SCIENTIFIC REP🞄RTS

OPEN

Risk factors for postoperative haemorrhage after total thyroidectomy: clinical results based on 2,678 patients

Xu Zhang, Wei Du & Qigen Fang

The aim of this study was to analyse postoperative haemorrhage (POH) after a total thyroidectomy and explore the possible risk factors. Records of patients receiving a total thyroidectomy were reviewed and analysed for risk factors of POH. From the 2,678 patients in this study, a total of 39 patients had POH, representing an incidence of 1.5%. The majority (59.0%) of POH events occurred within four hours after surgery. Arterial haemorrhage was the primary cause of POH and was identifiable prior to venous bleeding, making it the first sign of POH. A univariate analysis revealed an association between POH, certain disease factors and BMI, but only a BMI greater than 30 was found to significantly increase the risk of POH (almost 6-fold). At the first sign of POH, all patients showed an obvious red drainage, and 92.3% of the patients had neck swelling. In summary, arterial bleeding is the main cause and first sign of postoperative haemorrhage, as it starts earlier than venous bleeding. A BMI greater than 30 significantly increases the risk of neck haematoma.

A large proportion of the global increase in thyroid cancer is thought to be due to a real increase in the incidence and/or increased detection of papillary thyroid cancer[1]. Surgery is the preferred procedure for head and neck surgeons. Total thyroidectomy has been regarded as a safe and effective operative option for selected patients[2, 3].

Postoperative haemorrhage (POH) is an uncommon complication after thyroid surgery. Although some haematomas present superficially, in severe cases, haematomas can be lethal if they result in airway compression. Occasionally, blood transfusions are required. Therefore, patients undergoing thyroidectomy need close postoperative monitoring for any signs of bleeding. Various studies have reported the incidence of POH, which ranges from 0 to 4.2%[4–13]. Three categories of risk, namely, surgical technique, patient predisposition, and thyroid pathology, are responsible. Weiss *et al.*[4] has determined that high-volume hospitals and the female sex are important for decreased haematoma risk, and partial thyroidectomy, inflammatory thyroid disease, bleeding disorders, and chronic kidney disease increase the risk of haematoma. Recently, Liu *et al.*[5] reported that the occurrence of POH is just 0.85% and that benign pathology and a previous thyroid history are individual risk factors. Chavez *et al.*[13] notes an interesting finding that in a thyroid operation, compared to the traditional tie and suture technique, the use of an advanced bipolar device reduces the operation time with a similar postoperative outcome profile. All of these studies used a range of different surgical procedures, including partial thyroidectomy, unilateral lobectomy and subtotal thyroidectomy, but few authors have focused on the association between POH and total thyroidectomy[4–13]. Therefore, in this study, we analysed POH after a total thyroidectomy and explored the possible risk factors.

Results

From a total of 2,678 patients, 39 (15 male and 24 female) had POH, which was equal to an incidence of 1.5%. The mean age was 56.5 (range: 44–67) years old. Four patients received a bilateral cervical dissection (regions II–V), and 10 patients received a unilateral cervical dissection (regions II–V). All patients were diagnosed with papillary thyroid cancer.

POH was detected at various times post-surgery: in 15 (38.4%) patients, the first sign of POH occurred within 2 hours after surgery; in 8 (20.5%) patients, the first sign of POH occurred between 2 to 4 hours after surgery;

Department of Head Neck and Thyroid Surgery, Affiliated Cancer Hospital of Zhengzhou University, Henan Cancer Hospital, Zhengzhou, Henan Province, PR China. Correspondence and requests for materials should be addressed to Q.F. (email: qigenfang@126.com)

Category	Location	n
Artery (n = 23)	Branch of superior thyroid artery	15
	Branch of inferior thyroid artery	7
	Branch of transverse cervical artery	1
Venous (n = 13)	Anterior jugular vein	4
	Inferior thyroid vein	3
	Branch of internal jugular vein	2
	Subfascial vein	1
	Subcutaneous tissue	2
	Remnant thyroid tissue of Zach nodule	1
Unknown (n = 3)		3

Table 1. Summary of bleeding sources.

	Artery (n = 23)	Venous (n = 13)	p
0–2 hours	12	3	
2–4 hours	6	2	0.039
4–8 hours	5	5	
8–12 hours	0	3	

Table 2. Compare of different time of the first sign of artery or venous bleeding.

and in 10 (25.6%) patients, the first sign of POH occurred between 4 to 8 hours after surgery. POH was not first detected more than 12 hours after surgery.

In 23 (59.0%) patients, the cause of POH was recognized as arterial bleeding: a branch of the superior thyroid artery, 15 cases; a branch of the inferior thyroid artery, 7 cases; and a branch of the transverse cervical artery, 1 case. In 13 (33.3%) patients, the cause of POH was recognized as venous bleeding: the anterior jugular vein, 4 cases; the inferior thyroid vein, 3 cases; a branch of the internal jugular vein, 2 cases; a subfascial vein, 1 case; subcutaneous tissue, 2 cases; and the remnant thyroid tissue of the Zuch nodule, 1 case. In the remaining three (7.7%) patients, no apparent bleeding source was noted, and there was no obvious blood clot during the exploratory operation (Table 1).

In patients with arterial bleeding, the first sign of POH was noted in 12 patients within two hours after surgery, six patients between two and four hours after surgery and in five patients between four and eight hours after surgery. In patients with venous bleeding, the first sign of POH was noted in three patients within two hours after surgery, two patients between two and four hours after surgery, five patients between four and eight hours after surgery, and three patients between eight and 12 hours after surgery. The difference was significant ($p = 0.039$) (Table 2).

All patients with POH had malignant thyroid diseases, compared to 87.4% in patients without POH; the difference was significant ($p = 0.023$). The majority (79.5%) of patients with POH had a BMI greater than 30, compared to 12.8% of patients without POH; the difference was significant ($p < 0.001$). A univariate analysis showed that there were no other potential risk factors (all $p > 0.05$). Therefore, a multivariate analysis revealed that a BMI greater than 30 would increase the risk of POH nearly 6-fold (OR: 6.002, $p = 0.023$) (Table 3).

To determine how the cancer subtype and disease stage (based on the 2016 ATA guidelines) affected the POH, patients with malignant tumours were separately analysed, and it was noted that cancer subtype, tumour stage, node stage, and disease stage were not associated with POH (all $p > 0.05$, Table 4).

At the first sign of POH, all patients had an obvious red drainage, 92.3% of the patients had apparent neck swelling and 12.8% of the patients had bleeding from the incision. Four (10.26%) patients whose causes of POH were recognized as arterial bleeding complained of dyspnoea. No patients underwent an emergency tracheotomy or a third operation. No patients died of POH.

Discussion

This study is the first to report that arterial bleeding allows for earlier identification of POH, as arterial bleeding was discovered prior to venous bleeding. This finding is important because it may allow surgeons to plan for more targeted surgeries in exploratory operations. The source of the haematoma could almost always be found (92.3%), and the majority of haematomas were caused by arterial bleeding. This finding is consistent with other previous studies[5, 7]. Moreover, it was noted that the distribution of venous bleeding was more complex, making it more difficult to isolate the site of origin when venous bleeding was suspected.

The role of BMI in surgery-related complications has been well studied. Desai et al.[16] found that rates of reoperation and skin necrosis were significantly lower in patients who had undergone complex abdominal wall reconstructions if the patients had a BMI lower than 30, compared to subgroups with a greater BMI. During surgical resections of intracranial tumours, Wei et al.[17] noted that BMI was closely linked to preoperative-to-postoperative plasma fibrinogen consumption, and postoperative fibrinogen deficiency was a potential risk for postoperative bleeding. Similarly, Ahmed et al.[18] reported that BMI was an independent risk factor for vascular complications

		Patients with POH	Patients without POH	Univariate	Multivariate
Sex	Female	24	1825		
	Male	15	814	0.307	
Age	<55	18	1213		
	>=55	21	1426	0.981	
Disease	Benign	0	333		
	Malignant	39	2306	0.023	0.124
LND#	Yes	14	898		
	No	25	1741	0.807	
Diabetes	Yes	4	312		
	No	35	2327	0.814	
Hypertension	Yes	10	612		
	No	29	2027	0.719	
Antiplatelet	Yes	1	136		
	No	38	2503	0.720	
BMI&	>30	31	337		
	<30	8	2302	<0.001	0.031
Smoker	Yes	8	473		
	No	31	2166	0.676	

Table 3. Risk factor analysis of POH*. *POH: Postoperative hematoma; #LND: Lateral neck dissection; &BMI: Body Mass Index.

	Patients with POH	Patients without POH	Univariate
Cancer subtype			
papillary thyroid carcinoma	39	2265	
medullary thyroid carcinoma	0	26	
follicular thyroid carcinoma	0	15	1.000
Tumor stage			
T1	21	1012	
T2	12	961	
T3	5	295	
T4	1	38	0.523
Node stage			
N0	17	985	
N1	22	1321	1.000
Disease stage			
I	8	626	
II	13	689	
III	14	822	
IV	4	169	0.757

Table 4. Risk factor analysis of POH* in patients with malignant tumor. *POH: Postoperative hematoma.

in patients undergoing cardiac catheterization. Moreover, BMI has been associated variably with head and neck cancer outcomes. Gama et al.[19] found that being underweight at diagnosis was an independent, adverse prognostic factor, whereas being overweight conferred a better prognosis. In a study aiming to analyse how BMI affects infectious complications in free tissue transfer surgery[20], the authors failed to note a positive association, and a similar finding was also reported by de la Garza et al.[21]. However, both Lo et al.[22] and Heo et al.[23] concluded that a poor nutrition status, indicated by low BMI, was associated with a greater tendency to develop postoperative complications in free tissue transfer for head and neck reconstruction. However, few authors have analysed the association between BMI and POH in thyroid surgery. This study discovered that a BMI greater than 30 would increase the risk of POH nearly 6-fold. An important interpretation is that a deficiency in neck extension in obese patients leads to limited exposure of the surgical field and increases operation difficulty.

The incidence of POH in this study was 1.5%, and this finding was consistent with previous research[4, 5]. However, in this study, all patients underwent a total thyroidectomy, and a more extensive thyroid resection tends to increase the POH risk[7, 9]. Promberger et al.[7] noted that, compared with a subtotal bilateral resection, a bilateral near-total resection and total thyroidectomy results in a significantly higher risk of POH. Godballe et al.[9] reported that bilateral thyroid surgery had a significant influence on the frequency of POH. Possible explanations for our findings might be that all the procedures were performed by extremely experienced surgeons, so the risk of POH was reduced[6].

Complications from emergency tracheotomy or death resulting from POH are extremely rare, and neither we nor others have reported such serious events[8, 10, 12]. A previous study showed that the mean time between skin closure and the first sign of POH was threefold longer in patients undergoing emergency tracheotomy relative to patients without an emergency tracheotomy[7]. Most of the POH events were noted within four hours after surgery in our study. At the first sign of POH, all patients had an obvious red drainage, and 92.3% of the patients had apparent neck swelling; these signs might be reliable indicators of POH. A timely exploratory operation was strongly suggested when there were such signs. Overly conservative treatment might lead to serious complications.

A number of studies have evaluated the effects of blood pressure on the incidence of POH. Morton et al.[8] concluded that a post-anaesthetic systolic blood pressure in excess of 150 mmHg significantly increased the risk of haemorrhage following thyroid surgery. In another study, the authors reported a similar finding[11]. We agree, even though hypertension was not associated with POH in our study. In our cancer centre, patients with POH usually (more than 90%) had severe nausea and vomiting before the symptoms of POH emerged (unpublished data), during which the systolic blood pressure was more than 150 mmHg. Therefore, routine postoperative inhibition of vomiting might be helpful for reducing the number of POH events.

A conflicting result was described regarding the association between POH and disease pathology[4–13]. It could be explained by a range of different surgical procedures and various disease categories, including Graves' disease. No POH event was noted in patients with benign disease in the current study, and this observation might be well attributed by the following reasons. Firstly, Graves' disease was not treated at our institute. Secondly, benign disease usually has a clear boundary and can easily be dissected. Thirdly, total thyroidectomy was the only surgical procedure, and the resection extent was significantly associated with neck haematoma[4, 7].

In summary, postoperative haemorrhage is uncommon following total thyroidectomy. Arterial bleeding is the primary cause and is the first sign of postoperative haemorrhage, as it occurs earlier than venous bleeding. Obvious red drainage and apparent neck swelling are reliable indicators of postoperative haemorrhage. A timely exploratory operation is suggested to avoid severe complications. A BMI greater than 30 significantly increases the risk of neck haematoma.

Methods

The Zhengzhou University institutional research committee approved our study, and all participants signed an informed consent agreement. All methods were performed in accordance with the relevant guidelines and regulations.

From May 2014 to October 2016, after filtering patients who had undergone previous neck or thyroid surgery, we reviewed a consecutive series of 2,678 patients (829 male and 1,849 female) who had received a total thyroidectomy in the Department of Head, Neck and Thyroid Surgery at the Affiliated Cancer Hospital of Zhengzhou University. All related information including age, sex, smoking history, BMI, surgical records, postoperative records, pathology reports, time between skin closure and the first sign of POH and other related factors was obtained. A total of 2,345 patients had malignant thyroid diseases, and 316 patients underwent bilateral or unilateral neck dissection. A total of 137 patients had previously taken antiplatelet drugs routinely, and they were required to stop at least 1 week before the operation. A total 481 patients were recognized as current smokers. Smokers were defined as patients who were current smokers or had quit smoking for no more than half a year[14]. A total of 368 patients were obese according to the WHO guideline (BMI > 30). Patients who had POH had undergone secondary surgical interventions.

The collar incision was performed after the patient received general balanced anaesthesia. The strap muscles were divided in the middle and retracted laterally, and the subcutaneous tissue and platysma muscle were subsequently divided. The superior, middle, and inferior thyroid vessels were ligated with knot tying regardless of vessel diameter. All thyroid glands were resected using the capsular principle of dissection[15]. Routine applications of haemostatic agents and operative bed drainage prior to closure was performed.

General data were analysed by means of a chi-squared test or Fisher exact test. Independent risk factors were analysed by multivariable logistic regression. All statistical analyses were performed using SPSS 13.0. A p < 0.05 was considered significant.

Data availability. The corresponding author is responsible for the data availability.

References

1. Wiltshire, J. J., Drake, T. M., Uttley, L. & Balasubramanian, S. P. Systematic review of trends in the incidence rates of thyroid cancer. *Thyroid* **26**, 1541–1552 (2016).
2. Kim, S. K. *et al.* Total thyroidectomy versus lobectomy in conventional papillary thyroid microcarcinoma: analysis of patients at a single institution. *Surgery* **161**, 485–492 (2017).
3. Li, Y., Li, Y. & Zhou, X. Total thyroidectomy versus bilateral subtotal thyroidectomy for bilateral multinodular nontoxic goiter: a Meta-Analysis. *ORL J Otorhinolaryngol Relat Spec* **78**, 167–175 (2016).
4. Weiss, A., Lee, K. C., Brumund, K. T., Chang, D. C. & Bouvet, M. Risk factors for hematoma after thyroidectomy: results from the nationwide inpatient sample. *Surgery* **156**, 399–404 (2014).

5. Liu, J. *et al*. Risk factors for and occurrence of postoperative cervical hematoma after thyroid surgery: A single-institution study based on 5156 cases from the past 2 years. *Head Neck* **38**, 216–219 (2016).
6. Dehal, A., Abbas, A., Al-Tememi, M., Hussain, F. & Johna, S. Impact of surgeon volume on incidence of neck hematoma after thyroid and parathyroid surgery: ten years' analysis of nationwide in-patient sample database. *Am Surg* **80**, 948–952 (2014).
7. Promberger, R. *et al*. Risk factors for postoperative bleeding after thyroid surgery. *Br J Surg* **99**, 373–379 (2012).
8. Morton, R. P., Mak, V., Moss, D., Ahmad, Z. & Sevao, J. Risk of bleeding after thyroid surgery: matched pairs analysis. *J Laryngol Otol* **126**, 285–288 (2012).
9. Godballe, C. *et al*. Post-thyroidectomy hemorrhage: a national study of patients treated at the Danish departments of ENT Head and Neck Surgery. *Eur Arch Otorhinolaryngol* **266**, 1945–1952 (2009).
10. Meltzer, C. *et al*. Surgeon volume in thyroid surgery: Surgical efficiency, outcomes, and utilization. *Laryngoscope* **126**, 2630–2639 (2016).
11. Morton, R. P. & Vandal, A. C. Postoperative systolic blood pressure as a risk factor for hematoma following thyroid surgery. *Clin Otolaryngol* **40**, 462–467 (2015).
12. Oltmann, S. C. *et al*. Antiplatelet and anticoagulant medications significantly increase the risk of postoperative hematoma: review of over 4500 thyroid and parathyroid procedures. *Ann Surg Oncol* **23**, 2874–2882 (2016).
13. Chavez, K. V. *et al*. Comparative analysis between a bipolar vessel sealing and cutting device and the tie and suture technique in thyroidectomy: A randomized clinical trial. *Surgery* **161**, 477–484 (2017).
14. Fang, Q. G., Shi, S., Liu, F. Y. & Sun, C. F. Squamous cell carcinoma of the oral cavity in ever smokers: a matched-pair analysis of survival. *J Craniofac Surg* **25**, 934–937 (2014).
15. Du, W. *et al*. Unintentional parathyroidectomy during total thyroidectomy surgery: A single surgeon's experience. *Medicine* **96**, e6411 (2017).
16. Desai, K. A., Razavi, S. A., Hart, A. M., Thompson, P. W. & Losken, A. The effect of BMI on outcomes following complex abdominal wall reconstructions. *Ann Plast Surg* **76**(Suppl 4), S295–S297 (2016).
17. Wei, N. *et al*. Risk factors for postoperative fibrinogen deficiency after surgical removal of intracranial tumors. *Plos One* **10**, e0144551 (2015).
18. Ahmed, B. *et al*. Gender related differences in predictors of vascular complications: role of vessel size and BMI. *J Thromb Thrombolysis* **36**, 84–90 (2013).
19. Gama, R. R. *et al*. Body mass index and prognosis in patients with head and neck cancer. *Head Neck* **39**, 1226–1233 (2017).
20. Khan, M. N. *et al*. Association of body mass index with infectious complications in free tissue transfer for head and neck reconstructive surgery. *JAMA Otolaryngol Head Neck Surg* **143**, 574–579 (2017).
21. de la Garza, G. *et al*. Obesity and perioperative complications in head and neck free tissue reconstruction. *Head Neck* **38**(Suppl 1), E1188–91 (2016).
22. Lo, S. L., Yen, Y. H., Lee, P. J., Liu, C. C. & Pu, C. M. Factors influencing postoperative complications in reconstructive microsurgery for head and neck cancer. *J Oral Maxillofac Surg* **75**, 867–873 (2017).
23. Heo, Y. H. *et al*. Plast Reconstr Surg Glob Open 4, e636 (2016).

Acknowledgements

Author Contributions

Xu Zhang, Qigen Fang and Wei Du wrote this paper, revised this paper, reviewed this paper and agreed with the submission.

Additional Information

Competing Interests: The authors declare that they have no competing interests.

Publisher's note: Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.