THE RELATION BETWEEN PREOPERATIVE ULTRASONOGRAPHIC THYROID VOLUME ANALYSIS AND THYROIDECTOMY COMPLICATIONS

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Objective. To determine the relation between thyroid volume (ThV) and thyroidectomy complications using preoperative ultrasound and ellipsoid volumetric analysis in Turkish patients.

Patients and Methods. This prospective study included a total of 500 patients (401 females = 80.2 % and 99 males = 19.8 %) who were operated for benign goiter. According to their ThV estimated by ultrasound hey were classified in three groups: 1.less than 50 ml (n = 269; 53.8 %), 2. between 50 and 100 ml (n = 151; 30.2 %), 3. more than 100 ml (n = 80; 15.6 %). By comparing the association of thyroid volume with peroperative and postoperative complications it was evaluated whether the thyroid volume could be an effective factor participating in morbidity and mortality of patients.

Results. Total peroperative complication rate was 2 % (n= 10) with trachea injury in 2 (0.4 %), bleeding in 8 (1.6 %) patients. Peroperative complications were significantly more frequent in patients with large volume (p=0.003). Temporary hypocalcemia rate in patients with less than 50 ml volume was highly significant (p<0.001). Volume average was low in patients with hypocalcemia as compared to patients without hypocalcemia (p<0.001). Both the temporary and permanent vocal cord paralysis (VCP) were significantly more frequent in patients with larger volumes (p=0.002). All four patients with permanent VCP had more than 100 ml volume.

Conclusion. Thyroid volume is an important factor affecting thyroidectomy complications. In patients with smaller ThV increased risk of hypocalcemia was found, whereas in those with larger ThV increased risk of recurrent nerve damage and peroperative bleeding was observed.

Key Words: Thyroid volume – Thyroidectomy – Peroperative complications - Ultrasonoud.

Neoplastic, inflammatory and endocrine thyroid disorders are frequently encountered, since they occurr in about 11 percent of world population (Canaris et al. 2000). Thyroidectomy is one of the most frequently applied procedures in surgery clinics especially in countries with endemic regions such as Turkey. The accurate estimation of thyroid volume is very important for the evaluation and management of thyroid disorders, since thyroidectomy in patients with marked thyroid enlargement raises specific concerns over the optimal preoperative, peroperative and postoperative thyroidectomy complications (McHenry et al. 1994). The pur-

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pose should be the achievement of most effective treatment with minimum complications and recurrency rate. However, there is a little of information about identifying risk factors involved in the surgery of benign euthyroid goiter. Preoperative assessment is usually based on personal experience rather than objective parameters (Mc Henry et al. 1994; Lisboa and Gross 2002). Large thyroids and/or large lobes are generally considered as complex cases (Runkel et al. 1998).

Previous methods for the determination of thyroid volume (ThV) used palpation (Nordmeyer et al. 1997), chest X-rays, or radionuclide imaging or, in some epidemiological studies, also postmortal thyroid weight (Langer 1999). The knowledge on the thyroid volume as estimated by a reliable method could be a comforting factor for the surgeons with regard to the preparation for some possible complications. Ultrasonographic volumetry is now considered as most convenient, reliable and accurate method method not only for the determination of ThV, but also of the echostructure (e.g. echogenity, latent nodules, cysts etc.). Normal thyroid volume commonly varies between 10-25 ml, and volumes more than 18 ml or 6.2/m^2 of body surface are considered as goiter in adults (Brunn et al. 1981; Gutekunst et al. 1988; Langer 1999; Lisboa et al. 2002).

The purpose of this study is to determine the relation between ThV and thyroidectomy complications using the preoperative USG and ellipsoid volumetric analysis (Brunn et al. 1981) in Turkish people. Thus, to figure out if the thyroid volume is an objective predictive tool to keep away the surgeons from the complications of the thyroid surgery.

Patients and Methods

Patients. This prospective study included 500 consecutive patients who were operated due to benign goiter, without preoperative malignancy diagnosis and mediastinal goiter. Recurrent goiters were excluded from the study. All patients were subjected to thyroidectomy in the 2nd Surgery Clinic, Ankara Numune Education and Research Hospital between 2004 and 2005.

Thyroid ultrasound examination was performed in Radiodiagnostics Unit and carried out by Hitachi EUB-420 apparatus using 7.5 MHz linear probe. Thyroid volume was calculated by elipsiod formula (volume = width x height x depth x 0.479) as described by Brunn et al (1981) and also any nodule formations were identified. According to ThV, all patients were classified in three groups: 1. <50 ml, 2. 50 to 100 ml , 3. >100 ml.

Vocal cords of all patients were examined by Otorhinolarygologic Clinic before and after the operation. Total and ionized serum calcium levels were measured 48 hours after the operation regardless of any symptoms, ionized calcium <4.2 mg/dl being considered as hypocalcemia. Vocal cord paralysis (VCP) for less then one year was considered as temporary, while the presence of hypocalcemia exceeding one year was regarded as permanent.

Thyroidectomy. The extent of thyroidectomy was classified according to the volume of remnant tissue (RT). Thus, after subtotal thyroidectomy (ST) the RT was 4-8 g, while after nearly total thyroidectomy (NTT) it was 2-4 g and total thyroidectomy (TT) was a total dissection of the thyroid including its capsule. Recurrent nerve dissection was carefully prevented in all patients and great care was paid to visual control of the nerve during the operation.

The interrelations between preoperative ThV and frequency of on peroperative and postoperative complications were investigated to elucidate the question whether the ThV itself could be an effective factor influencing the morbidity and mortality.

Statistical evaluation was performed using SPSS For Windows (Release 10,5) software. The comparison between groups was made using chi-square, Anova and t-test where appropriate and p values below 0.05 were accepted as significant.

Results

Among the patients 401 (80.2%) were females, 99 (19.8%) were males and average age was 44.15±13 years (18-78y). Multinodulat goiter was present in 79.4 % (n=397), single nodule in 13.4 % (n=67) and 7.1 % (n=36) had diffuse variations as found by ultrasound.

As evaluated by scintigraphy, 10 % (n=50) had hot nodules, 26.4 % (n=132) had cold nodules, while 11.6 % (n=58) had both hot and cold, 8.2 % (n=41) had normal and in 2.8 % (n=14) diffuse variations were present. In the preoperative period, 305 (60.1 %) the patients were euthyrotic, 173 (34.6 %) were hyperthyrotic and 22 (4.4 %) hypothyrotic. A total of 203 (40.7 %) of patients was operated by professionals, 297 (59.3 %) by assistants under the supervision of professionals. As surgical procedure, BST was performed on 132 (26.4 %) patients, TT on 290 (58 %), and TYT on 78 (15.6 %) patients. Only 68 patients had ThV less than 18 ml (13.6 %), while 432 (86.4 %) patients had thyroid volume more than 18 ml. ThV <50 ml was found in 269 (53.8 %)

Table 1
The Relationship of Vavr and Thyroidectomy Complications

Complication	Vavr(ml)±Sd	P
Hypocalcemia (n=91) Yes/No	45.4±49/67.6±59	
Temporary Hypocalcemia (n=79)	**43.3±48/67.6±59**	P=0.003
Permanent Hypocalcemia (n=12)	59.6±5/67.6±59	
VCP (n=51) Yes/No	79.3±58/61.8±58	
Temporary VCP (n=47)	74.7±58/61.8±58	P=0.0019
Permanent VCP (n=4)	**133.7±26/61.8±58**	
Peroperative bleeding (n=8) Yes/No	**132.0±70/62.5±57**	P=0.003
Nerve observation Yes/No	**57.3±51/76.5±68**	P=0.024
Injury complications (n=26) Yes/No	**105.0±66/65±60**	P=0.023

VCP= vocal cord paralysis, Vavr= average volume

patients, while ThV of 51-100 ml was in 151 (30.2 %) patients and that >100 ml in 80 (15.6 %).

The relation between thyroidectomy complications and the surgeon who performed the operation as well as the effect of age, type of surgical procedure (TT, TYT, ST) and thyroid endocrine activation was not significant (p>0.05). When all the patients were evaluated; temporary hypocalcemia rate was 14.8 % (n=74), while that of permanent hypocalcemia was 1.4 % (n=7), among them on 5 females (1.0 %) and 2 males (0.4 %).

Total peroperative complication rate was 2 % (n= 10) with trachea injury in 2 (0.4 %) and bleeding in 8 (1.6 %) patients. Two of the bleeding patients had jugular vein injury, one had carotic artery injury and five patients had developed acute neck hematomas that were realized just before leaving the surgery table or in the recovery room. Seven (87.5 %) among 8 patients who had peroperative bleeding were these with ThV more than 50 ml (p=0.013). Whereas volume average (Vavr) was 132.5±79 ml in patients with peroperative complications, this rate was 62.5±57 ml in these without peroperative complications (p=0.003).

Total postoperative complication rate was 28 % (n=140) and hypocalcemia, vocal cord paralysis (VCP), infection at wound sight, ecchymose, seroma were developed. Tracheomalacia was never observed, but tracheostomy was performed in 6 (1.2 %) patients because of severe respiration difficulty. In 4 of these patients tracheostomy was closed in 6 months (0.8 %), while 2 (0.4 %) are still living with tracheostomy. Temporary VCP was in 47 (9.4 %) patients and permanent VCP in 4 (0.8 %) patients. Temporary hypocalcemia was observed in 79 (15.8 %) patients and permanent hypocalcemia in 12 (2.4 %) patients.

No significant differences were observed between the patients groups concering permanent hypocalcemia, but both the temporary and permanent hypocalcemia rates were increasing with decreasing volume averages. Whereas the average volume (Vavr) was 45.4±48 ml in patients with hypocalcemia, it was 67.6±58 ml in patients without hypocalcemia (p<0.001) (Table 1). Whereas temporary hypocalcemia rate in patients with less than 50 ml volume was 23.8 % (n=64), it was 6.6 % (n=10) in 50-100 ml and 6.3 % (n=5) in patients with more than 100 ml, being statistically significant (p<0.001) (Table 2). While the total hypocalcemia rate was 32.8 % especially in patients with thyroid volume lower than the normal thyroid volume (e.g. 18ml), it was 15.7 % in patients who have more than 18 ml (p=0.001).

Table 2
Relationship of thyroid volume and hypocalcemia

Complication	Volume<50ml (n=269)	Volume 50-100ml (n=151)	Volume>100ml (n=80)	P
Hypocalcemia (n=91)	**26.4 % (n=71)**	8 % (n=12)	10.1 % (n=8)	
Temporary (n=79)	**23.8 % (n=64)**	6.6 % (n=10)	6.3 % (n=5)	P<0.001
Permanent (n=12)	2. 6 % (n=7)	1.3 % (n=2)	3.8 % (n=3)	

Table 3
Relationship of Thyroid volume and VCP rates

Complication	Volume <50ml (n=269)	Volume 50-100ml (n=151)	Volume >100ml (n=80)	P
VCP (n=51)	7.3 % (n=11)	8.6 % (n=23)	21.3 % (n=17)	
Temporary (n=47)	7.3 % (n=11)	8.6 % (n=23)	16.3 % (n=13)	P<0.001
Permanent (n=4)	0 % (n=0)	0 % (n=0)	**5 % (n=4)**	

Unobserved recurrence nevre rate in patients with thyroid volume less than 50 ml was 8 % (n=22), 19.9 % (n=30) in 50-100 ml, 38 % (n=30) in more than 100 ml (p=0.034). Whereas Vavr was 76.5±68 ml in patients with unobserved nerve, it was 57.3±51 in patients with observed nerve (p<0.001). Similarly, Vavr was determined to be 79±58 ml in patients with VCP and 61±58 ml in patients without VCP (p=0.042). In addition, Vavr was 133.7±26 ml in patients with permanent VCP, 74±58 ml in temporary VCP and 61.8±58 ml in patients without VCP (p=0.016) (Table 1).

Whereas the total VCP rate was 7.3 % (n=11) in patients with less than 50 ml and 8.6 % (n=23) in these with ThV of 50-100 ml, it reached 21.3 % (n=17) in patients with ThV exceeding 100 ml (p=0.005). Temporary VCP to permanent VCP frequency was 7.3 % (n=11) to 0 % in patients with less than 50 ml, 8.6 % (n=23) to 0 % in 50-100ml and 16.3 % (n=13) to 5 % (n=4) in patients with more than 100 ml (p=0.002). All four patients with permanent VCP had ThVmore than 100 ml (Table 3).

Whereas the injury complications (hematoma that does not need interference, edema, ecchymose, infection) were 12.5% (n=10) in patients with more than 50 ml, this rate was 3.7 % (n=3) in patients with smaller volume (p=0.027). Whereas Vavr was 105±66 ml in patients with complications concerning the wound, it was 65±60 ml in patients without the complications, this ratio being significantly high in statistical means (p=0.023) (Table 1).

Discussion

Among major complications observed after thyroidectomy are hypocalcemia and VCP which were reported to be affected by different factors in various studies (Moulton-Barrett et al. 1997; Bhattacharya et al. 2002). According to commonly accepted opinion more complications occur in large thyroids (Runkel et al. 1998). Generally, the frequency of complications was investigated by the measurement of thyroid size in postoperative period (Hermann et al. 1991). However, we are not aware about any report using the estimation of preoperative thyroid volume in order to express the number of complications as used in this study. Today, USG is known to be the most accurate and and convenient useful method in preoperative evaluation of the thyroid gland (Gutekunst et al., 1988). We calculated the volume by the ellipsoid model which described by Brunn et al. (1981) and accepted by WHO.

According to Runkel et al. (1998), VCP was found in 2.7 % of patients with normal thyroid volume, while 12.9 % of cases was found in patients with the volume >50 ml. Also in our study the rate of both temporary and permanent VCP increased according to the thyroid volume, being 7.3 % in patients with the volume <50 ml, while it increased to 21.3 % in those with the volume >100 ml. In addition, four among a total of four our patients with permanent VCP had the thyroid volume >100 ml. Even though volume calculations were made in the postoperative period, Moulton-Barrett et al. (1997) determined the average thyroid volume as 91.15 ml in patients with recurrent laryngeal nerve (RLN) injury and as 56.56 ml in patients without RLN injury. Our study also supports these results. The reason for this condition may be the destruction and localization changes in parathyroidal tissues as a result of thyroid volume increase leading to difficulty in isolation of the nerve in these cases. In addition, excessive peroperative bleeding in patients with larger volumes, damage to the undesirable regions while performing ligation and cauterization to control bleeding may increase the VCP rates. Indeed, the patients with VCP were those with peroperative bleeding, with large volume and no nerve isolation. Large volume, especially for the threatement of complications of permanent nerve damage, is an important risk factor. For this reason, we think that careful dissection especially in cases with more than 100 ml volume and the experience of the surgeon is much more correct approach.

Risk factors for hypocalcemia are much more variable (Bhattacharya and Fried 2002; Bassam et al.

2002). No data were found in the literature regarding the effect of preoperative volume on postoperative hypocalcemia. However, although in one study it was found that RLN damage risk increases with the amount of resected tissue, it was not found to be associated with hypocalcemia. In this study the volume average of hypocalcemic patients was found to be lower than that in ones who are not hypocalcemic (Moulton-Barrett et al. 1997). Similarly, in our study the hypocalcemia rate showed a significant increase with decreasing volume average or as the thyroid volume reached the normal thyroid volume of 18 ml. The reason for this may be that the patients with smaller volumes are mostly those who are drug resistant hyperthyrotics and/or those with thyroiditis. In the presence of thyroiditis, surgical capsule of the gland may show cohesiveness with the parathyroidal tissues due to the inflammation and thus the medium spaces may be missing. In addition, dissection of small and hard thyroids is more difficult and though there any major bleeding is not present, there may be bleedings of the leakage type thus distrupting the exposure during this dissection. This condition, giving rise to ischemia in the parathyroid gland or unwanted parathyroidectomy, may cause hypocalcemia. For this reason, we believe that when the ThV is about 18 ml and lower, bkeeping in mind the increased risk of hypocalcemia in patients with volume less than 50 ml, it is important for the surgeon to be deliberate about informing the patient and technical-medical treatment topics.

In this study, the rate of surgical sight complications and peroperative bleeding were also found to be increasing as the volume increases. The volume average (Vavr) was over 100 ml in patients with surgical sight complications and among 8 patients with peroperative bleeding sevem had thyroid volume more than 50 ml. The reason for this may be that the vascular structures are hypertrophic and fragile and the accumulation of excess seroma in the formed resected space of patients with large volume. For this reason, maximal attention must be paid to hemostasis in these patients and the drainage should be kept in place for a longer period. Since volume-drainage relation was not determined in this study, this topic may be the issue of another study.

In conclusion, thyroid volume appears an important factor affecting thyroidectomy complications. In thyroids with smaller volume, risk of hypocalcemia increases whereas in larger volume thyroids the risk of recurrent nerve damage and peroperative bleeding increases. The estiamtion of thyroid volume with regard to USG data in the preoperative period would be a useful approach in being well-prepared for these complications.

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