence clinicians in making management decisions in these patients.

Aim: The aim of this study was to critically assess the quality of thyroid ultrasound reports generated at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), a training hospital in Johannesburg, South Africa.

Method: A retrospective cross-sectional study was performed. The quality of thyroid ultrasound reports was determined by using a data collection sheet that included items that should be contained in a thyroid ultrasound report. The contents of the data collection sheet was guided by current literature (including Thyroid Imaging Reporting and Data System (TIRADS); Thyroid, Head and Neck Cancer Foundation (THANC); American Thyroid Association guidelines (ATA), British Thyroid Association guidelines (BTA) and the Society for Endocrine, Metabolism and Diabetes of South Africa (SEMDSA)). The data collection sheet was designed by the principal investigator and supervisors. The quality of reports of training radiologists, sonographers as well as qualified radiologists were documented. Comparisons of the quality of reports was made between the above groups of reporters.

Results: A retrospective analysis of thyroid ultrasound reports done at CMJAH revealed that the reports are of poor quality and little value to the referring clinician. The quality of the reports was poor regardless of the training level or experience of the reporter.

Conclusion: Due to the poor quality of the reports, a standard thyroid ultrasound reporting template has since been introduced at CMJAH.

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The filing clerk in the sonography department for assisting with the retrieving of the sonar reports in the sonography filing room.

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LIST OF ABBREVIATIONS

AP:	Anterior-Posterior
ATA:	American Thyroid Association
BIRADS:	Breast Imaging Reporting Data System
BTA:	British Thyroid Association
CMJAH:	Charlotte Maxeke Johannesburg Academic Hospital
CT:	Computed Tomography
FNAB:	Fine Needle Aspiration Biopsy
MEN:	Multiple Endocrine Neoplasia
MRI:	Magnetic Resonance Imaging
RSSA:	Radiological Society of South Africa
SAS:	Statistical Analysis Software
SASPI:	South African Society of Paediatric Imaging
SEMDSA:	Society for Endocrine, Metabolism and Diabetes of South Africa
THANC:	Thyroid, Head and Neck Cancer Foundation.
TIRADS:	Thyroid Imaging Reporting and Data Systems
TUS:	Thyroid Ultrasound

1 INTRODUCTION

1.1 Motivation for this study

Thyroid ultrasounds (TUS) are performed on a daily basis, yet we receive numerous requests for repeating said ultrasounds. This is largely due to the fact that the referring doctors' clinical question was not adequately answered.

1.1.1 Background

Thyroid imaging is an indispensable part of the diagnostic work-up of patients with a palpable neck mass, Graves' disease, patients with abnormal thyroid function (especially hypothyroid) and patients with hoarseness(1).

Ultrasound is the conventional and best imaging modality used to visualize the thyroid and thyroid-related disease(2-5). It provides superior spatial resolution to MRI, CT scan and thyroid scintigraphy. It is safe (no radiation or radioisotopes involved) and cost effective(2). It has high sensitivity for thyroid nodules, but low specificity for malignancy(6).

An adequate ultrasound report may determine whether the patient should be managed by a physician or surgeon.

Academic hospitals such as Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) and Chris Hani Baragwanath Academic Hospital (CHBAH), make use of training radiology registrars to perform ultrasounds. There are qualified sonographers available for assistance, however due to the workload, lack of resources and staff shortages, many of the ultrasounds are done unsupervised.

The ultrasound examination is an operator-dependant procedure. Being able to view organs correctly entails that one has a thorough understanding of radiological anatomy and physics behind the generation of ultrasound images.

Being able to interpret the pathology visualised, form a differential diagnosis and suggest appropriate management, requires even more expertise and is largely dependent on the operator's knowledge regarding thyroid disease.

1.1.2 Ultrasound of the normal thyroid gland

The thyroid gland is hyper-echoic compared to adjacent strap and sternocleidomastoid muscles, as a result of its iodine content. The internal architectural appearance is homogenous and ground-glass. The average size of the thyroid lobes are 3-4cm in the longitudinal, 1-1.5cm in the transverse and 1cm in the anterior-posterior (AP) diameter(6). The thyroid isthmus is situated anterior to the trachea, which is devoid of signal, and the cartilaginous rings produce crescent shaped hyperechoic signal.

There are multiple anechoic foci on the surface and inside the gland, which exhibit flow on color Doppler, characteristic of blood vessels(6). Parathyroid glands are minute (+/- 3mm) and are usually only visualized in pathological circumstances. Hypo-echoic foci in the upper and lower poles of the gland are therefore parathyroid adenomas until proven otherwise(7, 8).

Other important regional structures include the central and lateral lymph node compartments and the neck vessels, namely the bilateral common carotid arteries and the more lateral internal jugular veins (8).

1.1.3 Thyroid nodules

A thyroid nodule is defined as a focal lesion distinct from the normal thyroid parenchyma(8, 9).

Thyroid nodules can be found in up to 67% of the population (3); of these nodules, 7-15% represent malignancy (9).

The prevalence of thyroid nodules is increased with female gender, the post-menopausal age group, iodine-deficiency and patients with a family history of thyroid nodules(2).

Risk factors for malignancy include:

- Age < 20 or >60
- Solid nodule on palpation
- Rapid nodule growth
- Vocal cord compromise
- Cervical lymphadenopathy
- Previous radiation therapy to the neck
- Family history of thyroid malignancy (8).

To maximally utilize ultrasound in the diagnosis of thyroid malignancies, it is advantageous to use a standardized ultrasound report format (10, 11).

According to the Thyroid, Head and Neck Cancer Foundation (THANC), a standard ultrasound report should comprise of the following:

- Size of the left and right lobe in three dimensions. If the gland is enlarged, the report must indicate whether the gland extends into the mediastinum, and if pressure effects are noted on the trachea and neck vessels.

- AP diameter of the isthmus
- Description of the echogenicity of the overall thyroid gland. Inhomogeneous echotexture could be suggestive of multinodular goiter or thyroiditis (12).
- Vascularity of the thyroid gland. Diffuse increase in vascularity of the gland could be suggestive of thyroiditis (12).
- Comments on the presence of a pyramidal lobe
- Visualization of any thyroid nodules
- Any extra nodular calcifications
- Any abnormal / variant anatomy
- Presence of any associated pathological lymphadenopathy

The THANC foundation also has guidelines regarding the description of thyroid nodules:

- Number of nodules noted, size and site within the thyroid gland
- Description of the margin of the nodule/s (circumscribed, irregular or obscured).
- Presence of extra-thyroid extension
- Composition of the nodule/s (cystic, solid, mixed, spongiform or complex)
- Nodule echogenicity
- Intra-nodular calcifications (coarse or microcalcifications).
- Nodule vascularity (scarce, predominantly peripheral, predominantly central).

In addition to these descriptive factors, multiple sources, including the ATA suggest description of the shape/ morphology of the nodule.

Multiple studies have been done to identify ultrasound features that could predict the possibility of a nodule being malignant, including the study which lead to the development of the Thyroid Imaging Reporting and Data System (TIRADS)(13, 14).

It is important to note, that no single ultrasound feature should be regarded in isolation as a predictor of malignancy, rather, a cumulative number of suspicious features will increase the likelihood of malignancy (10, 15).

Some authors suggest that two or more suspicious features warrant a fine needle aspiration biopsy (FNAB) (16), whereas others suggest that risk should be individualized per patient.

The American Thyroid Association (ATA) additionally suggest that any nodule together with abnormal cervical lymphadenopathy, requires an FNAB (17).

There is a general consensus in the literature that suggest that the following nodule features are considered suspicious:

- Solid consistency
- Hypoechoic echogenicity (when compared to surrounding normal thyroid tissue).
- Microcalcifications
- Nodule shape taller than wide
- Irregular border

The 2015 revised ATA guidelines suggested that the three most reliable predictors malignancy is microcalcifications, irregular margin and shape taller than wide(18).

Great controversy remains whether increased intra-nodal vascularity should be considered as a predictor of malignancy, and in some studies Doppler ultrasound have been shown to be of no added value to grey scale ultrasound(18, 19). The most recent ATA guidelines have removed the previously suggested intra-nodal vascularity as a predictor of malignancy. On the other hand, the BTA and multiple other institutions still consider intra-nodal vascularity as a suspicious factor(20).

The following features are greatly considered as indicative of benignity across the board(3, 8, 18):

- Purely cystic lesion.
- Colloid cysts / colloid degeneration with characteristic comet tail/ring down artifact.
- Multiple (>50% of nodule volume) microcystic changes (Spongiform nodule).
- Hypoechoic rim/halo surrounding the nodule.

Hyperechogenicity itself is not a benign feature, even though the majority of malignant nodules are hypoechoic, because profoundly hyperechoic nodules could represent follicular thyroid cancer(8).

With regards to indications for FNAB, the appropriate nodule size has caused much debate. In general, nodules are either referred to as sub-centimeter or size significant (>1cm). Whether a sub-centimeter nodule with suspicious features

qualify for FNAB remains controversial and the ATA suggests that only size significant suspicious nodules should undergo FNAB(18).

The British Thyroid association (BTA) recommends that nodules be grouped, according to their ultrasound appearance, into either benign, Indeterminate, Suspicious or Malignant(20); this compared to the ATA who characterize their nodules as benign, very low suspicion, low suspicion, intermediate suspicion and high risk for malignancy. Regardless of which classification system used, it remains important to stress the risk of malignancy in visualized nodules.

The BTA features of the different groups are listed below:

Benign features:

i. Halo Present. Increased echogenicity or isoechoic.
ii. Cystic changes.
iii. Spongiform or micro-cystic.
iv. Peripheral (uninterrupted) calcification.
v. Peripheral vascularity.

Indeterminate features:

i. Homogenous. Isoechoic or Increased echogenicity. Solid.
ii. Cystic change.
iii. Central vascularity or mixed vascularity (Controversial).

Suspicious features:

i. Solid. Decreased echogenicity compared to surrounding tissue

ii. Solid. Markedly hypoechoic (defined as hypoechoic compared to strap muscles)

iii. Interrupted peripheral calcification. Decreased echogenicity

iv. Multi-lobar / irregular outline

Malignant:

i. Solid. Decreased echogenicity. Irregular outline. Micro-calcification

ii. Solid. Decreased echogenicity. Irregular outline. Coarse calcification

iii. Intra-nodular vascularity (Controversial)

iv. Nodule taller than width in transverse plane.

v. Associated lymphadenopathy

1.1.4 Cervical lymphadenopathy

Lymph node metastasis from thyroid cancer is usually associated with papillary thyroid cancer. Nodal spread is present in up to 50% of patients with papillary thyroid cancer, at index presentation(8).

Pathological cervical lymphadenopathy is defined as, short axis >8mm; microcalcifications, cystic component, peripheral vascularity, round shape and hyperechogenicity(18, 21). The sensitivity for detecting lymph node metastasis using ultrasound is low(22), but when noted, assist in surgical planning with regards to lymph node dissection.

1.1.5 Structured reporting

Multiple attempts have been made to develop a structured reporting system for thyroid ultrasounds, the most well know system is the TIRADS. The TIRADS is similar to the well-known Breast Imaging Reporting Data System (BIRADS). TIRADS 1 refers to a normal thyroid gland. TIRADS2 refers to a benign lesion/nodule (0% malignancy risk), TIRADS3 (<5% malignancy risk), TIRADS 4 (5-80% malignancy risk) and TIRADS 5 (>80% malignancy risk)(14). The TIRADS is not well adhered to as some found it difficult to apply(23). Changes to the TIRADS has been proposed, including the French TIRADS and electronic synoptic reporting. Given the above-mentioned controversy with regards to which nodule features are suspicious, a universal structured reporting system remains a challenge.

1.2 Aim and Objectives

1.2.1 Aim

This study aimed to determine the quality of thyroid ultrasound done at a training hospital.

1.2.2 Study Objectives

1.2.2.1 To collect and analyse the thyroid ultrasound reports.

1.2.2.2 To compare these reports to a reporting template (data collection sheet) generated by the principle investigator and supervisors, the formulation of

this sheet was guided by international standards (as outlined by the ATA, BTA, THANC, TIRADS and SEMDSA).

2 MATERIALS AND METHODS

2.1 Study design

A retrospective cross-sectional study was performed. The quality of thyroid ultrasound reports was determined using a data collection sheet. The data collection sheet required "yes" or "no" responses to each of the variables/questions listed on it. Questions referred to the contents of the report; if the answer was "yes" (i.e. reported), it was a positive outcome and increased the quality of the report. If the response was "no" (i.e. not reported) this resulted in a report that was lacking in important information. No video clips of the ultrasound images were used as these are not available. At the time of the study there was no efficient picture archiving system (PACS) at CMJAH. It is clear from the reports that not all the nodules were reported on, for example, a report would read, "There are multiple bilateral thyroid nodules, the biggest of which measures…, and is situated…, is hypoechoic…etc." It was noted that multiple reports only reported on the largest nodule, although it is clear from the report that there were multiple nodules. This has raised concerns as the largest nodule is not necessarily the most suspicious nodule.

The questions asked/included in the data collection sheet are listed below:

- Was the left lobe measured in all three dimensions?
- Was the right lobe measured in all three dimensions?
- Was the isthmus measured in AP diameter?
- Was there mention/comment of the echogenicity of the gland?
- Was there mention/comment with regards to vascularity of the gland?
- Was visualisation (or lack thereof) of the parathyroid glands mentioned?

- Was the position of the trachea mentioned/commented on?
- Was the adjacent neck vessels mentioned/commented on?

Where nodules were visualised, additional questions were asked:

- Were all nodules described? (as opposed to just the largest/ most suspicious one)
- Was the size of the nodules measured?
- Was the specific site within the gland mentioned? (upper pole of left lobe, instead of just left lobe).
- Was the shape of the nodule mentioned?
- Was the echogenicity of the nodule mentioned?
- Was there mention of calcification within the nodule?
- Was there mention of a halo?
- Were the margins of the nodule mentioned?
- Was the vascularity of the nodule mentioned?
- Was the consistency of the nodule mentioned?
- Was the nodule classified as benign, indeterminate, suspicious or malignant?
- Was there mention of the need for FNAB?

2.2 Study setting

The study was performed at CMJAH where thyroid ultrasounds are routinely performed on the following machines: Two Toshiba Xairo XG machines, one Toshiba Xario 200, one Toshiba Nemio XG and one Siemens Acuson X300.

The frequency of the linear probes used range between 7,5 – 13 MHz. When using the Thyroid setting on the ultrasound machines, the linear probe becomes active and the frequency increases, in order to achieve better spatial resolution.

Data was collected by retrieving thyroid ultrasound reports from the ultrasound record database files at CMJAH.

All the reports were reviewed by myself (a third-year radiology registrar), and were checked by my supervisors. The data collection sheet was developed by the principle investigator and supervisors based on a conglomeration of sources, including the ATA, BTA, THANC, TIRADS and SEMDSA guidelines for thyroid ultrasound reporting(10).

A comparison was made between the quality of reports done by radiology registrars, sonographers and qualified radiologists.

Important reporting parameters not adhered to were charted on to a Microsoft Excel spreadsheet. The spreadsheet represents the general shortcomings of thyroid ultrasound reporting.

Consequently, a standard thyroid ultrasound reporting template was drafted and introduced at CMJAH.

2.3 Sample

The study sample included adult patients who presented to the ultrasound department at CMJAH for elective thyroid ultrasounds during the time period 1 Jan 2013 – 31 May 2015. An adult in this study is defined as an individual who is over the age of 18 years.

On average CMJAH perform 3 thyroid ultrasounds per week. It is important that the data be statistically significant. Since the main aim of the project was the descriptive reporting

of percentages, a sample size estimation was based on the reporting of a 50% proportion (worst-case) with 5% precision, at the 95% confidence level. This requires a sample size of 384 to be statistically significant.

Sample size for proportions was determined using the formula:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where:

n = sample size,

Z = Z-statistic for the chosen level of confidence,

P = expected prevalence or proportion

d = precision(24).

The actual sample size of 287 is slightly smaller than the calculated sample size. The obtainable precision for a proportion of 50%, with a confidence interval of 95%, was thus increased to 5.8%. The increase in precision is due to the smaller sample size. This is without consequence, as the study sample was too small for the results to be statistically significant.

2.4 Inclusion criteria

Thyroid ultrasound reports of patients over the age of 18 years.

2.5 Exclusion criteria

2.5.1 Illegible reports. The aim of the study was to determine whether the contents of the report could compete with international standards. Illegible reports could not be analysed and were therefore excluded.

2.5.2 Emergency thyroid ultrasound requests. This was due to the fact that thyroid ultrasound rarely constitutes an emergency. Also, the poor resolution of the after-hours ultrasound machine, might have had a negative impact on the results.

2.6 Limitations

Due to the lack of resources the ultrasound reports that were reviewed were hand-written and not stored on a backed-up computer.

True to the stigma, some doctors' handwriting was illegible and such reports were excluded from the data collection.

We analysed reports from 1January 2013 – 31 June 2015, instead of only 12 months as initially planned in an attempt to collect an adequate number of patients for the study. This excluded data from the months of May 2013 and September 2014, as no data from these 2 months were found in the department archives.

Unfortunately, the number of reports obtained during the period of the study was 287, not 384, and therefore the results are deemed not statistically significant. However useful and important information was still obtained from the study.

2.7 Methods of analysis

Descriptive analysis of the data was carried out as follows: Categorical variables were summarised by frequency and percentage tabulation, and illustrated by means of bar

charts. Continuous variables were summarised by the mean, standard deviation, median and interquartile range, and their distribution illustrated by means of histograms.

The chi-square test was used to assess the relationship between reporter group and categorical variables. Fisher's exact test was used where the assumptions of the chi-square test were not met. The strength of the associations was measured the phi coefficient (Fisher's exact test) and Cramer's V (chi-square test). The following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

The relationship between reporter group and age was assessed by the unpaired t-test.

Data analysis was carried out using SAS. The 5% significance level was used throughout.

In other words, p-values <0.05 indicate significant results.

2.8 Ethics

Ethics clearance was granted by The Human Research Ethics Committee at the University of Witwatersrand on 3 July 2015. The Ethics Clearance number is M150617 (see Appendix A).

3 RESULTS

A total of 287 thyroid ultrasound (TUS) reports done at CMJAH from Jan 2013 – May 2015 were analysed (excluding May 2013 and September 2014).

3.1 Data Collected

3.1.1 Demographics

3.1.1.1 Age

The average age of the patients in the study group was 50.5 years (SD=15.3 years; range 18-93 years). The distribution of ages is shown in Figure 1.

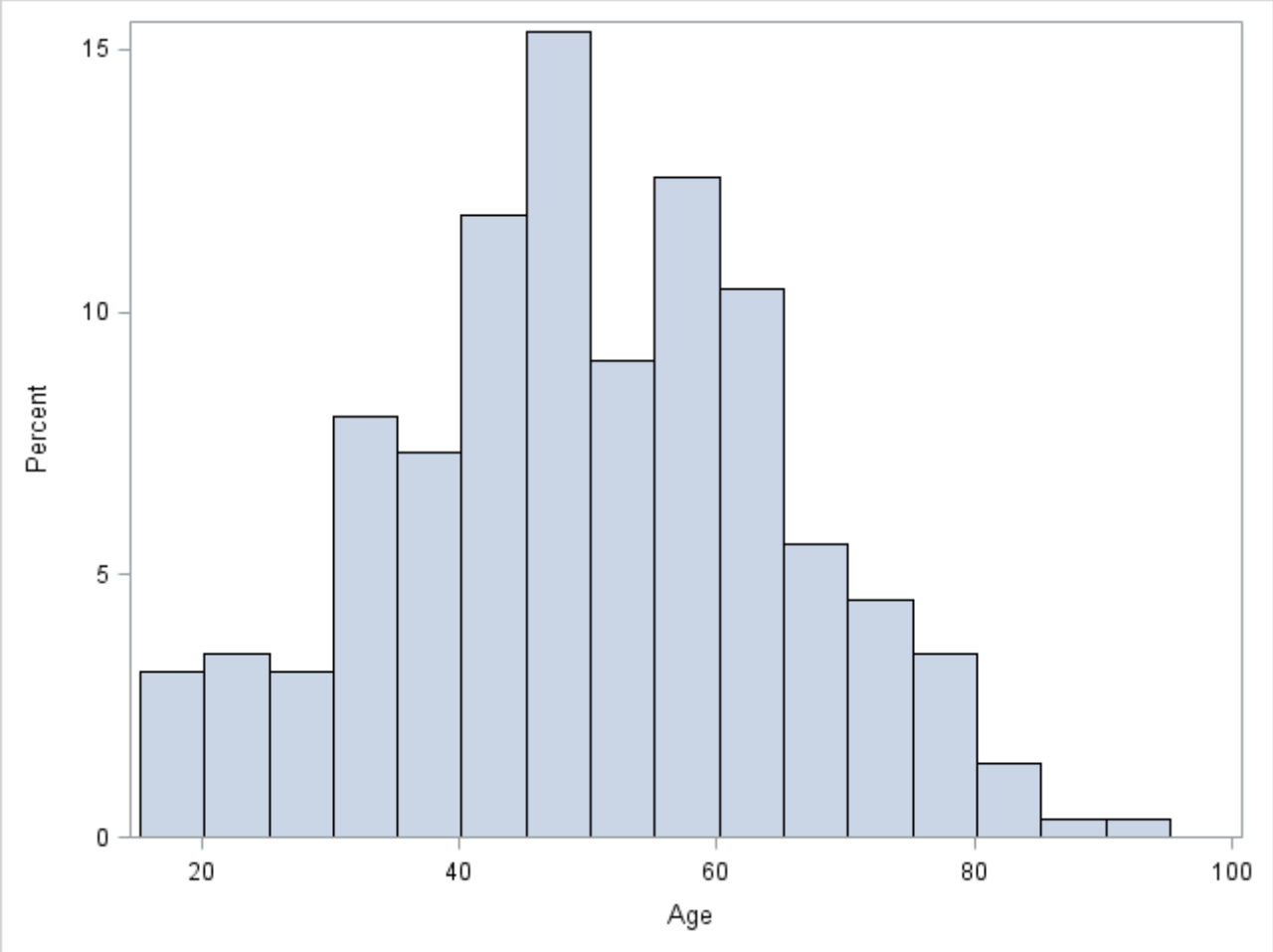

Figure 1: Age distribution of the study population

3.1.1.2 Gender

The study population was predominantly female (83.6%).

3.1.1.3 Reporter Group

The distribution of reporter groups is shown in Figure 2.

The qualified sonographers are permanent staff of the ultrasound department and therefore accounted for 31% of the TUS reports. The registrars do a basic/beginners ultrasound block in their first year and a specialised/advanced ultrasound block during their second year, therefore the 2nd year registrars were responsible for 38.6% of the reports. The other registrars, student sonographers and radiologists were responsible for producing the rest of the reports.

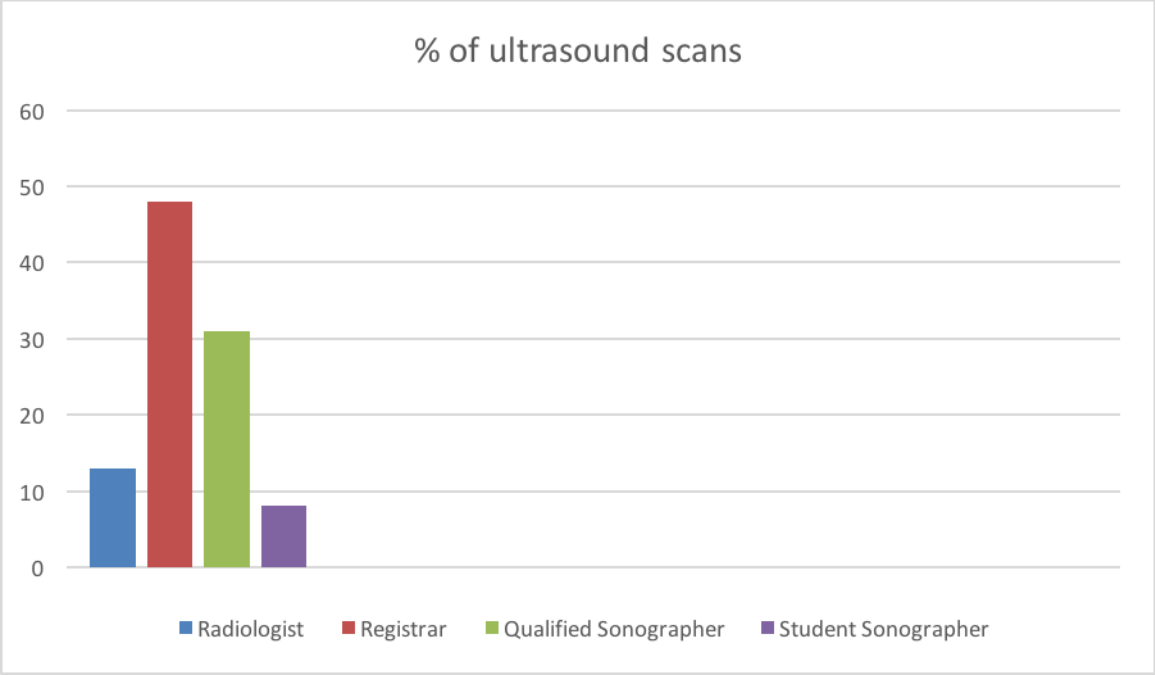

Figure 2: TUS reporting groups in the study

For the between group analysis, the following groupings were used:

- All registrars were grouped together (n=137; 48 % of TUS)
- Radiologists (n=38; 13% of TUS)
- Qualified sonographers (n=89; 31% of TUS)
- Student sonographers (n=23; 8% of TUS)

3.2 Reporting of features found in general TUS

Figure 3 shows the percentage of TUS's with reporting of each feature. Only lymph nodes and the echogenicity of the thyroid gland were reported on in more than 50% of cases. All other aspects were reported on in less than 40% of cases.

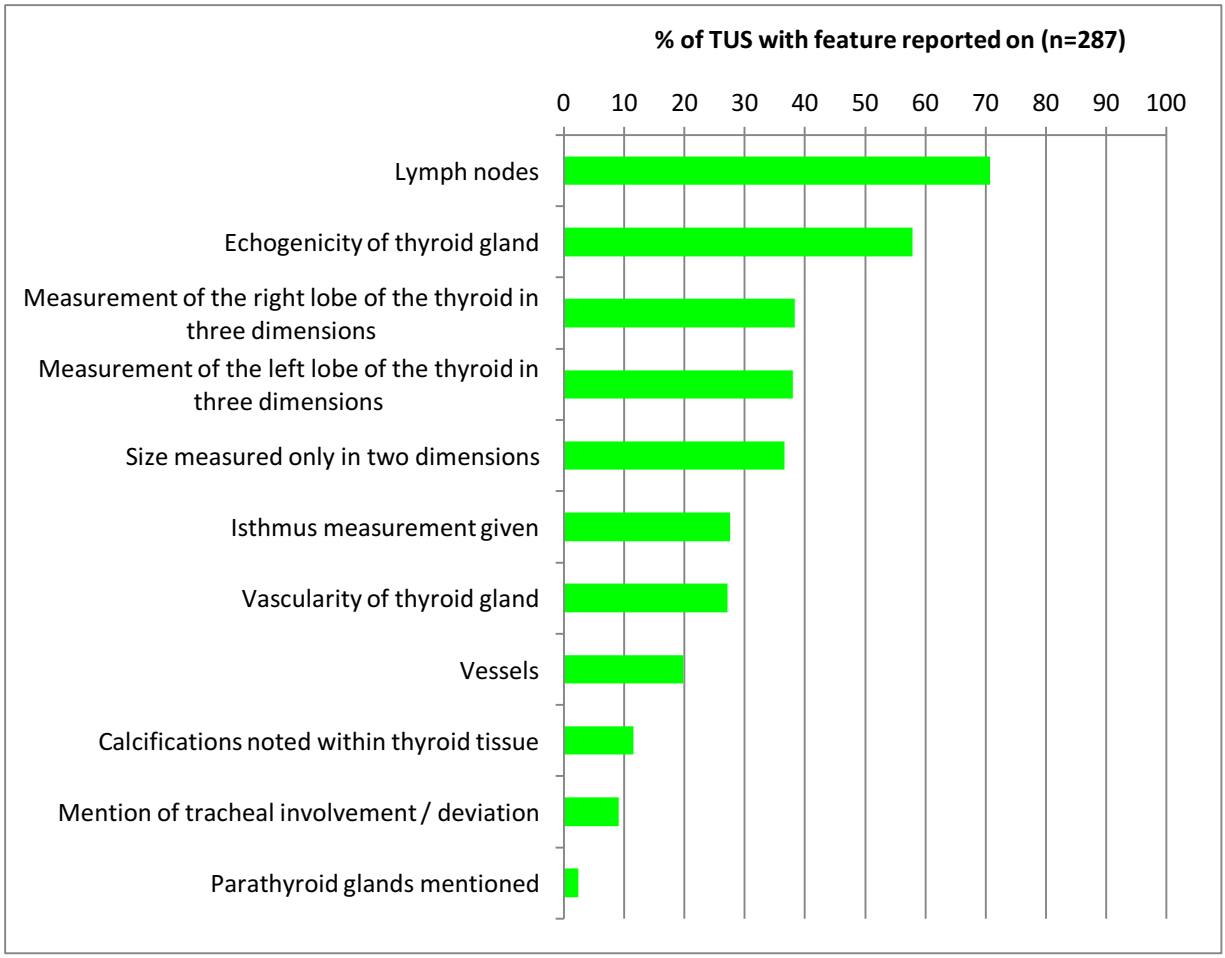

Figure 3: Reported frequency of the general thyroid features

In the above graph, vessels refer to the common carotid arteries and internal jugular veins found lateral to the thyroid gland. It is important to mention any visualised pathology, for example a carotid body tumour, which could be associated with thyroid malignancy in the setting of Multiple endocrine neoplasia type 2 (MEN2). (25)

3.3 Reporting of features found in TUS with nodules (n=220)

It is important to further characterise the imaging features of a thyroid nodule when one is identified on a TUS. Thyroid nodules were visualised in 76.7% (n=220/287) of the TUS. Figure 4 below highlights the percentage of eligible TUS's with reporting of each feature listed on the data collection sheet. Only size of individual nodules, echogenicity of the nodules, nodule consistency, intra-nodular vascularity, and description of all nodules, were reported on in more than 60% of cases. All other aspects were reported on in less than 50% of cases (most less than 30% of cases).

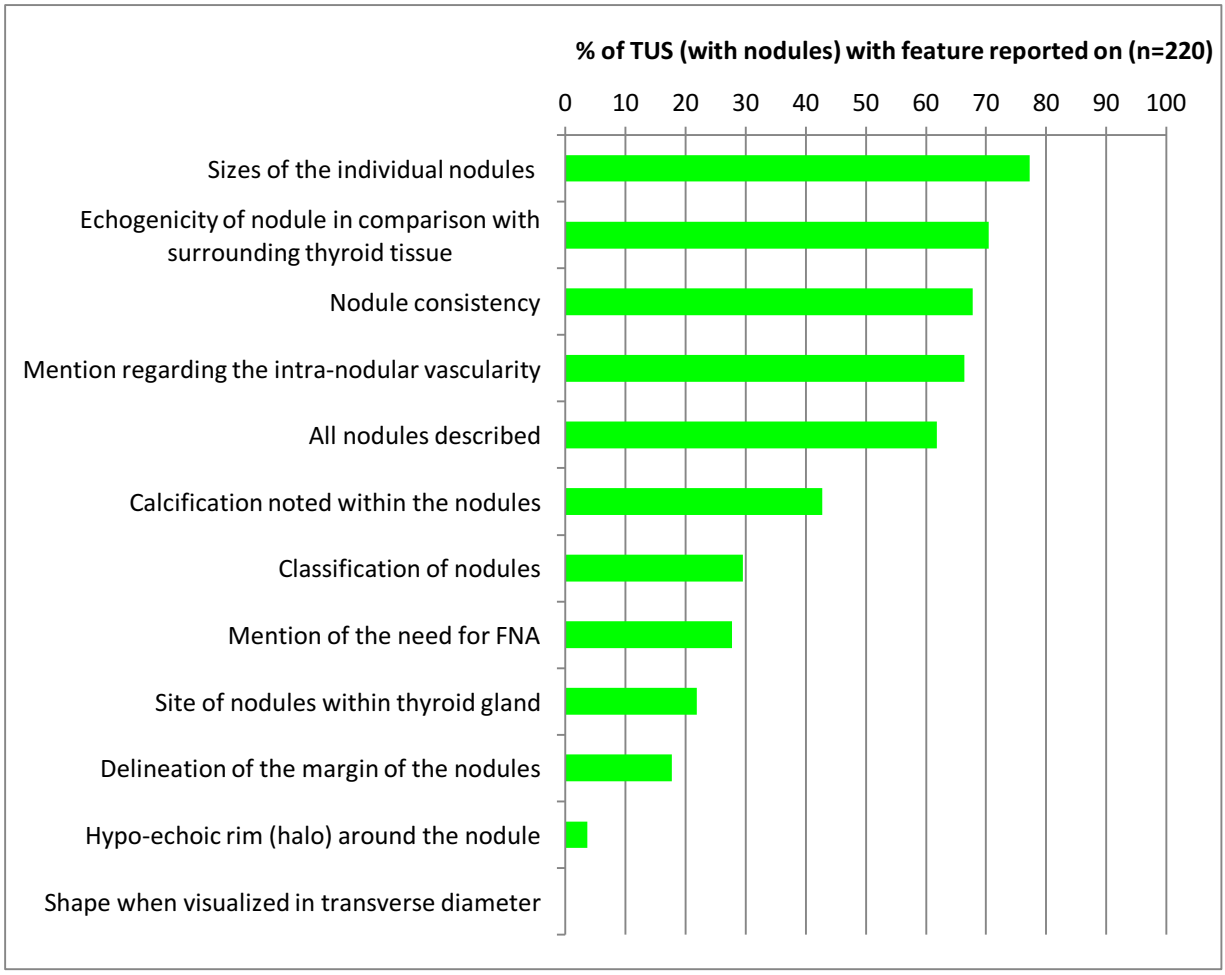

Figure 4: Specific features of thyroid nodules as reported on

3.4 Differences in the quality of reports between the different groups in the study

3.4.1 Reporting of features found in general TUS

There were no significant difference in reporting between the different groups with regards to:

- Vascularity of thyroid gland
- Parathyroid glands mentioned
- Mention of tracheal gland involvement

For all other features, there were significant differences; with no clear pattern in the nature of the differences. The above findings are represented in Figure 5.

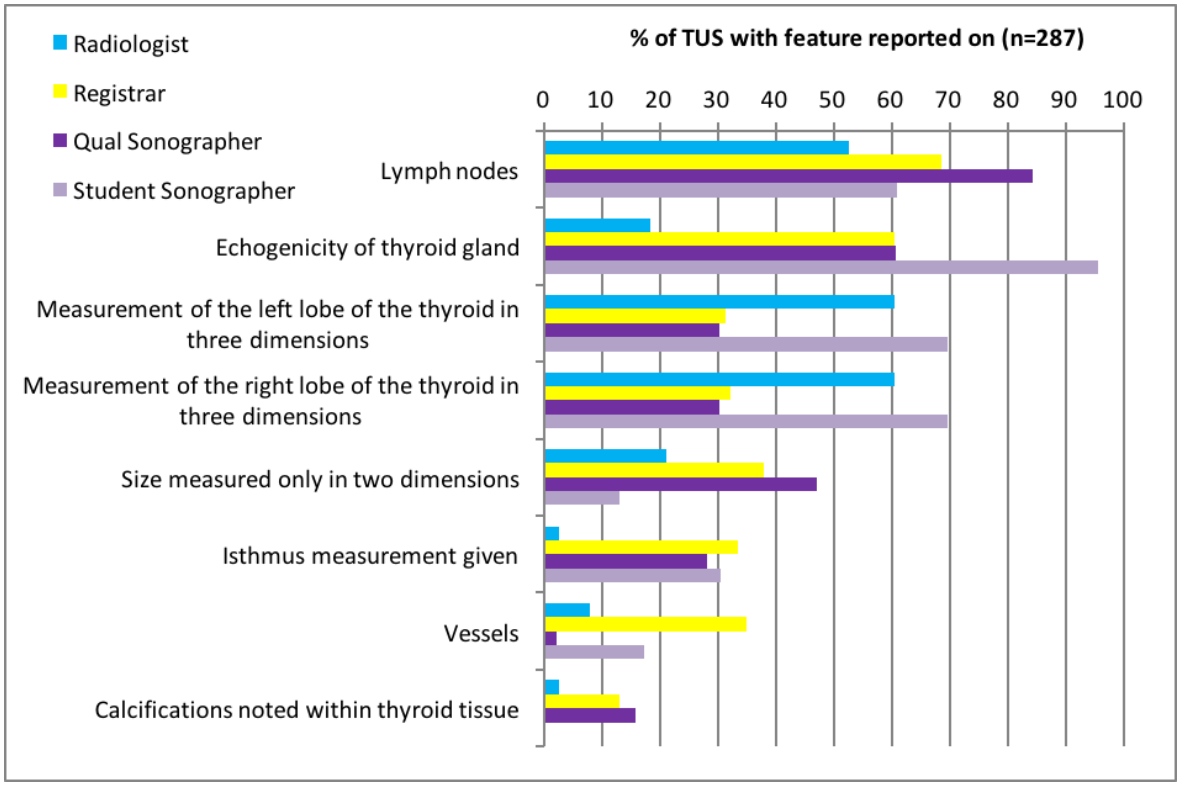

Figure 5: Reporter group differences with reporting of each feature per reporter type

The between-group reporting differences may be described as follows:

- Lymph nodes:

  Lymph nodes were reported on more frequently by the qualified sonographers who reported on the presence or absence of lymph nodes 84% of the time. This compared to the qualified radiologists who only reported on this feature in *53%* of their reports.

- Echogenicity:

The frequency of the description of the echogenicity of nodules was reported on in the following order: student sonographer (96%)> qualified sonographer (61%) > (61%) > radiologist (18%).

- Measurement of L/R thyroid lobe in 3 dimensions:

  Proportion of reporting decreases in the order: student sonographer (70%) > radiologist (61%) > registrar (32%) > qualified sonographer (30%).

- Isthmus measurement:

  This feature was reported on by less than 40% of individuals in all 4 groups. Only 3% of the qualified radiologists reported on this feature.

- Neck Vessels:

  The common carotid arteries and internal jugular veins were neglected in the majority of the reports. The registrars mentioned these vessels in 35% of their reports; student sonographers 17%, radiologists 8% and student sonographers 2%.

- Calcification within the gland:

  The presence or absence of extra-nodal calcifications within the gland was reported on more frequently by the qualified sonographers. However comparison of the frequency of comments on this feature was poor across the board (qualified sonographer (16%) > registrar (13%) > radiologist (3%) > student sonographer (0%).

3.4.2 Reporting of features found in TUS with nodules (n=220):

There were no significant inter-reporter group differences for

- All nodules described

- Site of nodules
- Shape of nodule in transverse plane
- Halo
- Margin

No reporting group consistently reported on the above findings, therefore no group was better in this regard. For all other features, there were significant reporting differences; but again, no clear pattern was found in the nature of the differences. These findings are reflected in Figure 6.

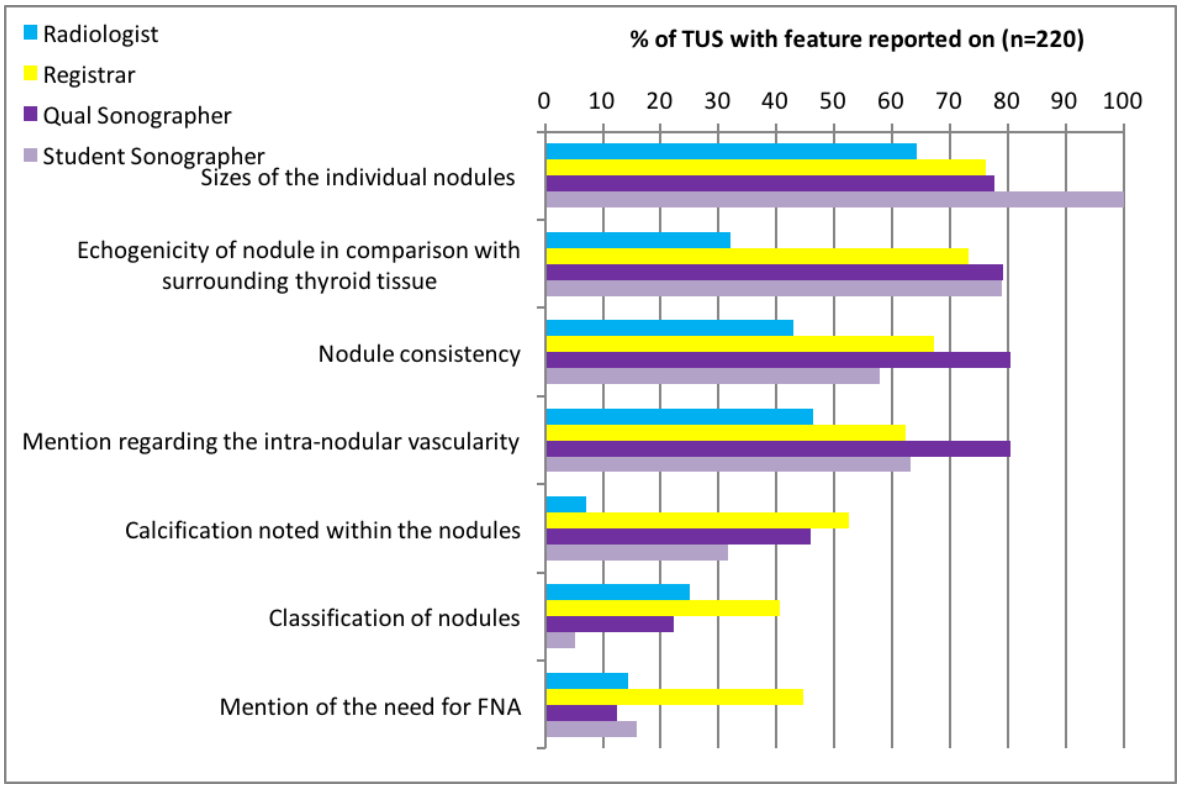

Figure 6: Reporter differences with regards to nodule description

The between-group differences may be described as follows:

- Size of individual nodules:

The student sonographers consistently and uniformly measured the size of individual nodules in all of their reports (100%), compared to the qualified sonographers who measured nodules 78% of the time, registrars 76% and radiologists only 64%.

- Nodule Echogenicity:

  Significantly lower proportion of reporting by radiologists (only 32%) than the other three groups, whom all mentioned nodule echogenicity in more than 70% of their reports.

- Nodule consistency:

  Mention of the cystic or solid nature of nodules were reported on more frequently by the qualified sonographers, who mentioned nodule consistency in 81% of the cases. Radiologists only mentioned consistency in 43% of their reports.

- Intra-nodular vascularity:

  The vascularity of the nodules were mostly reported on by qualified sonographers in 81% of the cases. The registrars and student sonographers mentioned vascularity in 62% and 63% of their reports, respectively. The radiologists only reported on nodal vascularity in 46% of cases.

- Intra-nodular calcification:

  The registrars did the best job at mentioning intra-nodal calcifications, however they only mentioned the presence or absence of intra-nodal calcification in 52% of reports. The radiologists on the other hand did the worst job, by only reporting on this feature 7% of the time.

- Classification of the nodules with regards to malignant potential:

Higher proportion of reporting by registrars (41%), radiologists (25%), and qualified sonographers (22%) compared to student sonographers (5%).

- Mentioning the need for FNA:

  Higher proportion of inclusion in reports by registrars (45%) than the other three groups. (student sonographer 16%, radiologist 14% and qualified sonographer 13%)

4 DISCUSSION OF RESULTS

A total of 287 Thyroid ultrasound reports were analysed. The average patient who had a TUS in our study was a middle aged female (50.5 years), in keeping with research with regards to prevalence and incidence of thyroid disease (26).

The reporters were mostly qualified sonographers and 2nd year radiology registrars, but also included student sonographers and radiologists.

The results showed that important thyroid ultrasound parameters were not regularly or adequately reported on, as summarised below.

With regards to general thyroid ultrasound, the only two parameters reported on in more than half the reports analysed, were lymph nodes in 70% of reports, and echogenicity of the thyroid gland in 57% of the reports. All the other important parameters were neglected, and not frequently reported.

Adequate measurement of the thyroid gland was only mentioned in 38% of reports: Correct measurement of the gland is essential, because an enlarged gland should prompt thorough investigation of possible nodules or other pathology such as thyroiditis.

Vascularity of the thyroid gland, only reported on in 27% of reports:

Generalized increased vascularity could be secondary to thyroiditis, highlighting the importance of mentioning this factor in reports.

Neck vessels, only mentioned in 19,9 % of reports:

The neck vessels can be laterally displaced by an enlarged thyroid gland or thyroid nodule. An incidental carotid body tumour should alert to possibility of MEN2, which is associated with thyroid cancer(25). Noting overt atherosclerotic plaque in the adjacent common carotid arteries and suggesting carotid Doppler investigation with subsequent appropriate referral could be lifesaving.

Calcification within thyroid gland only reported on in 11,5% of cases:

Calcification within the thyroid gland could represent benign or malignant disease. It is important to comment on this within a report as up to 59% of thyroid calcification is associated with malignancy, the remainder is associated with multinodular goitre(27).

Trachea mentioned in 9% of reports:

The trachea is an important landmark when assessing normal thyroid anatomy and displacement of the trachea should alert to possible thyroid pathology.

Parathyroid glands mentioned in only 2,4% of the reports:

Normal parathyroid glands are not visualised on ultrasound and this is likely the reason for the poor reporting thereof. When a parathyroid gland is visualised, this usually indicates pathology such as parathyroid adenoma.

With regards to thyroid nodules, approximately half of the important parameters were reported on in more than 50 % of cases, whereas half of the important parameters were neglected, as summarized below:

Size of the individual nodules given in 77% of reports:

Whether a nodule is sub-centimetre or size significant, could alter the decision to perform FNAB.

Nodule echogenicity reported in 70%:

Up to 55% of benign nodules are hypoechoic, however the vast majority of malignant nodules are hypoechoic and therefore it is important to mention echogenicity(18).

Nodule consistency mentioned in 67%:

Malignant nodules are predominantly solid, and purely cystic nodules is considered benign.

All nodules (as opposed to biggest nodule) described in 61%:

When multiple nodules are noted within the gland, each nodule has the same risk of malignancy. It is important to describe nodules individually with regards to suspicious features and not just size, as the biggest nodule might be benign and a smaller (however still size significant) nodule could have suspicious features prompting FNAB.

Intra-nodal vascularity in 66%:

Though intra-nodal vascularity remains a controversial topic, it needs to be mentioned.

Margin of the nodule mentioned in 17%:

Together with microcalcifications and 'tall shape', irregular margins are one of the top three suspicious ultrasound features as outlined in the revised 2015 ATA guidelines(18).

Calcification within nodules only reported in 42%:

Microcalcifications is one of the features with the highest specificity for thyroid cancer (18).

Shape in transverse diameter not reported on in any of the reports reviewed:

As much as there is some controversy about certain ultrasound features and whether they are suspicious for malignancy, it is widely agreed upon, that a nodule that has an AP diameter bigger than transverse diameter (taller than wide on transverse view), is a suspicious feature (8, 9, 12, 15, 17, 18, 28, 29).

Site of the nodule within the gland only mentioned in 21,8%:

The site of the individual nodules is extremely important as the patient may have multiple nodules, and the interventionist doing the FNAB needs to know where the most suspicious nodule is, which requires FNAB, to avoid unnecessary FNAB of another nodule. Also, nodules situated posteriorly might decrease the accuracy of FNAB(18), and elastography (30).

Halo (hypoechoic rim) mentioned in 3,6%.

The presence of a halo/hypoechoic rim is highly suggestive of benignity (3).

The nodules visualised were only classified in 29,5% of the cases and the need for FNAB was only mentioned in 27,7% of reports. It is important to remember that the person

reading the report is not a sonographer or a radiologist, and merely describing a nodule does not tell the clinician whether to be worried or not, however if the radiologist or sonographer can classify a nodule as either benign, indeterminate, suspicious or malignant. This is beneficial to the clinician who will have better understanding of the report and can be guided on further patient management such as whether or not to perform FNAB.

The size of reporting difference between the groups (effect sizes) were weak, except those for echogenicity, calcification, and the need for FNA, which were moderate.

One would expect the qualified sonographers and radiologists to have comprehensive, high quality reports, and the training registrars and student sonographers to have inferior reports. This was not the case.

In the literature some studies have found that people in training, such as training radiologists and student sonographers are more thorough in their reports as they are still learning, compared to the more qualified individuals who were less thorough(31).

On the other end of the spectrum, studies have shown that training radiologists make significant errors in doing and reporting ultrasounds without adequate supervision(32).

However, as mentioned above, in this study, there was no specific pattern to the between group reporting differences. The differences were completely arbitrary. There is no explanation as to why for example the presence of calcifications is reported more by qualified sonographers, but these same sonographers hardly ever mentioned the neck vessels; as well as why registrars mention lymph nodes, but do not mention calcification

within the nodules. There are cases in the literature that support these findings, that showed no difference in reporting, on the basis of type of training, years in practice, or number of examinations done(33).

There was no clear pattern with regards to the between reporter group differences of general TUS or ultrasounds with thyroid nodules. No reporter group were better at reporting thyroid ultrasounds than others.

From the above findings a reporting template was designed by the investigator and her supervisors to assist with the reporting of TUS (see appendix C) to ensure more thorough and standardised reporting.

4.1 Limitations of the current study

The sample size was smaller than anticipated, and therefore the results are not statistically significant.

The reporting registrars were mostly in their 2nd year, because the 2nd year registrars do a senior ultrasound block, and therefore the registrar body as a group is not represented. Also, there is a permanent qualified radiologist working at the sonar department of CMJAH and therefore that radiologist was responsible for most of the ultrasounds in the Radiologist group, and all the radiologists working at CMJAH were not represented in that group.

Comparing of the study variables between the three reporters assumed that each group was exposed to the same variety of thyroid conditions, which is not always the case.

4.2 Recommendations from the study

Review of the quality of ultrasound reports at several centres , assessing and comparing reports from sonographers, radiology registrars and consultants and comparing the quality of reports against the experience of the individuals within each group.

There has been 2 ultrasound workshops in the radiology department at since the period of the study. Comparison of reports before and after these courses to assess whether there has been an improvement in the quality of reports would be insightful.

A retrospective analysis of thyroid ultrasound reports after the implementation of the reporting template at CMJAH and other centres could be performed to assess the value and impact of the template.

5 CONCLUSION

Thyroid disease is very common, and said to affect 750 million people across the globe. The incidence of thyroid cancer is increasing, likely due to a combination of early detection, as well as unknown thyroid specific carcinogens (34). Approximately 300 000 people are diagnosed with thyroid cancer annually (26).

Thyroid ultrasound is the imaging modality of choice to evaluate thyroid disease and screen for suspicious nodules which might represent early thyroid cancer (9). It is of utmost importance that thyroid ultrasound reports are of a high standard to diagnose thyroid disease and especially thyroid cancer early. The importance of structured thyroid ultrasound reporting has been widely published (10, 14, 23, 35), however consensus with regards to the structure and classification is still under review.

Our retrospective analysis of 287 thyroid ultrasound reports performed at a training hospital revealed that the reports are of poor quality and little value to the referring clinician. The standard of reporting was inadequate, regardless of the level of training or experience of the reporter.

A standard thyroid ultrasound reporting template has since been introduced at CMJAH. (*Appendix C).* This template provides an easily adaptable approach to thyroid ultrasound. A PACS system was introduced at CMJAH in April 2016 and the thyroid template was loaded on the system, this has ensured adherence to the template and an improvement in the quality of reports generated.

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APPENDIX A: HREC CLEARANCE CERTIFICATE

R14/49 Dr Sunette Claassens

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150617

NAME: (Principal Investigator)	Dr Sunette Claassens
DEPARTMENT:	Radiation Sciences Charlotte Maxeke Johannesburg Academic Hospital Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Quality Assessment of Thyroid Ultrasound and Immplementation of a Standard Reporting Template to be used in Training Hospitals
DATE CONSIDERED:	26/06/2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Claire Mitchell
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	11/01/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX B: PROTOCOL COMMITTEE LETTER OF PERMISSION

University of the Witwatersrand

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
FACULTY OF HEALTH SCIENCES
ASSESSORS MEETING

CANDIDATE: Sunette Claassens
Student no:- 0501014A

Date of Assessor Group Meeting: 15/10/2015 School / Department / Division: Radiation Sciences

Yes ✓ | No | Is the research question clearly identified and described?

Comments:

Yes | No | Not entirely ✓

Is the design of the study and methods used appropriate for the research question being asked?

Comments:
1. Mention approximate number of patients
2. Specify "international standards."
3. De-identify patients on data sheet
4. Change "~~doctor~~ quality score sheet" to "data collection sheet" on page 10
5. Exclude emergency ultrasounds (not night time)
6. Specify frequency of ultrasound probes used.
7. Reference 1-12 incomplete.
8. Adjust time lines for study
9. Change "critically review" to "collect + analyse" on page 8 (Study objectives)

Is the study feasible within:

i.	the applicant's resources?	Yes ✓	No
ii.	the departments resources?	Yes ✓	No
iii.	the time frame?	Yes ✓	No

Do you recommend:

i. shortening / lengthening of the protocol? Please specify and explain.

No

ii. the appointment of a co-supervisor? Yes ✓ No

Nominee/s : Dr. L Hlabangana (70%)

Overall recommendation regarding the protocol : Prof Vangu

		Yes	No
i.	revision of the protocol to the Supervisor (if HOD approval is also required, please specify): (**Candidates**: one copy, list of corrections, supervisor approval letter – submit to PG Office)	✓	
ii.	revision of the protocol to the satisfaction of the Assessor Group: (**Candidates**: six copies, list of corrections, supervisor approval letter – submit to PG Office)		✓
iii.	revision of the protocol and resubmission of the revised protocol to the next Assessor Group Meeting: (**Candidates**: six copies, list of corrections, supervisor approval letter – submit one copy to PG Office / 5 to school assessor group administrator/ for PhD all six copies to be submitted to the PG Office)		✓
iv.	candidate goes ahead:		✓

Assessor Names and Signatures :

P. Luff

Prof Vangu

Vinay Shenoy

C D Libhaber

L. Luff

Assessor Group Chair

12/11/15

Date

APPENDIX C: STANDARD THYROID ULTRASOUND REPORTING TEMPLATE

THYROID ULTRASOUND REPORT

Patient name: _____Hospital nr: _____Date:_____
Echogenicity of overall thyroid gland: Normal / ↑ / ↓ /Heterogeneous
If Heterogeneous, describe: _____
Lymph nodes: Normal / Pathological. Description and Zone (I-VII): _____
_____
Parathyroids visualised: Y / N Description:
_____

If Nodules are present, please describe in table below or answer Y or N. (Features in brackets listed from benign to suspicious, very suspicious features listed in bold).

NODULES	1	2	3	4
Size (**>1cm** is significant)				
Site within gland				
Consistency (purely cystic, spongiform, mixed, **solid**)				
Echogenicity (Hyper-, Iso- or **Hypo**-)				
Taller than wide? (AP> transverse diameter)				
Margin/ contour (Circumscribed, Obscured, **Irregular**)				
Microcalcifications				
Vascularity (scarce, peripheral, central)				
Hypoechoic rim/Halo				
CLASSIFICATION Benign, Indeterminate, Suspicious, Malignant				
FNA recommended?				

ASSESSMENT: _____

ULTRASOUND DONE BY: _____