Microscopic Identification of the Parathyroid Glands Feeding Blood Vessels: A Method to Preserve Parathyroid Glands during Thyroidectomy

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ABSTRACT
Background: After a total thyroidectomy (TT), hypoparathyroidism may develop as a result of intraoperative stress, injury to the vasculature supplying the parathyroid glands, or accidental loss of parathyroid tissue during surgery. Depending on the cohort examined, the type of surgery utilized, and the diagnosis of hypoparathyroidism used, the reported incidence of hypothyroidism after thyroidectomy varies greatly. The aim of the current study is to preserve the parathyroid glands during total thyroidectomy operation by microscopic identification of their blood supply so preventing post total thyroidectomy hypocalcemia due to hypoparathyroidism.
Patients and methods: This study was conducted at Otorhinolaryngology, Head and Neck Surgery Department of Zagazig University Hospitals. A total of 24 patients prepared for total thyroidectomy were included in this clinical trial. The patients were randomly divided into two groups; *Group I* included 12 patients who underwent total thyroidectomy with preservation of the parathyroid glands by microscopic identification of the arterial blood vessels of parathyroid glands. *Group II* (control group) included 12 patients who underwent a traditional total thyroidectomy.
Results: As regarding the postoperative hypocalcemia and hypoparathyroidism in our study, there was an increase in their frequency among the traditional total thyroidectomy group (*Group II*) (25%) in comparison to microscopic dissection group (*Group I*) (zero). Although that was not statistically significant "due to the small sample size" but we can clearly notice that the use of microscopic identification technique led us to zero postoperative hypocalcemia and hypoparathyroidism. **Conclusions:** Microscopic identification of the parathyroid feeding blood vessels as a method to preserve parathyroid glands during total thyroidectomy is a safe procedure with low rate of complications and better clinical outcome without exposure of the patient to toxic or allergic material as dye or specific light.
Keywords: Thyroidectomy, Parathyroid identification, Parathyroid, Hypocalcemia, Hypoparathyroidism.

INTRODUCTION

The most frequent long-term consequence following total thyroidectomy is hypoparathyroidism, and with proper diagnosis and treatment, its morbidity and expense can be reduced [(1)]. During thyroid surgery, it was crucial to keep the parathyroid glands (PGs) functioning properly. For safe thyroid and parathyroid surgery, it's crucial to recognise the parathyroid glands and understand where their blood supply comes from [(2)]. According to various large series, the thyroidectomy's mortality rate is almost 0%. However, the morbidity of thyroidectomy remains a cause for concern [(3)].

When the parathyroid hormone (PTH) is not produced or is produced insufficiently, normal levels of calcium and phosphate are not maintained. As a result, hypocalcemia, hyperphosphatemia, and low PTH are the biochemical manifestations of the disease. Inadvertent injury to the parathyroid glands during thyroid surgery is the most frequent cause of hypoparathyroidism [(4)].

Since postoperative hypocalcemia can lead to extended hospital stays, frequent clinic visits, the requirement for lifelong calcium and vitamin D supplementation, and long-term complications like cerebral, vascular, ocular, and renal damage, lowering the rate of hypoparathyroidism is crucial for raising quality of life [(5,6)].

The preservation of the parathyroid glands' blood supply, crucial to maintain their function and should be reimplanted if inadvertently removed, is the most crucial factor in preventing hypoparathyroidism [(7)].

Thus, the current study aimed to preserve the parathyroid glands during total thyroidectomy operation by microscopic identification of their arterial blood supply, preventing post total thyroidectomy hypocalcemia due to hypoparathyroidism.

PATIENTS AND METHODS

This randomized controlled clinical trial was conducted at Otorhinolaryngology, Head and Neck Surgery Department of Zagazig University Hospitals. A total of 24 patients prepared for total thyroidectomy were included in this study.

The patients were randomly divided into two groups; *Group I* included 12 patients who underwent total thyroidectomy with preservation of the parathyroid glands by microscopic identification of the arterial blood vessels of parathyroid glands, and *Group II* (control group) included 12 patients who underwent a traditional total thyroidectomy.

One case from group I was prepared for total thyroidectomy for a 5 cm right thyroid lobe colloid nodule but intraoperatively the surgical team found no apparent macroscopic abnormality in the left thyroid lobe so they decided to perform only right hemithyroidectomy and to do completion thyroidectomy after definitive histopathological examination which proved that it was a colloid nodule

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without any neoplastic changes so it was excluded from the study and as a result *Group I* has only 11 patients.

Patients prepared for total thyroidectomy (TT), patients who had normal preoperative parathyroid hormone and serum calcium levels and patients fit for general anesthesia, and consenting the study were included in the study.

Patients with previous thyroid surgery history, patients prepared for hemithyroidectomy, abnormal preoperative parathyroid hormone or serum calcium level, unfit patients for general anesthesia, and patients not consenting the study were excluded.

All patients enrolled in our study were subjected to the following:

A full history was taken from all patients. General and local examination including neck ultrasound and fine needle aspiration cytology (FNAC) were done when indicated. Routine preoperative laboratory investigations including complete blood count (CBC), fasting blood sugar (FBS), liver function test (LFT), renal function test (RFT) and bleeding profile and thyroid function test (TFT), serum calcium (S.CA) and parathyroid hormone (PTH) levels were done.

Identifying the parathyroid glands

Group I: We used the surgical (operating) microscope, with objective lens 400mm focal distance, to identify the arterial blood vessels of the parathyroid glands.

By identifying the inferior thyroid artery, which was a branch of the thyrocervical artery, and having it ascend in the neck behind and deep to the common carotid artery (CCA) in the para-carotid tunnel, we were able to employ a well-known landmark. Additionally, the inferior thyroid artery's main trunk crosses medially (horizontally) to provide the parathyroid and thyroid glands' end glandular branches. Then, using either the well-known Lore's triangle, which is bounded by the trachea medially, the carotid sheath laterally, and the underside of the retracted inferior thyroid pole superiorly, or the Beahr's triangle, which is bounded by the common carotid artery as base, inferior thyroid artery superiorly, and RLN as lower arm of triangle, we concentrated on identifying the recurrent laryngeal The nerve should be safely identified with careful dissection in this region that is parallel to the RLN's course. Sometimes a thyroid tumor that is extremely large has the ability to move the nerve.

A superior approach, identifying the RLN at its entry into the larynx, may be necessary for identification of the nerve in these circumstances. After that, we carefully microscopic dissect the ITA's whole course, identifying its branches till we reach the parathyroid glands, and then we ligate the thyroid branch at the thyroid gland's lower lobe. We discovered various connections between the RLN and The ITA during this microscopic dissection, whether they were deep, surface-level, or between its branches. Following the identification of the inferior and superior parathyroid glands and their feeding arterial blood supply, the parathyroid glands' medial branch sutures were closed, and the glands were then separated from the thyroid gland. This thyroid lobe's complete mobilization from the trachea was accomplished. Then, once the entire thyroid gland had been safely removed, the same procedure was repeated on the opposite lobe.

Group II: The parathyroid glands were determined based on surgeon experience by the macroscopic appearance of the parathyroid glands.

Postoperative: i). All patients had parathyroid hormone level measurement immediately post-operatively. ii). Calcium level was measured 8 hours postoperatively. iii). Direct laryngoscopic assessment of the vocal fold mobility 1 day postoperative at the phoniatric unit. iv). Antibiotics for 1 week and daily dressing. v). Stitches removal 1 week postoperative. vi). Patients were discharged after drain removal within 2-3 days postoperatively if all investigations were within normal limits.

Ethical consent:

The study was approved by the Institutional Review Board (IRB) of Faculty of Medicine, Zagazig University. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean and standard deviation (SD). Mann Whitney test was used to compare between two independent groups. P value ≤ 0.05 was considered significant.

RESULTS

Table (1) shows that there were no statistically significant differences between the studied groups regarding age or sex distribution.

Table (1): Comparison between the 2 studied groups regarding the demographic data.

Variable		*Group I* (Microscopic Identification) (n=11)		*Group II* (Normal thyroidectomy) (n=12)		MW	P-value
Age: (years)	Mean ± SD Median Range	40.4 ± 27.08 45 21-58		41.9 ± 22.36 41.5 23-60		0.15	0.87 NS
Variable		**No**	**%**	**No**	**%**	χ^2	**P**
Sex:	Female Male	10 1	90.9 9.1	9 3	75 25	1.01	0.32 NS

SD: Standard deviation. MW: Mann Whitney test. χ^2: Chi square test. NS: Non significant (P>0.05).

Table 2 shows that there was an increase in frequency of hypoparathyroidism among *Group II* compared to *Group I*, but without statistically significant difference.

Table (2): Frequency of postoperative hypoparathyroidism among the 2 studied groups.

Hypoparathyroidism	*Group I* (Microscopic Identification) (n=11)		*Group II* (Normal thyroidectomy) (n=12)		χ^2	P-value
	No	**%**	**No**	**%**		
No Yes	11 0	100 0	9 3	75 25	3.16	0.08 NS

χ^2: Chi square test. NS: Non-significant (P>0.05).

Table 3 shows that there was an increase in frequency of hypocalcemia among *Group II* compared to *Group I* but without statistically significant difference.

Table (3): Frequency of postoperative hypocalcemia among the 2 studied groups.

Hypocalcemia	*Group I* (Microscopic Identification) (n=11)		*Group II* (Normal thyroidectomy) (n=12)		χ^2	P-value
	No	**%**	**No**	**%**		
No Yes	11 0	100 0	9 3	75 25	3.16	0.08 NS

χ^2: Chi square test. NS: Non-significant (P>0.05)

Table 4 shows that there was an increase in frequency of RLN injury among *Group II* compared to *Group I* but without statistical significance differences.

Table (4): Other complication of operation among the 2 studied groups.

Complication	*Group I* (Microscopic Identification) (n=11)		*Group II* (Normal thyroidectomy) (n=12)		χ^2	P-value
	No	**%**	**No**	**%**		
No Yes Right RLN injury Left RLN injury	10 1 1 0	90.9 9.1 9.1 0	9 3 1 2	75 25 8.3 16.7	1.01	0.32 NS

χ^2: Chi square test. NS: Non-significant (P>0.05). RNL: Recurrent Laryngeal Nerve

Table 5 shows that there was a statistically significant increase in operative time among *Group I* (microscopic identification) compared to *Group II* (normal thyroidectomy).

Table (5): Operative time among the 2 studied groups.

Variable		Group I (Microscopic Identification) (n=11)	Group II (Normal thyroidectomy) (n=12)	MW	P-value
Time: (minute)	Mean ± Sd Range	206.45 ± 8.42 195-217	153 ± 9.42 134-164	**14.30**	**<0.001 ****

SD: Standard deviation. MW: Mann Whitney test. **: Highly significant (P<0.001)

DISCUSSION

As regarding the postoperative hypocalcemia and hypoparathyroidism in our study, there was an increase in their frequency among the traditional total thyroidectomy group (*Group II*) (25%) in comparison to microscopic dissection group (*Group I*) (zero). Although that was not statistically significant "due to the small sample size" but we can clearly notice that the use of microscopic identification technique led us to zero postoperative hypocalcemia and hypoparathyroidism.

This is consistent with **Ravi *et al.*** [(8)] retrospective study of 30 patients that underwent total thyroidectomy by using microsurgical technique and loupes from May 2016 to April 2020. The only 2 patients (6.6 %) of temporary hypocalcemia among 30 patients and there was no permanent hypoparathyroidism or permanent hypocalcemia in any cases**.**

D'Orazi *et al.* [(9)] in their 10 years of performing microscopic assisted thyroidectomy, they had 10.36% of their patients presented with transient hypocalcemia and nearly all of them recovered between 2 and 6 weeks (mean 20 days) and only in 3 cases (0.38% of all 782 patients) there was permanent hypoparathyroidism with permanent hypocalcemia.

Abir *et al.* [(10)] in their retrospective analysis found that 27(11.8%) cases among 320 patients who had a total traditional thyroidectomy complicated by hypocalcemia throughout the study period. Also, **Espino *et al.*** [(11)] in their observational study of 481 patients undergoing total traditional thyroidectomy found that transient hypocalcemia was the most common early complication after total thyroidectomy (49%), and permanent hypoparathyroidism was the most common long-term complication (6%).

Lastly, **Gorobeiko and Dinets** [(12)] performed evaluation of near-infrared autofluorescence on 15 patients who underwent surgical treatment for thyroid and parathyroid neoplasms by use two different image-based systems for the identification of parathyroid glands. And the result was a low rate of unintentional parathyroid glands excisions.

They documented that despite this low rate of unintentional parathyroid removal but they found postoperative hypoparathyroidism among their patients. So, they had lower rate, but not the complete reduction of postoperative hypoparathyroidism which should be expected from the use of this expensive infrared camera and the injection of this expensive indocyanine green (ICG) dye.

As regarding the other postoperative complication in our study, there was an increase in RLN injury in *Group II* compared to *Group I* but without statistically significant difference (3 patients in *Group II* and 1 in *Group I*)

Ravi *et al.*[(8)] regarding other post-operative complications after total thyroidectomies under magnification found that there were no cases of unilateral or bilateral permanent vocal cord palsy. Also, **D'Orazi *et al.***[(9)] found only six patients from 782 (0.76%) suffered from transient unilateral vocal fold immobility with dysphonia.

As regarding the operative time in our study, there was an increase in operative time in *Group I* compared to *Group II* with statistical significance differences where the mean (SD) in microscopic thyroidectomy group was 206.45 (SD 8.42) minutes while in traditional thyroidectomy group was 153 (SD 9.42).

Ravi *et al.* [(8)] in their study found that the operative time was between 60 and 180 minutes (mean 90 minutes) and concluded that thyroid surgery with a microscope significantly reduced the complication without increasing the operative time compared to traditional thyroidectomy.

It is well understood that surgeon will spend more time in order to find the inferior thyroid artery, set up the microscope, do careful microvascular dissection to find the branches of the ITA and to follow them till finding the parathyroid glands and preserve them and also to spend more time to identify the RLN and determine its relation with the ITA. Also, there is a learning curve for this technique but surgeons with background of doing microscopic surgeries can learn this technique quite fast and we noticed in our last 2 cases of microscopic assisted thyroidectomy that we have decreased the duration of the operation to 195 minutes and of course if the sample size was bigger, that would have been reflected on the overall mean of operation time.

This technique doesn't include the injection of special expensive dye like ICG, th7e use of methylene blue spray which may have possible toxic side effects or the use of special expensive devises like image-based systems equipped with a near-infrared laser camera. We use only Microscope which is readily available in all otorhinolaryngology departments.

It is also worthy to mention that the use of microscope during thyroidectomy has other advantages like that mentioned by **Davidson *et al.*** **[13]** who have proposed that the operating microscope was beneficial in maintaining an upright posture for the operating surgeon with neutral cervical position during thyroid surgery in comparison with the use of loupe magnification and so reduces occupational musculoskeletal risk. Also, the use of the operating microscope allows for recording which has obvious benefits for both teaching purposes and from a medico-legal standpoint **[14].**

In conclusion, microscopic identification of the parathyroid glands arterial blood vessels is a very useful technique for identification of parathyroid glands during thyroidectomy, it is considered to be safe procedure with low rate of complications and better clinical outcome without need for exposure of the patient to toxic or allergic material as dye or specific light. Although it takes a longer operative time but its benefits in preserving the parathyroid glands and recurrent laryngeal nerve and preventing permanent complications are remarkable.

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