INTRODUCTION

Thyroidectomy is one of the most frequent operations conducted in surgical practice. Although the Moorish surgeon Albucasis performed the first thyroidectomy in AC 952\(^1\) and Roger Frugardi transfixed large goiters in AC 1170\(^2\), thyroidectomy was not performed until the 19th century because of the high intraoperative and postoperative mortality and morbidity rate. Theodor Kocher performed the first thyroidectomy with modern surgical principles in 1872. He is known as the “Father of Thyroid Surgery” because he developed thyroid surgery from his studies.\(^2\)

Despite increased knowledge and technical developments in thyroid surgery, a thyroidectomy may result in morbidity complications, such as recurrent nerve palsy (RNP), hypoparathyroidism, injury of the external branch of the superior laryngeal nerve or hemorrhage.\(^3\) As a new concept, we recognized delayed recurrent nerve palsy 24 to 72 hours later in some patients having normal postoperative phonation and vocal cord movements.

There are different applications for draining the thyroid cavity, which include a closed suction drain, an open Penrose drain, and a thyroidectomy may be applied without drainage, depending on the surgeon’s experience.

In this study, our aim was to identify the effects of different drainage procedures during thyroid surgery on postoperative delayed recurrent nerve palsy (DRNP) and postoperative bleeding.

PATIENTS AND METHODS

After receiving ethics approval, we retrospectively analyzed 342 patients having thyroidectomy between January 2001 and December 2009 at Ondokuz Mayis University, Faculty of Medicine, Department of Surgery. Decreased vocal cord movements and hoarseness were observed in two patients immediately after the operation. These patients were excluded from the study. The eight patients who only received a biopsy due to inoperable malignancies and 52 patients who did not complete the follow-up were excluded from the study. Remaining 280 patients were analyzed statistically. The patients were assigned to group A if they received a closed suction hemovac drain and to group B if they received an open Penrose drain. We have used routine hemovac drains until 2007. After 2007, our first choice was the Penrose drain, but a hemovac drain was used when Penrose drains were not in the hospital stock. There was no patient operated without drains.

In group A, at the end of the thyroidectomy and hemostasis, one or two 8 to 12 ch (Charriere) hemovac drains were placed in the lobectomy space and passed outside the skin through a 0.5 cm suprasternal incision. We prefer this caliber because they drained adequate amount without coagulum formation inside and with the patient comfort. During lobectomy, we
placed a hemovac drain with one cannula, and for a total thyroidectomy we placed a hemovac drain with two cannules. In group B, after thyroidectomy and hemostasis, Penrose drain or drains placed in the lobectomy spaces were passed through the sternocleidomastoid muscle and skin incision on both sides. All drains were removed on postoperative days 1 to 3 (mean: 2.2).

All patients’ vocal cords were examined at the end of the surgery under direct laryngoscopy just after the extubation. Indirect laryngoscopic examinations of the vocal cords were made in patients with hoarseness after postoperative 24th hour. The patients whose vocal cord movements were normal during the early postoperative period but had decreased during the postoperative 24 to 72 hours were defined as patients with delayed recurrent nerve palsy (DRNP). The patients who had a postoperative bleeding or hematoma that required surgical exploration were defined as patients with postoperative bleeding. The differences between the number of these complications related to the risk factors were statistically determined.

A total of 280 patients (230 in group A, 50 in group B) were evaluated.

The patients with DRNP and bleeding were followed-up monthly for a year. According to our data recording system, the follow-up period was 61.11 ± 27.016 months (range 3-108) in group A and 14.45 ± 7.023 months (range 1-27) in group B.

The Chi-square test was used to compare the drainage methods, the student’s t-test was used for the age distribution, and a z-test was used for the other risk factors.

RESULTS

The mean age of the patients was 47.09 ± 12.351 years (range 19-83). Most of the cases were younger than 60 years old (223, 79.64%). The male/female ratio was 81/199. Thirty-one patients (11.07%) had undergone a previous subtotal or near total thyroidectomy. A secondary operation was performed due to recurrence in 23 (9.64%) patients, and due to determined thyroid malignancy in pathology specimens in eight (2.86%) patients.

Most of the patients (170, 60.71%) were treated with a subtotal thyroidectomy (3-4 gr thyroid remnant in each lobe). In 27 (9.64%) patients, lobectomy and counterlateral near total thyroidectomy (1-2 gr thyroid remnant) were performed due to malignancy.

Suction hemovac drains were used in 230 (82.14%) patients, while Penrose drains were used in 50 (17.86%).

In five patients (2.17%) in group A, although the vocal cord movements were normal in the early postoperative period, hoarseness and decreased vocal cord movements developed 24 to 72 hours postoperatively. In four patients, the hoarseness decreased and the voice became normal within 15 to 30 days using conservative treatment, but in one patient the recovery period was 6 months.

Bleeding and hematoma requiring surgical drainage occurred within 30 to 180 minutes postoperatively in seven patients (3.04%) with suction drains. All these patients had almost 100 ml/hour bleeding and obstruction of the suction drain. One patient was explored at bedside under local anesthesia, and the obstructed drain was opened and irrigated. The other six patients underwent reoperations, and there were no apparent foci of the massive bleeding in five patients. The minimal oozings from the remnant thyroid gland and the superior and inferior vascular poles were controlled. In one patient, visible bleeding from the superior pole artery of less than 1 mm in diameter was controlled by ligation, and the drains were replaced with larger diameter suction drains.

There were no statistically significant differences in age, gender, reoperation, malignancy or type of surgery with bleeding and DRNP. Suction drainage was found to be a significant risk factor for bleeding and DRNP (p = 0.007 and p = 0.024 respectively) (Table 1).

There were no postoperative bleeding and hematoma requiring surgical drainage and no DRNP in patients in group B (open Penrose drainage).

DISCUSSION

The most important complications of the thyroidectomy are bleeding and recurrent nerve paralysis (RNP). Hypoparathyroidism and injury to the external branch of the superior laryngeal nerve are also morbid complications, but the RNP is a disappointing complication both for the patient and the surgeon, and the bleeding is life-threatening.

The rate of transient RNP is 1.64 to 6.7%, and the rate of permanent RNP is 0.7 to 1%. The risk factors for RNP have been reported as recurrence, completing thyroidectomy, dissection of the recurrent laryngeal nerve (RN) and inexperience of the surgeon. During the last 20 years and with the use of recurrent laryngeal nerve monitoring, the idea that RN dissection negatively affects the RN has changed. Nerve monitoring is useful for decreasing the risk of nerve injury during repeated surgical procedures, and the experience of the surgical team is extremely important. Ignjatovic reported that the rate of RNP in his 2100 cases operated in between 1988 and 2002 was 9.3% before 1997 and 4.4% after 1997, related to the nerve monitoring.

RNP is clinically grouped as a transient and permanent palsy. Cutting or disruption of the nerve or increased thermal and electrical trauma may cause axonal injury and permanent nerve palsy.

The clinical findings of RNP depend on whether it is a unilateral or bilateral injury. Hoarseness is the main finding in unilateral palsy. Dyspnea necessitating tracheostomy may occur in bilateral palsy. The resolving period for transient palsy is about 2 to 24 weeks, but there is no specific treatment for transient RNP. Hydman reported good results with nimodipine in three axonal injury cases in his series of 15 cases with unilateral RNP. This is a valuable finding for the research area.
Our observation, which was not present in the literature, was the time of RNP. While in some patients RNP and hoarseness occurred immediately after the operation, the vocal cord movements and voice quality were normal in others. In the latter patients, hoarseness developed more than 24 hours postoperatively. In patients with suction drainage, hoarseness was also observed after drain removal. For all these transient palsies, the term delayed recurrent nerve palsy (DRNP) would be appropriate. In our study, although there was DRNP in seven patients, only two were directly related to surgical trauma. These patients were excluded from the study. In the other five patients, hoarseness developed 24 to 72 hours after surgery. One of them developed hoarseness after removal of the suction drain, which is difficult to explain only by the surgical trauma.

There is relatively less bleeding after thyroidectomy, but it is an expected complication. Bleeding may come from the superficial or strap muscles, thyroid arteries or veins, or from remnant thyroid tissue. The complex vascular anatomy of an extremely enlarged thyroid gland and diseases, such as Basedow-Graves, which increase vascularization of the gland, are individual risk factors for bleeding. Godballe defined old age, male gender, malignancy, and extent of surgery as risk factors for bleeding in his series of 5,490 cases in a nationwide cohort study in 2009.13 But, Leyre found no significant relationship between age, gender, thyroid gland pathology or type of bleeding in his series of 6,830 cases.14 Rosenbaum reported that medications such as ketorolac, aspirin and warfarin as well as a strong cough and hypertension could be factors for bleeding.15

The rates of bleeding in the literature range from 0.49 to 4.3%,5,6,11,15-17 unless massive bleeding develops or a transfusion is required, the bleeding from a thyroidectomy incision is not harmful, and no invasive procedure is necessary for its treatment. Bleeding that requires changing gauze 3 to 5 times per day disappears spontaneously without any sequela. The small amount of bleeding and the drainage make this type of bleeding harmless. Bleeding due to opening or sliding of the thyroid vessel ligation should be controlled by emergent surgery. This type of bleeding is recognized within minutes after the end of surgery. Fortunately, the incidence of this type of bleeding is less than 0.1%, and is related to technical insufficiency.

Problems with closed suction drains are somewhat different. Drain obstruction or the loss of negative suction (related to the filling of drainage space) may result in a hematoma in the thyroid bed. A hematoma that compresses the trachea may cause a dangerous airway obstruction that is more life-threatening than the blood volume loss. The period of formation for a life threatening hematoma is from 10 minutes to 7 days.13,15,18-20 The shortest period of 10 minutes, which was defined in Rosenbaum’s series,15 was probably due to the opening or sliding of the thyroid artery ligation. Usually, bleeding occurred within the first 6 hours postoperatively.

Respiratory distress, pain and tension in the neck, wound drainage, dysphagia, agitation and sweating were the main postoperative bleeding symptoms. In our study, bleeding and hematoma occurred in seven patients within 30 to 180 minutes. All hematomas were related to a drainage catheter obstruction.

### Table 1: Evaluation of the risk factors for DRNP and postoperative bleeding

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>DRNP</th>
<th>Postoperative bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 59</td>
<td>223</td>
<td>4</td>
<td>1.79</td>
</tr>
<tr>
<td>≥ 60</td>
<td>57</td>
<td>1</td>
<td>1.75</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>199</td>
<td>3</td>
<td>1.51</td>
</tr>
<tr>
<td>M</td>
<td>81</td>
<td>2</td>
<td>2.46</td>
</tr>
<tr>
<td>Previous thyroid surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31</td>
<td>3</td>
<td>9.68</td>
</tr>
<tr>
<td>No</td>
<td>249</td>
<td>2</td>
<td>0.80</td>
</tr>
<tr>
<td>Malignancy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>27</td>
<td>1</td>
<td>3.70</td>
</tr>
<tr>
<td>No</td>
<td>253</td>
<td>4</td>
<td>1.58</td>
</tr>
<tr>
<td>Surgical procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near total thyroidectomy</td>
<td>61</td>
<td>1</td>
<td>1.64</td>
</tr>
<tr>
<td>Total thyroidectomy</td>
<td>49</td>
<td>1</td>
<td>2.04</td>
</tr>
<tr>
<td>Subtotal thyroidectomy, lobectomy</td>
<td>170</td>
<td>3</td>
<td>1.76</td>
</tr>
<tr>
<td>Drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penrose</td>
<td>50</td>
<td>0</td>
<td>0.024</td>
</tr>
<tr>
<td>Negative suction (hemovac)</td>
<td>230</td>
<td>5</td>
<td>2.17</td>
</tr>
</tbody>
</table>

DRNP: Delayed recurrent nerve palsy; NS: Not significant
There has been no consensus about the use of drains for thyroid surgery. Besides the extreme recommendations of strict use and strict nonuse, the choice depends mostly on the surgical procedure. Hartado,\textsuperscript{21} Morrissey\textsuperscript{22} and Heranz\textsuperscript{23} reported that the size of the thyroid, diagnosis, type of surgery and intraoperative bleeding were not related with the use of drains, and hospital stay and costs were reduced if no drains were used. In addition, Tabaqchali\textsuperscript{24} reported that the use of drains increased bleeding and hematomas, and the risk for wound infection. In contrast, Tüürgen\textsuperscript{25} reported that although more bleeding was observed in patients with drains, the hematoma volumes were less than those in undrained patients. We think these results are related to patient characteristics. Schwarz stated that, “this study supports prophylactic routine nonsuction wound drainage after elective thyroid surgery”, in his study on selecting patients for drains.\textsuperscript{26}

In his review of 13 studies, Samraj reported no difference in the number of reoperations between thyroidectomies with or without drains.\textsuperscript{27} He also indicated that there is a debate on collection and hematomas and found no difference between closed suction and passive and open drainage for the number of reoperations.

We found that the suction drainage group had more of a risk for DRNP and a bleeding hematoma than the open drainage group. We think that this results from the properties of the drainage systems.

A Penrose drain is a soft, tube-shaped rubber or silicone drain, named after the American gynecologist Charles Bingham Penrose. Recently, it has become a very soft rubber tube that is commonly used in surgery because it causes little tissue reaction. After a thyroidectomy, a Penrose drain is placed in the thyroid bed to prevent a hematoma or seroma, so it never causes pressure on nerves or vessels.

The closed suction device, which is called a Jackson-Pratt drain or hemovac, contains harder silicon tubing than a Penrose drain. These types of drains are connected to suction or there is a built-in reservoir to maintain constant low suction.

Although the reservoir balloons and the aspiration apparatus can be in different volumes, the ones available in the field have 100 to 250 ml capacity reservoirs.

We confirmed some negative effects of closed suction drains for the formation of DRNP and bleeding hematomas. The diameter of the closed suction drain is small. The internal diameter of the 8 to 18 ch hemovac drains is 1.4 to 3.5 mm (Table 2). The 8 to 12 ch hemovacs, which are used after a thyroidectomy, have an internal diameter of 1.4 to 2 mm. To prevent an obstruction, such a thin drain should have continuous suction and an anticoagulant effect on the inner side. The decrease or disappearance of negative pressure in a suction drain (filling of the reservoir) results in drain obstruction in a short period. To prevent this, the reservoir should be frequently controlled and immediately emptied when it becomes full.

A hemovac suction drain produces negative pressure inside the closed space of the thyroidectomy, which produces a negative effect on coagulation. Arterial vasoconstriction is a reliable factor during hemostasis; 1 to 2 mm diameter arteries constrict when they are left open, and a thrombosis may occur inside after vasoconstriction occurs. In this procedure, the vessels of 1 to 2 mm diameter were left open without ligation, they constrict and thrombosis occurs inside the vessels.

During a thyroidectomy, there may be missed or neglected bleedings. With a negative suction drain, the obstructed vessel would be opened and the risk of bleeding would increase. Normal or decreased arterial tension during anesthesia increases after the operation, and the additional suction of the obstructing particles within the arterial lumen by the hemovac drain may cause bleeding and a hematoma.

A suction drain is usually routed outside the incision through a mini puncture below the middle part of the incision in the fossa jugularis. The drain tips are extended into each space of the lobectomy; thus, the hard silicon drain crosses the recurrent laryngeal nerve. Close touching or pressure of the drain on the nerve may cause a defect in neural transmission. Furthermore, adhesion of the drain to the adjacent tissues by the suction effect and the probable injury during removal of the drain may result in nerve injury. This hypothesis may be important for identifying transient DRNP after removal of the drain.

The seven bleedings and five DRNPs in our series may be explained based on these hypotheses. We could not find the bleeding focus in six patients who developed bleeding and hematoma. We think that the bleeding was due to the suction effect of the hemovac and it decreased and stopped because a hematoma formed, which was related to the decreased, and later disappearing negative pressure. The bleeding from a 1 mm sized vessel in one patient was suspected to be related to the negative pressure of the suction drain, not to an intraoperative error.

**CONCLUSION**

Although there are no strict rules about the use of drains during thyroid surgery, it should be decided based on the patient’s individual operative findings. There may be a risk for postoperative hematoma and DRNP after the use of suction drains, and patients with suction drains should be closely monitored. The risk of bleeding is less with the use of Penrose

<table>
<thead>
<tr>
<th>Drain size (ch)</th>
<th>Internal diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08</td>
<td>1.4</td>
</tr>
<tr>
<td>10</td>
<td>1.7</td>
</tr>
<tr>
<td>12</td>
<td>2.0</td>
</tr>
<tr>
<td>14</td>
<td>2.5</td>
</tr>
<tr>
<td>16</td>
<td>3.2</td>
</tr>
<tr>
<td>18</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Role of Drainage of the Thyroid Bed