

## Original Article

# Clinical burden of neck hemorrhaging after thyroidectomies

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**Abstract:** Background: Life-threatening neck hemorrhaging is one of the most dangerous complications of thyroidectomies. They can cause death, within minutes, unless properly treated at once. Methods: Six patients that developed life-threatening neck hemorrhages during or after thyroidectomies, between January 2008 and December 2013, were included in this retrospective study. This study analyzed the causes, time to hemorrhage, and treatment approaches for the six neck hemorrhage cases. This study also shares the experiences of preventing and treating neck hemorrhages caused by thyroidectomies. Results: All six cases of neck hemorrhaging were due to arterial bleeding, including three cases of carotid injuries, one tracheoinnominate artery fistula (TIF) caused by infection of the surgical wound, one case of superior thyroid artery hemorrhage (STAH) caused by loose ligation, and one case of inferior thyroid artery hemorrhage (ITAH), also caused by loose ligation. Two cases of carotid injury were caused by tumor carotid invasion, while the other was due to improper intraoperative treatment. Hemorrhaging was successfully controlled by different surgical hemostasis treatments in five patients, while one patient did not survive hemostasis surgery. Conclusion: There was no one cause of life-threatening hemorrhages in or after thyroid surgery. Infections, tumor invasion, unskilled surgical techniques, and severe comorbidities may increase the risk of hemorrhaging in thyroidectomies. However, correct surgical interventions, if performed promptly, can save the lives of affected patients.

**Keywords:** Hemorrhage, thyroidectomy, neck hematoma, tracheoinnominate artery fistula

### Introduction

Thyroid carcinoma (TC) is the most common malignancy in the head and neck region, especially differentiated thyroid carcinoma (DTC), which accounts for 1% of all malignant neoplasms and 2.7% of all malignant tumors in females [1, 2]. Many great surgeons, such as Norman Thompson and Thomas Reeve, have developed and refined the technique of capsular dissection, greatly reducing the mortality of thyroidectomy.

However, hemorrhaging remains one of the most dangerous complications of thyroidectomies. It should be noted that not all bleeding, in or after thyroidectomies, turns out to be life-

threatening [3]. The patient may die due to airway obstruction or circulatory failure if life-threatening bleeding is not properly managed right away. Previous studies have shown that incidence of neck hematoma ranges from 0% to 6.5% [4, 5]. A recent study by Hermann et al. reported 519 cases of postoperative neck bleeding (1.7%) in 30,142 patients that had undergone thyroidectomies, among which nine developed life-threatening bleeding and three (0.01%) died [6]. Therefore, it is important to develop a better understanding of this rare but dangerous life-threatening complication.

The current study retrospectively analyzed causes, hemorrhage time, treatments, and outcomes of six patients that suffered life-threat-

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**Table 1.** Demographic and perioperative data of study patients

Case	Gender	Age	Surgical history	TMN	Extent of surgery
1	F	57	1	T4bN1bM0	Tracheotomy + total thyroidectomy + central & bilateral neck dissection
2	M	55	0	T4aN1bM0	Total thyroidectomy + central & bilateral neck dissection
3	F	55	0	T4bN1bM0	Total thyroidectomy + central & bilateral neck dissection
4	F	81	2	T4bN1bM0	Selective ipsilateral neck dissection
5	F	45	0	T3N1aM0	Total thyroidectomy + central neck dissection
6	F	40	0	T2N1aM0	Lobectomy + central neck dissection

**Table 2.** Details on hemorrhages of 6 study patients

Case	Bleeding Sites	Time	Amount	Incentives	Main causes
1	Right innominate artery	21 days	500 ml	Wound dressing	Tracheal fistula + infection
2	Right thyrocervical trunk artery	0 min	2500 ml	N/A	Carcinoma invasion + improper disposal
3	Right thyrocervical trunk artery	0 min	200 ml	N/A	Carcinoma invasion
4	Lower segment of right carotid artery	0 min	300 ml	N/A	Carcinoma invasion
5	Left superior thyroid artery	30 mins	200 ml	Extubation	Insecure ligature
6	Right inferiorthyroid artery	6 hours	90 ml	Severe cough	Insecure ligature

ening intraoperative and postoperative hemorrhaging due to thyroidectomies. Finally, the current study shares the experiences of preventing and treating life-threatening hemorrhages for thyroidectomy patients.

### Materials and methods

The current study was approved by the Institutional Ethics Review Board. Informed consent was obtained from all patients. A total of 2,782 patients underwent thyroid surgery, from January 2008 to December 2013. Of these, 1,562 patients were diagnosed with thyroid cancer. Pathological stages of these thyroid cancer patients ranged from T1N0M0 to T4bN1bM0. Six thyroid cancer patients (0.38%) developed life-threatening neck bleeding. Age, gender, histopathological results, extent of the surgery, cause of bleeding, rescue process, and any other clinicopathological characteristics were extracted (**Table 1**).

### Results

All six cases of life-threatening neck hemorrhaging included in this study were due to arterial bleeding. Of the six patients, long-term (>8 years) hypertension was identified in four cases, one of which was concomitant with long-term Type II diabetes.

Of the six patients with life-threatening neck hemorrhaging, three cases were caused by ca-

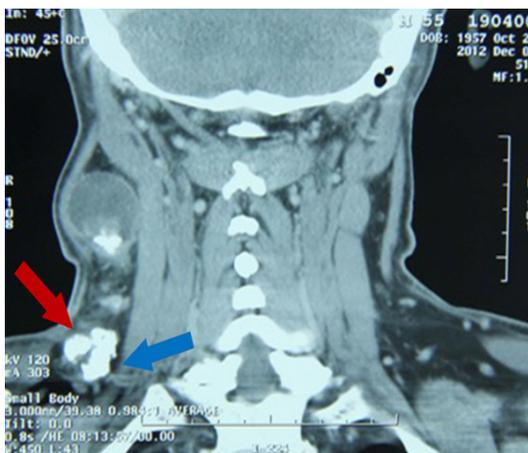
rotid injury. The other three were due to tracheoinnominate artery fistula (TIF), superior thyroid artery hemorrhage (STAH), and inferior thyroid artery hemorrhage (ITAH), respectively (**Table 2**).

Three cases of carotid injury occurred during lymph node dissection. Of these, two were found on the lower segment of the right carotid artery, while one was in the right thyrocervical trunk. Instant hemostasis was conducted to terminate hemorrhaging. Two bleeding sites were sutured with 6-0 prolene vascular sutures, then strengthened with the residual sternocleidomastoid muscles. The patient with thyrocervical trunk bleeding, with a long history of hypertension, did not survive the operation due to failed hemostasis and subsequent circulatory failure. The 56-year-old male patient had thyroid carcinoma with a preoperative metastasis in the right cervical lymph node. The TMN stage of this patient was determined to be T4bN1bM0. It was verified as papillary thyroid carcinoma (PTC) by postoperative pathology. In the process of right cervical lymph node dissection, enlarged lymph nodes, found in the right IV zone, were tightly adhered to the right common carotid artery. Blunt separation was performed to detach the bottom of the lymph nodes from the thyrocervical trunk artery. During the separation process, the artery was torn and retracted under the clavicle. Gauze packing was adopted after three failed attempts

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**Figure 1.** Axial CT showing metastasis-calcified cervical lymph node in the second case (red arrow).



**Figure 2.** Coronal CT showing the relationship between the metastasis-calcified cervical lymph node (red arrow) and the thyrocervical trunk artery (blue arrow) in the second case.

to clamp bleeding. Blood pressure was undetectable due to failed hemostasis 5 minutes later. Finally, the patient died, although the bleeding artery was stitched (**Figures 1, 2**).

One case of STAHD was detected in the endotracheal tube removal process 30 minutes after thyroidectomy. The patient had a long history of hypertension and presented with a severe cough during anesthesia recovery. There was also a large amount of fresh blood in the drainage tube. Intubation was repositioned and the wound was reopened. The cause was found to be ligature slippage and bleeding was cured with the bleeding superior thyroid artery re-ligated. The ITAH case was detected six hours

after thyroidectomy. This patient developed dysphoria, followed gradually by increased dyspnea and swelling in the neck. The wound was re-opened but dyspnea was not alleviated. An emergency bedside tracheotomy was performed, considering the laryngeal spasm. The bleeding site was located beside the right trachea, due to the unreliable ligation of a branch of the inferior thyroid artery. Hemorrhaging was successfully controlled by re-ligation.

The TIF case occurred 19 days after radical thyroidectomy. The 57-year-old female patient had a long-term history of both hypertension and severe Type II diabetes. A tracheotomy was performed during radical thyroidectomy, because the carcinoma had invaded the bilateral recurrent laryngeal nerves and the anterior wall of the trachea. The tracheal tube was extracted 17 days after thyroidectomy. Sudden bleeding occurred on the 19<sup>th</sup> day, presenting with fresh blood flushed from the oral cavity, nasal cavity, and tracheal stoma. Confusingly, nothing was found when the patient underwent an exploratory surgery to remedy the problem. Two days later, on the 21<sup>st</sup> day after surgery, acute bleeding recurred. This time, the bleeding site was located at the innominate artery, close to the front wall of the trachea. After general anesthesia, the upper sternum was split to gain adequate access. The hemorrhage was remedied after the innominate artery was stitched and the blood vessel was ligated, taking into consideration the risk of re-bleeding from possible local infection or necrosis of the anterior tracheal wall. The patient was cured, without any neurological complications, according to the 4-year follow-up (**Table 3**).

### Discussion

The thyroid is one of the most highly vascularized organs. When performing thyroidectomies, surgeons must be careful to properly dispose of thyroid blood vessels. Due to their biological characteristics, thyroid cancers often tend to transfer to a lower section of the neck, such as in the VI, III, and IV region, even in the upper mediastinum. Thyroid tissues are surrounded by the common carotid, subclavian, and innominate arteries, as well as the interior jugular vein. It is uncontented that hemorrhaging is a complication of thyroid surgery. One of six patients in this study and three of nine patients

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**Table 3.** Emergency procedures and outcomes of 6 study patients

Case	Salvage measures at bedside	Salvage measures in OR	Outcomes
1	Acupressure hemostasis and transferred to OR	Upper sternum split + innominate artery ligated	Controlled without complications
2	N/A	Thyrocervical trunk artery re-ligated	Died of circulatory failure
3	N/A	Thyrocervical trunk artery ligated + strengthened by sternocleidomastoid muscles	Controlled without complications
4	N/A	Carotid artery was re-ligated + strengthened by sternocleidomastoid muscles	Controlled without complications
5	N/A	Superior thyroid artery re-ligated	Controlled without complications
6	Tracheotomy performed and the branch of ITA re-ligated	N/A	Controlled without complications

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in Hermann's died, showing that even though this complication is rare, the high mortality demands attention.

### *Possible causes of hemorrhaging in thyroidectomies*

There are numerous possible causes for hemorrhaging in thyroidectomies, including failed ligature on a major vessel, reopening of coagulated veins, coughing during reversal of anesthesia, post-anesthetic systolic blood pressure in excess of 150 mmHg, and diffuse bleeding due to anticoagulant drugs [7-11]. Several studies have shown that comorbidities, other underlying diagnoses, and less experienced surgeons are independent risk factors for neck hematomas [12, 13].

The current study found that some factors, such as severe thyroid disease, infections, and inappropriate surgical techniques, increase the risk of developing a neck hemorrhage following thyroidectomies, although there is no single perioperative risk factor that can be identified to predict hemorrhaging. All patients in this study were diagnosed with thyroid carcinoma at an advanced stage. Of the six patients, there were four cases with T4 disease. In these patients, the carcinoma invaded not only the larynx, trachea, and recurrent laryngeal nerve, but also the carotid artery, making it difficult to separate the artery from carcinoma tissue. Furthermore, the weakened arterial wall also increased the risk of bleeding. Two of the patients had already undergone neck operations. The scar tissue of the surgical wound lacked clear anatomical levels, significantly increasing the difficulty of operation.

Infections were also found to be a cause for bleeding. When a radical thyroidectomy, combined with tracheotomy, is performed, the risk of infection increases since the wounds are easily contaminated by exposure to upper respiratory bacteria [14]. In the first case, the patient underwent a tracheotomy because the carcinoma had invaded the anterior wall of the trachea and bilateral recurrent laryngeal nerves. Due to sputum immersion surrounding the tracheal stoma, an infection developed, eventually leading to the breakdown of innominate arteries. Excessively high mechanical pressure generated by the endotracheal tube cuff may also increase the risk of bleeding.

Therefore, the cuff should be periodically released.

Unskilled surgical techniques were another cause for bleeding. A higher hemorrhage risk was seen in patients that were operated on by inexperienced surgeons [15]. Of the six cases, the fifth and sixth cases appeared to be caused by loosening of the ligature. An incautious separation led to the rupture of blood vessels in the second case, bringing about failed hemostasis and the patient's death. These illustrations underscore the importance of cautious surgery, although each of the surgeons had performed at least 100 thyroid operations per year. Many factors cannot be controlled, such as patient demographic situations, age, gender, and underlying diagnosis. However, surgeons can decrease the risk of hemorrhaging by improving their surgical skills and taking the utmost care throughout the surgery.

Previous research has shown that comorbidity score was an independent risk factor of neck hemorrhaging [12]. In this study, there were four patients with long-term history of hypertension, one of which had type II diabetes at the same time. Hypertension, diabetes, arteriosclerosis, and other comorbidities can make the arterial wall brittle and decrease elasticity, resulting in bleeding due to clamping or ligation of the weakened wall. Diabetes may also be related to the infection seen in the first case. Thyroid surgeons should consider these factors when performing preoperative risk evaluations.

### *Bleeding time and symptoms*

Bleeding developed anywhere from during the surgery to 21 days after. The three with simultaneous tracheotomies occurred at 30 minutes, 6 hours, and 21 days after surgery. The time to hemorrhage data in the study population was in accord with results of other studies [8, 16]. That is, almost all hemorrhages occurred within the first 24 hours post-surgery. The first case was an exception, in which the hemorrhage was corrected 21 days after surgery but was heralded with bleeding 2 days before. In addition to the single patient that developed life-threatening bleeding 19 days after surgery, Li et al. reported a life-threatening hemorrhage in one of their patients that developed 21 days after surgery [17]. Therefore, surgeons should

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be aware that hemorrhaging might develop even after the initial 24 hours following thyroidectomies, especially in patients that undergo simultaneous tracheotomies and have concomitant infections.

### *Source and location of bleeding*

Generally, the possible source of bleeding could be arterial, venous, or diffuse. The most frequent bleeding sites are in the thyroid bed, the surface of the strap muscle, or in subfascial veins [6]. In the present study, arterial bleeding was the only cause of life-threatening hemorrhaging. Therefore, the most common signs leading to diagnosis were major visible bleeding. However, the initial sign of the sixth case was dysphoria 5 hours after the thyroidectomy, with no obvious blood in the drainage tube. The patient gradually developed respiratory distress and an increasingly swollen neck by the time the wound was re-opened one hour later. Thus, a bedside emergency tracheotomy was performed. It was found that the total amount of bleeding was not significant, but a clot had blocked the drainage tube. Respiratory distress was caused by laryngeal edema due to impairment of the venous return from the larynx because of the bleeding [18]. This finding highlights the importance of early diagnosis of bleeding, preventing patients from developing laryngeal edema.

### *Emergency operations*

Once life-threatening bleeding is detected, emergency treatment should be provided without any hesitation. Above all, the airway should be protected. Any significant amount of bleeding is apt to cause blood aspiration. If the patient undergoes a tracheostomy, a tracheal cannula should be inserted. The cuff of the tracheostomy tube should be hyperinflated. If not, the surgical incision must be immediately re-opened to relieve pressure on the trachea. A tracheotomy should be performed if these interventions do not alleviate respiratory distress.

Necessarily, the effective control of bleeding is the key factor in saving lives. In the current study, if the bleeding was not severe, surgeons could properly manage it by locating the bleeding point and clamping and/or re-ligating the blood vessels. If the bleeding was uncontrollable, fingertip compression of the bleeding site

was the most desirable means of immediate control of blood loss. One fingertip can be used to feel the position and pressure of the hemorrhage. Two or more fingertips may be used if necessary. In one such case, the broken innominate artery was compressed against the posterior surface of the manubrium by an experienced surgeon, which effectively controlled the bleeding. Under similar circumstances, however, an inexperienced surgeon attempted to stop the bleeding by gauze packing. This was ineffective and cost the patient his life. This situation is fatal unless prompt treatment of the innominate artery occurs, often performed under desperate circumstances [19]. Therefore, surgeons should endeavor to stop bleeding quickly and effectively.

Once bleeding is preliminarily under control, the following measures should be utilized according to the actual situation: (1) Transfer the patient to the operating room; (2) Aggressive anti-shock therapy; and (3) Restoration of the broken blood vessels. The OR has more advanced and useful equipment, providing the opportunity for multidisciplinary collaboration when necessary. Thus, treatments of such hemorrhages in this study were preferably carried out in the OR. Simultaneously, multiple vein accesses or a central venous access should be set up, aiming to correct acute hemorrhagic shock by administration of fluids and blood.

Hemostasis methods varied with the causes of bleeding. In the fifth case and sixth case, they re-ligated the bleeding superior thyroid artery and the inferior thyroid artery, respectively, successfully controlling bleeding. In the third and fourth cases, with CBS, the slit lengths were under 1 cm. Thus, the blood vessels were re-sutured since they were still in fairly good condition. The remnant sternocleidomastoid muscle flaps were then used to protect the blood vessels. The first case with BAH was more challenging, as the bleeding site was hard to expose. To gain adequate access to the vessels posterior to the sternum, a median sternotomy was performed. Considering the risk of using synthetic materials in the infected area, none were used.

There was a high risk of re-bleeding due to the patient's condition, namely the bleeding innominate artery being adjacent to the tracheal

stoma, apparent local infections, and concomitance of long-term hypertension and diabetes. After informing the patient of the possible comorbidities of ligation and obtaining her consent, a ligation of the innominate artery was performed. Surgical ligation of the main artery of the neck could lead to neurological complications and mortality [20]. Fortunately, the patient was cured without any neurological or vascular complications. Recent advances in endovascular technology have led to therapies utilizing coils or balloon embolization. In the future, endovascular intervention may be less invasive than open surgery, becoming a suitable substitute under certain circumstance.

In conclusion, this study summarized the experiences of diagnosis and treatment of life-threatening intraoperative and postoperative hemorrhaging in thyroidectomies. It is a rare but serious complication that demands more attention. Certain factors, such as severe thyroid disease, infections, and inappropriate surgical techniques, may increase the risk of hemorrhaging. Almost all hemorrhages occurred within the first 24 hours after surgery, while late hemorrhage was mainly related to infections. Early detection, as well as timely and correct treatment, of this deadly disease can save the lives of patients.

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Before collecting human samples, all participants signed informed consent forms, according to institutional guidelines. Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient/parent/guardian/relative of the patients. A copy of the consent form is available for review by the Editor of this journal.

### Disclosure of conflict of interest

None.

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