Modified thyroidectomy: 4 techniques to prevent recurrent laryngeal nerve injury and postoperative hypocalcaemia

Abdulwahid M. Salih, MDa,b, Hiwa O. Baba, MDb,c, Mohsin M. Ahmed, MDb, Fahmi H. Kakamad, PhDab,c,* Hunar A. Hassan, BSb,c, Marwan N. Hassan, MDc, Berwn A. Abdulla, BSb,c, Aso S. Muhialdeen, MDc, Shvan H. Mohammed, BSc

Objective: To share 4 techniques that decrease the rate of postoperative hypocalcaemia and save recurrent laryngeal nerve with a good cosmetic outcome.

Method: The research included all consecutive patients of thyroidectomy (hemi and total thyroidectomy) during 4-year practice. The techniques included (1) elevation of a circular flap after 4 cm collar incision. (2) Ligation of the pedicles (middle first-vein, inferior last-artery). (3) Sharp dissection of the parathyroid glands. (4) Sharp and blunt dissection and exposing the nerve in all of the patients.

Result: The total numbers of patients were 2399. At least 1 symptom of hyperthyroidism was found in 1271 patients (53%). The main indication for operation was multinodular goiter and compression symptoms in 1331 (55.5%) patients, followed by thyrotoxicosis in 598 (25%) patients and malignancy in 402 (16.8%) patients. The most common operations were total thyroidectomy in 1880 (78.4%) patients, followed by thyroid lobectomy in 495 (20.6%) patients and completion thyroidectomy in 24 (1%) patients. Among all patients, 4 (0.16%) patients developed permanent voice change. Seven (0.3%) patients developed permanent hypocalcemia.

Conclusion: This study offers a set of surgical techniques that reduced the risks of complications of thyroidectomy to a minimal range.

Keywords: Thyroid cancer, Goiter, Thyroidectomy, Hypoparathyroidism, Hypocalcemia

Thyroid diseases are among the most commonly encountered endocrine diseases worldwide[1]. The incidence of thyroid diseases is about 11% in the general population[2]. Thyroidectomy (hemi or total) is regarded as the main treatment modality for some thyroid disorders such as cancer and prolonged hyperthyroidism[3]. It is also recommended for benign symptomatic conditions that produce compression symptoms such as cough and dyspnea[4]. The options for surgical management of various thyroid diseases include: total thyroidectomy, subtotal thyroidectomy, in which bilateral small thyroid remnants are left, and thyroid lobectomy; which involves removing the affected part[5]. Every surgical procedure with the inclusion of thyroidectomy has the possibility of complications[6]. The most critical postoperative complications of the thyroidectomy are recurrent laryngeal nerve injury, hypocalcemia, hematoma and sepsis[7]. These potential complications negatively affect the quality of the life of the patients, leading to an increase in the costs and administering lifelong alternative therapy[1].

The current study aims to provide a set of safe techniques for the thyroidectomy minimizing the postoperative complications for patients undergoing thyroidectomy, which is the major concern of both surgeons and patients.

Method

Study design

This is a single center retrospective study of patients who underwent thyroidectomy during 4 years (2016–2020) in a private setting. The sociodemographic and clinical data were retrieved from the patients’ medical records and hospital database.

Inclusion criteria

The study included all patients who underwent thyroidectomy (hemi and total thyroidectomy) regardless of the indications of the operation.

Exclusion criteria

The followings have been excluded: patients with enucleation, isthmectomy, preoperative vocal cord paralysis and/or abnormal calcium level (hypo or hypercalcemia).
**Preoperative assessment**

After detailed history and physical examination, all of the patients underwent a neck ultrasound. Laboratory tests included measurement of thyroglobulin, thyroxine, tri-iodothyroxine, calcium, and thyroid antibody. Fine-needle aspiration cytology was performed for selective cases. All of the patients were assessed by otolaryngologists for vocal cord motility.

**Surgical intervention**

Under general anesthesia, in supine position, the neck was extended and elevated using an underneath roller. The 4 techniques included (1) elevation of a circular flap after 4 cm collar incision. The flap is elevated in both lateral and medial sides as the lower and upper regions. (2) Ligation of the pedicles (middle first-vein, inferior last-artery). To avoid using cautery, multiple suture ligations were used to control the ooze. (3) Sharp dissection of the parathyroid glands (Fig. 1). To prevent injury to the parathyroid glands, inferior thyroid vessels were ligated and divided very close to the thyroid capsule. All the fat tissues in the regions of the parathyroid glands were preserved. (4) Sharp and blunt dissection and exposing the nerve in all of the patients (Fig. 2). Dissection was kept near the gland throughout the operation.

**Statistical analysis**

The data were recorded using an excel sheet, later, they were transferred to the statistical package for the social science (SPSS) version 24 after coding. The descriptive analysis was calculated in the form of percentage, mean, and range.

**Result**

**Sociodemographic data**

There were 2514 cases. One hundred fifteen patients were excluded (73 patients had preoperative abnormal calcium levels, 32 patients had vocal cord paralysis, and 10 patients had parathyroid diseases). The remaining 2399 patients have undergone analysis. The age ranged from 10 to 89 years, with a mean age of 44.72 years. The majority of the patients (1955, 81.5%) were females and 2188 (91.2%) patients were married. One hundred sixty-three patients (6.8%) were smokers.

**Clinical data**

The most common comorbidity was hypertension (103 patients, 4.3%), followed by diabetes mellitus (76 patients, 3.2%). Neck swelling was the most common presenting symptom (844, 35.2%). Seven hundred ten patients (29.6%) had G1, 561 (23.4%) G2. At least one symptom of hyperthyroidism was found in 1271 patients (53%). Thyroid function tests revealed hyperthyroidism in 1320 (53%) patients and euthyroid in 998 (41.6%) patients. Eight hundred twenty-six (34.5%) underwent fine-needle aspiration cytology. The main indication for operation was multinodular goiter and compression symptoms in 1331 (55.5%) patients, followed by thyrotoxicosis in 598 (25%) patients and malignancy in 402 (16.8%) patients. The most common operations were total thyroidectomy in 1880 (78.4%) patients, followed by thyroid lobectomy in 495 (20.6%) patients and completion thyroidectomy in 24 (1%) patients. Retrosternal extension was found in 246 (10.3%) patients. The mean duration of operation was 88.1 minutes.

**Outcomes**

Among all cases who underwent thyroidectomy, only 4 (0.16%) patients developed permanent voice change; all of them occurred in the totally thyroidectomized patients (0.2%). Seven (0.3%) patients developed permanent hypocalcemia, and all of them had total thyroidectomy (0.37%).

**Discussion**

Following diabetes mellitus, thyroid disorders are the second most common endocrine diseases[8]. Thyroid pathologies are managed either medically or surgically, and thyroidectomy is among the most commonly performed procedures globally, which could be either partial or total[9]. Thyroid cancer and goiter are among the most prevalent indications for thyroidectomy[23]. The indications for surgical treatment in goiter are the presence of compression symptoms, cosmetic reason, hyperthyroidism and suspicion of cancer[10]. Postoperative outcomes following thyroidectomies are usually related to the condition of the patient, thyroid pathology, experience of the surgeon and the type of surgery[11]. The rate of unacceptable postthyroidectomy results varies including, persistence of the disease, recurrence and post-operative complications[10]. Previously, thyroidectomy was
regarded as a dangerous procedure with high morbidity and mortality, but now it is regarded as a safe operation with decreased morbidity and mortality due to developed surgical techniques and an understanding of the detailed anatomy and physiology of the thyroid[12]. However, there are many serious complications postthyroidectomy including recurrent laryngeal nerve paralysis, hemorrhage, and hypocalcemia[13].

There are transient and permanent complications after thyroideaectomy, the transient complications vary from mild to severe life-threatening ones[14]. As defined by most authors, transient hypocalcemia is the inability of the parathyroid gland to maintain normal calcium levels for 6–12 months after the operation[15]. Ramirez et al[16] reported that the complication rate following thyroidectomy is directly proportional to the extension of the pathology and inversely proportional to the surgeon’s experience. There are many risk factors associated with increased postoperative complications. One of the risk factors is malignancy, as it associates with increased vascularity, suppresses the immune system, and delays wound healing[17]. Certain thyroid diseases such as goiter, hyperthyroidism, and thyroiditis need more attention and could lead to more difficult operation[18]. It is demonstrated in many studies when thyroideaectomy is performed by high-volume surgeons, the patients may develop fewer complications and need shorter hospital stays[19]. However, experienced surgeons may injure the nerve due to anatomic variability of the recurrent laryngeal nerve (RLN)[20].

Hypocalcemia is the most common complication of postthyrocricotomy and often represents as the most troubling long-term complications of total thyroidectomy[21]. It occurs as the result of incidental parathyroid removal, decreased blood flow to the parathyroid glands and damage to the glands[22]. It can be transient or permanent secondary to hypoparathyroidism[23]. Transient hypocalcemia accounts for 10%–50% of thyroidectomies, and permanent hypocalcemia accounts for up to 2% of cases[24]. The incidence increased after total thyroidectomy, in which transient hypocalcemia occurs in 50%–68% of patients and permanent hypocalcemia occurs in 3% of patients[25]. Rosato et al[26] reported that permanent hypocalcemia after a surgical procedure for thyroid malignancy is significantly higher, with the incidence of 3.3%. However, in the current study, hypocalcemia is only developed in 0.3% of the cases, which is the minimum complication rate ever reported following thyroideaectomy. This might be due to the 4 techniques mentioned above. Recent studies proposed many parathyroid hormone criteria to predict the risks of developing postoperative hypocalcemia in patients undergoing thyroidectomy[27]. A single postoperative PTH measurement checked 1–6 hours after surgery seemed to have an excellent accuracy in identifying which patients will develop severe hypocalcemia[28,29]. Regarding management, all patients with hypocalcemia are treated with calcium supplement orally; for those developing symptoms, an injection of 10% calcium gluconate 10–20 mL is given slowly 2 times a day, with oral administrations of calcium containing vitamin D3 times a day[30]. If the decrease of postoperative calcium is <70%, the patients could be discharged in the first 24 h following operation, if it is >70% the patients need longer hospitalization other than calcium supplement[28,31,32].

The most severe complication of thyroidectomy is recurrent laryngeal nerve injury (RLNI), that results in transient and permanent changes in the voice[33]. The incidence of RLNI complications varies, as reported in the literature from 2% to 6%[14]. Another study reported that permanent RLNI occurs approximately in up to 3% of patients and transient palsies in up to 8%[35]. The incidence of RLNI increases in certain conditions such as those who have an extensive reaction, Graves disease, reoperation, and thyroid malignancy[31]. The risk is more common in reoperating patients because of the presence of too much scarring, with incidence of up to 12%[36]. However, in the present study, the rate of RLNI was only 0.17%, which is the lowest complication rate. To reduce the injury of the RLN during operation, intraoperative nerve monitoring was introduced by Thomusch and colleagues, and decreased the risk of this injury in an observational study[37]. However, it is reported that the rate of permanent RLNI was not decreased significantly by the use of intraoperative neuromonitoring compared with visual nerve identification[38].

To reduce the rate of complications, many techniques have been introduced[36]. The standard technique for total thyroidectomy is capsular dissection, first described by Theodor Kocher, which potentially reduced the rate of recurrent laryngeal nerve damage and hypocalcemia[37]. The reported incidences of permanent recurrent laryngeal nerve damage and hypocalcemia for this method were (0.8%) (1.4%)[37]. Praženica et al[39] reported permanent hypocalcemia in 1.5% of their cases. The traditional method for obtaining hemostasis is tying off and ligation of the cut vessels, ultrasonic vibration and bipolar electrocoagulation[39]. Grajek et al[39] reported in their study that the incidence of permanent RLN palsy and hypocalcemia were 0.8% and 2.4% in those who underwent bipolar electrocoagulation. However, the 4 techniques described in the current study reported the lowest incidence of permanent RLN palsy (0.16%) and hypocalcemia (0.3%).

In conclusion, thyroidectomy is a safe procedure with limited serious complications that concern both surgeons and patients. New techniques are emerged but the risks still remain. The presenting study offers new surgical techniques that reduced the risks of complications of thyroideaectomy to a minimal range.

Ethical approval
Ethical approval was provided by Kscien Organization.

Sources of funding
None.

Author contribution
A.M.S., H.O.B., M.M.A., and A.S.M.: surgeons performing the operations, follow up the cases, final approval of the manuscript. F.H.K., H.A.H., M.N.H., B.A.A., S.H.M.: literature review, writing the manuscript, final approval of the manuscript.

Conflicts of interest disclosure
The authors declare that they have no financial conflict of interest with regard to the content of this report.

Research registration unique identifying number (UIN)
The research was registered in the Research Registry with a registration number of researchregistry7513.

Guarantor
None.
References

[1] Chahardolahmoumi E, Salehidoost R, Amini M, et al. Assessment of the early and late complication after thyroidectomy. Adv Biomed Res 2019;8:1–11.

[2] Bhattacharyya N, Fried MP. Assessment of the morbidity and complications of total thyroidectomy. Arch Otolaryngol Head Neck Surg 2002;128:389–92.

[3] Sun GH, DeMonner S, Davis MM. Epidemiological and economic trends in inpatient and outpatient thyroidectomy in the United States, 1996–2006. Thyroid 2013;23:727–33.

[4] Al-Hussain OH, Kurdi AK, Almoqaidan EA, et al. An overview of thyroidectomy complications management: literature review. J Biochem Technol 2020;11:24–7.

[5] Hashem EM, Mohammed ZA, Ahmed MT, et al. Effect of designed nursing guidelines on minimizing postoperative complications for patients undergoing thyroidectomy. Assut Sci Nurs J 2018;6:29–38.

[6] Reeve T, Thompson NW. Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. World J Surg 2000;24:971–5.

[7] Christou N, Mathonnet M. Complications after total thyroidectomy. J Visc Surg 2013;150:249–55.

[8] Karamanakos SN, Markou KB, Panagopoulos K, et al. Complications and risk factors related to the extent of surgery in thyroidectomy. Results from 2,043 procedures. Hormones 2010;9:318–25.

[9] Alqahtani SM, Almussallam B, Alatawi AS, et al. Post-thyroidectomy complications and risk factors in Tabuk, Saudi Arabia: a retrospective cohort study. Cureus 2020;12:1–10.

[10] Filho JG, Kowalski LP. Surgical complications after thyroid surgery performed in a cancer hospital. Otolaryngol Head Neck Surg 2005;132:490–4.

[11] Neto ME, Tagliarni JV, López BE, et al. Factors influencing thyroidectomy complications. Braz J Otorhinolaryngol 2012;78:63–9.

[12] Kwak HY, Dionigi G, Liu X, et al. Predictive factors for longer operative times for thyroidectomy. Asian J Surg 2017;40:139–44.

[13] Bai B, Chen Z, Chen W. Risk factors and outcomes of incidental parathyroidectomy during total thyroidectomy: a systematic review and meta-analysis. PloS One 2018;13:207088.

[14] Zambudio AR, Rodríguez J, Riquelme J, et al. Surgical management of thyroid surgery using capsular dissection technique. Otolaryngol Head Neck Surg 2011;145:561–4.

[15] Suhbhati A, Rubin SJ, Park J, et al. Preventative and management strategies of hypocalcemia after thyroidectomy among surgeons: an international survey study. Am J Otolaryngol 2020;41:102394.

[16] Luo H, Yang H, Wei T, et al. Protocol for management after thyroideectomy: a retrospective study based on one-center experience. Ther Clin Risk Manag 2017;13:635.

[17] Ramirez AT, Gibelli B, Tradati N, et al. Surgical management of thyroid cancer. Exp Rev Anticancer Ther 2007;7:1203–4.

[18] Ramrhit AD, Rodrigues J, Riquelme J, et al. Prospective study of postoperative complications after total thyroidectomy for multinodular goiters by surgeons with experience in endocrine surgery. Ann Surg 2004;240:18.

[19] Walker Harris V, Jan De Beur S. Postoperative hypoparathyroidism: medical and surgical therapeutic options. Thyroid 2009;19:967–73.

[20] Al-Qahtani SM, Almussallam B, Al-Latabi AS, et al. Post-thyroidectomy complications and risk factors in Tabuk, Saudi Arabia: a retrospective cohort study. Cureus 2020;12:1–9.

[21] Noordzij JP, Lee SL, Bernet VJ, et al. Early prediction of hypocalcemia after thyroidectomy using parathyroid hormone: an analysis of pooled individual patient data from nine observational studies. J Am Coll Surg 2007;205:748–54.

[22] Wang W, Meng C, Ouyang Q, et al. Magnesium: an independent risk factor of hypocalcemia after thyroidectomy. Cancer Manag Res 2019;11:8135.

[23] Bai B, Chen W. Protective effects of intraoperative nerve monitoring (IONM) for recurrent laryngeal nerve injury in thyroidectomy: meta-analysis. Sci Rep 2018;8:7761.

[24] Nyeki AR, Njock LR, Miloundja J, et al. Recurrent laryngeal nerve landmarks during thyroidectomy. Eur Ann Otorhinolaryngol Head Neck Dis 2015;132:265–9.

[25] Hayward NJ, Grodski S, Yeung M, et al. Recurrent laryngeal nerve injury in thyroid surgery: a review. ANZ J Surg 2013;83:5–21.

[26] Erb Y, Bobzora A, Obzey N, et al. Predictive value of age and serum parathormone and vitamin d3 levels for postoperative hypocalcemia after total thyroidectomy for nontoxic multinodular goiter. Arch Surg 2007;142:1182–7.

[27] Yearbrough DE, Thompson GB, Kasperbauer JL, et al. Intraoperative electromyographic monitoring of the recurrent laryngeal nerve in reoperative thyroid and parathyroid surgery. Surgery 2004;136:1107–5.

[28] Thomusch O, Sekulla C, Walls G, et al. Intraoperative neuromonitoring of surgery for benign goiter. Am J Surg 2002;183:673–8.

[29] Alesina PF, Rolfs T, Hommeltenberg S, et al. Intraoperative neuromonitoring does not reduce the incidence of recurrent laryngeal nerve palsies in thyroid reoperations: results of a retrospective comparative analysis. World J Surg 2012;36:1348–53.

[30] Baldew K, Haniff M, Somasundar P. Initial experience using a bipolar radiofrequency ablation device for hemostasis during thyroidectomy. Head Neck 2013;35:118–22.

[31] Chand G, Agarwal S, Mishra A, et al. The impact of uniform capsular dissection technique of total thyroidectomy on postoperative complications: an experience of more than 1000 total thyroidectomies from an endocrine surgery training centre in North India. Indian J Endocrinol Metab 2018;22:362.

[32] Prazenica P, O’Driscoll K, Holy R. Incidental parathyroidectomy during thyroid surgery using capsular dissection technique. Otolaryngol Head Neck Surg 2014;150:754–61.

[33] Graeze ZW, Dadan J, Ladny JR, et al. The assessment of the influence of the method for obtaining hemostasis on the occurrence of postoperative complications after thyroid surgery. Adv Clin Exp Med 2015;24:273–8.