An Undesirable Post-Thyroidectomy Surprise for the Surgeon: Inadvertent ParathyROIDectomy

Ankara Üniversitesi Tıp Fakültesi Dergisi 2018; 71(3):244-250

Address for Correspondence/Yazı suma Adresi: Ahmet Cem Dural MD, İstanbul Bakırköy Dr. Sadi Konuk Araştırma ve Eğitim Hastanesi, Genel Cerrahi Kliniği, İstanbul, Turkey
Phone: +90 212 414 7171 E-mail: cemdural@hotmail.com ORCID ID: orcid.org/0000-0003-3479-725X
Received/Geliş Tarihi: 07.10.2018 Accepted/Kabul Tarihi: 18.12.2018

©Copyright 2018 Ankara University Faculty of Medicine
Journal of Ankara University Faculty of Medicine is published by Galenos Publishing House. All content are under CC BY-NC-ND license.
Introduction

Accidental removal of the parathyroid gland (PG) is a frequently encountered complication after thyroidectomies and may result in iatrogenic hypocalcemia, which is a well-known major complication following thyroidectomy (1). The mechanism of transient hypocalcemia is multifactorial and still unclear in most of the cases. Direct trauma to the PGs or their devascularization, hypothermia of the glands, extent of surgery or lack of surgical experience are potential risks for hypocalcemia (2-4). Despite recent surgical advances in thyroid surgery, surgeons are still faced with unexpected pathological results indicating parathyroidectomy even after a meticulous resection of the thyroid gland (5). The common vascular supply shared by both parathyroid and thyroid glands together with their close anatomical association or the intrathyroidal location of the gland may be the cause of inadvertent excision of PGs during thyroidectomy (6).

In spite of the low mortality and morbidity rates recorded by modern thyroid surgeries, the effects of iatrogenic hypocalcemia on patients’ quality of life still remain a major medical concern (7,8). Rates of iatrogenic hypocalcemia after thyroidectomies as reported in the literature range between 0.5% and 40% (9-12). A greater percentage of these cases are reported as transient, however, 1.5-4% of the cases are known to cause permanent hypocalcemia (3,13-16). While transient hypocalcemia usually resolves on its own via compensatory mechanisms by the parathyroid gland, permanent hypocalcemia may require lifetime medical treatment.

Increased rates of inadvertent parathyroidectomy (IP) after thyroid surgery have been reported by several studies, however, hypocalcemia or hypocalcemic symptoms weren’t described in all patients (17-19). Risk factors for inadvertent parathyroid resection and iatrogenic injuries caused to the PG during neck surgeries include, neck dissections, re-operative thyroid surgeries, total thyroidectomy, hyperthyroidism and lack of surgical experience (3,4,17-19).

This study aims to report the incidence of inadvertent PG removal during standard total thyroidectomy, as documented by pathology reports from our center, and investigate its association with hypocalcemia.

Materials and Methods

All thyroidectomies (lobectomy, subtotal and total) performed at our department between January 2009 and May 2013, were retrospectively reviewed. All procedures were performed in a similar fashion with careful dissection along the thyroid capsule attempting to identify and preserve the PGs with their vascular supply, as well as the recurrent laryngeal nerves as described by Bliss et al. (20). Cases that were performed between 2009 and 2012, were done by surgeons who were board certified in general surgery only, however those procedures performed after 2012, were done by two surgeons with specialized training in the field of endocrine surgery (21). A written informed consent for total thyroidectomy was received from all patients. In all pathology specimens, right lobe was sutured for pathologic orientation routinely. Also, the right and left lobes were sent separately if en-bloc resection could not be performed. The lateralization of removed PG was recorded based on this standardized orientation suture on histopathology examination.

Pathology reports of all the patients were evaluated to identify patients who had accidental removal of their PGs during thyroid surgery (Figure 1). The patients who have at least 6 months follow-up period were included into the study. Patients were divided into two groups according to findings from pathological examination of the excised thyroid gland. (group P: presence of PG, group T: absence of PG).

Figure 1: Flow chart of patients included to study

Sonuç: İstemeden yapılan paratiroidektomi cerrahları açısından hoş sonuçlanmayan bir durumdur. Çalışmamıza ait sonuçlar cerrahi tecrübesi arttıkça IP oranının azaldığı yönündedir. Ancak bu durum postoperatif hipokalsemi ile ilişkisiz bulunmuştur.
Anahtar Kelimeler: İstemeden Yapılan Paratiroidektomi, Tiroidektomi, Hipokalsemi, İntraoperatif Komplikasyon
The inclusion criteria for Group P was the presence of PG on the pathological examination of the excised thyroid gland. Therefore, group T includes the cases with absence of PG in the specimen and the cases with parathyroid auto-transplantation. Despite the unclarity on PG’s proper function after autotransplantation; the patients with PG autotransplantation were included to group T based on recent studies and the design of the groups in the study (22).

Extent of surgery is one of the described risk factors for IP and/or hypocalcemia in the literature. For the purpose of standardization, patients who (a) underwent other procedures (lobectomy, subtotal thyroidectomy) beside standard total thyroidectomy, (b) had a pre-operative diagnosis of malignancy, (c) were admitted for completion thyroidectomy, (d) were planned for additional procedures (prophylactic or therapeutic neck dissection) and (e) hyperparathyroid patients in whom additional interventions were planned were excluded from study (Figure 1). Post-operative calcium status were seen at the morning of post operative day (POD) 1 before discharge home, at first week, first month, 3rd month and 6th month of surgery at outpatient clinic visits. Asymptomatic (biochemical) hypocalcemia was defined when serum total calcium level was measured below 8 mg/dL, symptomatic hypocalcemia was defined when there was any clinical signs of hypocalcemia such as tingling and numbness, nerve hyperexcitability (Chvostek's sign) and/or latent tetany (Trousseau's sign) seen during the hospital stay. Permanent hypocalcemia was defined as persistence of hypocalcemia after 6th month of surgery.

Data on patient demographics, pre and post-operative laboratory results, surgical and medical history were obtained. Also, the information from pathology reports, anatomic localization of excised glands, postoperative hypocalcemia symptoms, total serum calcium, parathormone, 25-OH Vit D and albumin levels, postoperative treatment and duration of hospital stay were included in the data collection. These findings were compared between the two groups. Patients in whom postoperative hypocalcemia developed were hospitalized and observed closely until hypocalcemic symptoms resolved and later on discharged with appropriate calcium and vitamin D prescriptions. All other postoperative complications were noted.

Data was anonymously entered into a computerized database program (Excel 2007, Microsoft Inc., Redmond, WA) for individual privacy protection. In terms of anonymized data usage and retrospective manner of the study, no local ethics committee approval was obtained. Therefore, the study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. This manuscript was prepared in accordance with STROBE guidelines for case control studies.

Statistical Analysis

Data was analyzed using a statistical package software (JMP® version 10.0.0, SAS®, Cary, NC). Continuous variables were expressed as mean ± SD and categorical variables as frequencies and percentages. Comparison of continuous variables was performed using the student’s t-test. The chi-square tests were used in the comparison of categorical variables and Mann-Whitney U test was used for comparison on non-parametric variables. Univariate and multivariate analysis with nominal regression model were performed to identify factors that predicted postoperative transient and permanent hypocalcemia. P values of 0.05 or less was considered as statistically significant.

Results

Between January 2009 and May 2013, a total of 522 adult patients underwent thyroidectomies (lobectomy, subtotal and total) at our department. Of these, data on 355 patients who met the study criteria was evaluated and 167 patients were excluded from the study. Twelve of these 355 patients have been lost to follow up and the data of remaining 343 patients was completely recorded (Figure 1). The median age was 48 years (20-81) and female/male ratio was 4.8/1. Two hundred thirty two of surgeries were performed by all surgeons in the department between 2009 and 2012. One hundred eleven out of 343 patients were provided by two surgeons who have been involved in the field of endocrine surgery after 2012. Mean follow up period was 6.4±0.6 months.

In group P there were 26 patients while group T consisted of 317 patients. Table 1 shows the demographic and clinical characteristics of the patients in both groups. Demographic variables and patients characteristics including age, sex and history of hyperthyroidism were similar in both groups (Table 1). Pre-operative total serum calcium levels of patients in groups T and P did not differ significantly (p=0.32). Asymptomatic or symptomatic hypocalcemia (the presence of clinical symptoms of hypocalcemia such as tingling and numbness, Chvostek's sign. Trousseau’s sign and/or total serum calcium laboratory levels < 8 mg/dL) was seen in 37 (10.7%) patients. This included 33 patients (10.4%) from group T and 4 patients (15.3%) from group P (p=0.45). Nodule size was comparable in both groups (p=0.08) (Table 1).

The mean age of patients with hypocalcemia was 44.2±11.3 years, the mean age of patients who did not developed hypocalcemia was 48.6±12.4 years (p=0.04). In univariate analysis of age for hypocalcemia p value was also 0.04 (Table 2). Within the described periods, the rate of IPs after total thyroidectomy (TT) (3.7%, n=4) was lower after 2012, compared to previous (10.4%, n=22) period (p=0.04). Although, the IP rate was lower for surgeons who were specialized in endocrine surgery compared to other surgeons, surgeon factor did not show any
statistical correlation with the development of hypocalcemia on univariate analysis (p=0.72). In addition, univariate analysis showed that sex, hyperthyroidism parameters, IP and nodule size were not predictive for postoperative transient and permanent hypocalcemia (Table 2 and 3, respectively). On multivariate analysis, all factors including IP, did not reveal any statistically significant correlation with postoperative transient hypocalcemia (Table 2). A multivariate analysis was not performed for permanent hypocalcemia as p value was higher than 0.3 for all parameters (Table 3).

The total number of patients with PG autotransplantation was 11. Seven of these were performed in 2009-2012 period and 4 of these were performed in 2012-2013 period (p=0.77). One patient in each period experienced temporary hypocalcemia (p=45). No any permanent hypocalcemia was seen on these eleven patients with autotransplantation.

The incidence of post-operative hypocalcemia was investigated among patients in whom IP occurred (n=26).

Pre-operative total serum calcium levels were <8.4 mg/dL in four of these patients, however postoperative symptomatic hypocalcemia developed in only one of them. On the contrary, 3

| Parameter | p value univariate | OR* univariate | p value multivariate** | OR multivariate** |
|-----------|--------------------|----------------|------------------------|-------------------|
| Age       | 0.95               | 0.99           | 0.13                   | 0.56              |
| Gender**  | 0.28               | N/A***         | 0.34                   | 0.97              |
| Dominant nodule size | 0.37           | 0.95           | 0.22                   | 0.98              |
| Inadvertent parathyroidectomy | 0.45             | 0.63           | N/A***                 |                   |
| Hyperthyroidism | 0.33           | 1.04           | N/A***                 |                   |
| Surgeon factor | 0.97             | N/A***        | 0.97                   |                   |

* OR: Odds Ratio  
** Multivariate analysis was performed for the parameters whose p<0.3  
***N/A: Not Applicable

**Table 1:** Demographics of the groups

| Parameter                          | Group T (n=317) | Group P (n=26) | p value |
|------------------------------------|----------------|----------------|---------|
| Age (years, median)                | 48 (20-81)     | 43 (28-74)     | 0.63    |
| Gender                             |                |                |         |
| Female (n/%)                       | 260/82         | 24/92.3        | 0.14    |
| Male (n/%)                         | 57/18          | 2/7.7          |         |
| Hyperthyroidism (n/%)              | 84/26.4%       | 5/19.2%        | 0.65    |
| Dominant nodule size (cm, mean ± SD) | 3.3±1.8     | 2.7±1.1        | 0.08    |
| Presence of subcentimetric nodules (n/%) | 20/6.3%    | 2/7.6%         | 0.83    |
| Pre-operative total serum calcium (mg/dL, mean ± SD) | 8.9±0.8     | 8.8±0.6        | 0.32    |
| Post-operative total serum calcium (mg/dL, mean ± SD) | 8.3±0.7     | 8.1±0.8        | 0.27    |
| Total serum calcium at 6th month (mg/dL, mean ± SD) | 8.8±0.4     | 8.7±0.3        | 0.28    |
| Post-operative transient hypocalcemia* (n/%) | 33/10.4%  | 4/15.3%        | 0.45    |
| Post-operative permanent hypocalcemia (n/%) | 3/0.9%    | 0/0%           | 0.49    |
| Mean follow-up period (months, mean ± SD) | 6.4±0.6    | 6.5±0.6        | 0.81    |

*The patients with asymptomatic and symptomatic hypocalcemia, SD: Standard deviation

**Table 2:** Univariate and multivariate analysis of factors affecting post-operative transient hypocalcemia in patients with standardized surgery

| Parameter                          | p value univariate | OR* univariate | p value multivariate** | OR multivariate** |
|------------------------------------|--------------------|----------------|------------------------|-------------------|
| Age                                | 0.04               | 0.97           | 0.13                   | 0.56              |
| Gender**                           | 0.28               | 0.55           | 0.34                   | 0.97              |
| Dominant nodule size               | 0.19               | 0.98           | 0.22                   | 0.98              |
| Inadvertent parathyroidectomy      | 0.45               | 0.63           | N/A***                 |                   |
| Hyperthyroidism                    | 0.38               | 0.61           | N/A***                 |                   |
| Surgeon factor                     | 0.72               | 0.87           | N/A***                 |                   |

* OR: Odds Ratio  
** Multivariate analysis was performed for the parameters whose p<0.3  
***N/A: Not Applicable
out of 22 patients, in whom pre-operative total serum calcium levels were within the normal laboratory range developed post-operative transient hypocalcemia (p=0.73).

The number of PGs totally excised was 31 in 26 patients. The number of excised PGs was one in 21 of these patients and two in remaining 5 patients. Anatomical localization of excised PG were: right side in 17 of patients (54.8%), left side in 8 patients (25.8%), intrathyroidal in 3 cases (9.7%), and bilateral in 2 patients (6.5%). In one patient (3.2%), the PG was in an ectopic location (isthmus). The location of IP was not associated with hypocalcemia (p=0.14). Twenty one of accidentally removed PGs (67.7%) were at the adjacent side of the dominant thyroid nodule. The incidence of dominant nodule and excised PG did not correlate significantly with hypocalcemia (p=0.17). Postoperative transient hypocalcemia occurred in 3 (14%) patients who had one gland removed and in 1 (20%) patient in whom two glands were removed (p=0.73). Permanent hypocalcemia developed in 3 patients in group T (0.9%), and in none of the patients in group P (Table 1).

**Discussion**

The indisputable role of thyroid surgery in the treatment of thyroid disorders in goiter- endemic regions such as Turkey has been defined (1). Recent surgical advances in thyroid surgery have led to an emphatic decrease in thyroid surgery related mortality and morbidity. While reported rates on mortality are around nil, the rates of major complications are below 5% (3). The major decrease in mortality and morbidity has been attributed to the increase in surgical experience over years (4,15,23-25).

In the current literature, the relationship between accidental parathyroidectomy and hypocalcemia is doubtful (26-28). Also, surgical experience, extent of surgery, previous surgical history, hyperthyroidism, young age, malignancy are potential risk factors for post-operative hypocalcemia and all these risk factors have been broadly discussed in the last 2 decades (3,4). In a recently published study by Lorenta-Poch et al. (22), the authors recommended the Parathyroid Glands Remaining In Situ (PGRIS) classification system which is based on the number of ‘in-situ preserved’ parathyroid glands. PGRIS scores were found to be inversely related with the development of post-operative hypocalcemia (p<0.001). In our study, inadvertent parathyroidectomies reported in final histopathology report were included to group P, Therefore, group T includes the cases with IP and parathyroid auto-transplantation which were considered as “four parathyroid gland preserved” during thyroidectomy. Eleven of the patients had PG autotransplantation in our serie and two of them had temporary hypocalcemia. On their follow-up, any of these autotransplanted patients had permanent hypocalcemia.

Postoperative hypocalcemia may last for less than six months (transient) or more (permanent). Its reported incidence varies from center to center and range between 1.6% and 50%, with most of the reported cases being transient in nature (17-19,29). In our study, mean follow up time was 6.4±0.6 months and was similar in both group (p=0.81). Transient hypocalcemia rate in all patients was 10.8% and permanent hypocalcemia rate in all patients was 0.8%. In group P, there was no permanent hypocalcemia. However; in group T, the rate of permanent hypocalcemia rate was 0.9%. This may also be related with ischemia of the PG or related factors rather than the number of remaining PGs.

The prevention and management of iatrogenic hypocalcemia should include the correct selection of patients who are at a higher risk for postoperative hypocalcemia, identification of the PGs during thyroidectomies, and a careful application of the surgical technique. Intraoperative pathologic verification of inadvertent PG removal during thyroid surgery may be necessary. Previously published reports suggest intra-muscular auto transplantation of accidentally removed PGs that are encountered peri-operatively (22,30-32). An appropriate and timely fashioned management of postoperative hypocalcemia that may occur as a result of accidental removal of PGs is warranted to ensure better patients outcomes and protection of the surgeon against medico-legal issues.

Risk factors for IP, as described in the literature include young age, hyperthyroidism, malignant diseases, previous surgical history and lymph node dissection (14-17). Other factors include bilateral surgical procedures and extent of surgery (33). Four-gland exploration of parathyroid glands may predispose the PGs to surgical trauma thus leading to vascular compromise of the PGs (6,22). Our study therefore focused on patients who underwent standard bilateral thyroidectomies and investigated the incidence of accidental parathyroidectomies. Thyroid surgeries are usually performed for the treatment of benign thyroid disorders which are prevalently seen in young patients. Most of the patients enrolled into the study consisted of young adults, specifically young female adults in their reproductive age. Demographic characteristics of both groups including age and sex, showed a homogenous distribution (p=0.14 and p=0.63, respectively). However, younger age was relevant with post-operative hypocalcemia in univariate analysis (p=0.04).

The incidence of bleeding has been reported to be high in thyroid surgeries for hyperthyroidism (13). This condition has been associated with difficult visualization of the PGs during thyroid surgeries (3,13). Also, attempt to control bleeding during thyroid surgeries may predispose the PGs to ischemia. In our study, hyperthyroidism was not a predictive factor of post-operative hypocalcemia in both groups.

Thyroid surgery for malignancy, may increase the risk of inadvertent PTs. Specifically, the risk of accidental
Inadvertent Parathyroidectomy During Thyroid Surgery

In a retrospective review of medical records, the incidence of inadvertent parathyroidectomy was found to be 3.7% (4 of 111 patients) in surgeons specialized in endocrine surgery, compared to 10.4% (22 of 232 patients) in surgeons practicing general surgery only (p=0.04). Although, a higher rate of IP was seen among surgeons practicing in general surgery only, the incidence of hypocalcemia was not attributed to the fact that, although most of the parathyroid glands were intact in group T, their vascularization may have been compromised as a result of surgery.

Surgical experience is known to play an important role in reducing mortality and morbidity rates after thyroid surgeries (4). Within the study period, the incidence of IPs after BTT, was 3.7% (4 of 111 patients) in surgeons specialized in endocrine surgery, compared to 10.4% (22 of 232 patients) in surgeons practicing general surgery only (p=0.04). Although, a higher rate of IP was seen among surgeons practicing in general surgery only, the incidence of hypocalcemia was not attributed to the fact that, although most of the parathyroid glands were intact in group T, their vascularization may have been compromised as a result of surgery.

Surgical experience is known to play an important role in reducing mortality and morbidity rates after thyroid surgeries (4). Within the study period, the incidence of IPs after BTT, was 3.7% (4 of 111 patients) in surgeons specialized in endocrine surgery, compared to 10.4% (22 of 232 patients) in surgeons practicing general surgery only (p=0.04). Although, a higher rate of IP was seen among surgeons practicing in general surgery only, the incidence of hypocalcemia was not attributed to the fact that, although most of the parathyroid glands were intact in group T, their vascularization may have been compromised as a result of surgery.

In our study, younger age was relevant with post-operative hypocalcemia and it was significant in univariate analysis but not an independent risk factor yet.

In terms of anonymized data usage for the study, no local ethics committee approval was obtained.

Informed Consent: A written informed consent for total thyroidectomy was received from all patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.C.D., C.A., M.F.Ç., M.G.Ü., Concept: A.C.D., S.B., Design: A.C.D., C.A., Data Collection or Processing: S.B., H.T., Analysis or Interpretation: Y.O., H.A., Literature Search: M.F.Ç., M.G.Ü., Writing: A.C.D., C.A.,

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Altaca G, Onat D. Tiroidektomi ve komplikasyonları. In: Sayek I (ed) Temel Cerrahi, 4th Edn. Ankara: Gunes Kitabevi; 2013. p. 1924 - 35
2. Ozogul B, Akcay MN, Akcay G, et al. Factors affecting hypocalcaemia following total thyroidectomy: A prospective study. Eurasian J Med. 2014;46:15-21.

3. Sippel RS, Ozgul O, Hartig GK, et al. Risks and consequences of incidental parathyroidectomy during thyroid resection. ANZ J Surg. 2007;77:33-36.

4. Erbil Y, Barbaros U, Iscever H, et al. Predictive factors for recurrent laryngeal nerve palsy and hypoparathyroidism after thyroid surgery. Clin Otolaryngol. 2007;32:32-37.

5. Shaha AR, Jaffe BM. Complications of thyroid surgery performed by residents. Surgery. 1988;104:1109–1114.

6. Yazici P, Bozkurt E, Citgez B, et al. Incidental parathyroidectomy as a cause of postoperative hypocalcemia after thyroid surgery: Reality or illusion? Minerva Chir. 2014;69:315-320.

7. Bender O, Yuney E, Capar H, et al. Our experience on total thyroidectomy. Endokrinoloji Dıyalog. 2004;1:15-18.

8. Lal G, Clark OH. Thyroid, Parathyroid and Adrenal. In: Brunicardi CF (ed), Schwartz's Principles of Surgery, 10th Edn. New York: Mc Graw Hill; 2015. p.1521-97.

9. Pottou F, Combemale F, Fabre S, et al. Hypocalcemia following thyroid surgery: Incidence and prediction of outcome. World J Surg. 1998;22:718-724.

10. Shaha AR, Jaffe BM. Parathyroid preservation during thyroid surgery. Am J Otalaryngol. 1998;19:113-117.

11. Harness JK, Fung L, Thompson NW, et al. Total thyroidectomy: Complications and technique. World J Surg. 1986;10:781–786.

12. Edis AJ. Prevention and management of complications associated with thyroid and parathyroid surgery. Surg Clin North Am. 1979;59:83-92.

13. Abboud B, Sargi Z, Akkam M, et al. Risk factors for postthyroidectomy hypocalcemia. J Am Coll Surg. 2002;19:113-117.

14. Kupferman ME, Mandel SJ, DiDonato L, et al. Safety of completion thyroidectomy following unilateral lobectomy for well-differentiated thyroid cancer. Laryngoscope. 2002;112:1209–1212.

15. Bergamaschi R, Becouarn G, Ronceray J, et al. Morbidity of thyroid surgery. Am J Surg. 1998;176:71–75.

16. Zhou HY, He JC, McHenry CR. Inadvertent parathyroidectomy: incidence, risk factors, and outcomes. J Surg Res. 2016;205:70-75.

17. SassonAR, PingpangKF, WetheringtonRW, et al. Incidental parathyroidectomy during thyroid surgery does not cause transient symptomatic hypocalcemia. Arch Otalaryngol Head Neck Surg. 2001;127:304-308.

18. Hone RW, Tiaka T, Kaleva AI, et al. Analysis of the incidence and factors predictive of inadvertent parathyroidectomy during thyroid surgery. J Laryngol Otol. 2016;130:669-673.

19. McGoldrick DM, Majeeed M, Achakzai AA, Redmond HP. Inadvertent parathyroidectomy during thyroid surgery. Ir J Med Sci. 2017;186:1019–1022.

20. Blas RD, Gauger PG, Delbridge LW. Surgeon’s approach to the thyroid gland: surgical anatomy and the importance of technique. World J Surg. 2000;24:891-897.

21. Dural AC, Akarsu C, Unsal MG, et al. Multidisciplinary management of surgery for thyroid diseases: Analysis of five years with the experience of Bakirkoy Dr. Sadi Konuk Education and Research Hospital, Endokrinoloji Dıyalog. 2015;12:1-8.

22. Lorente-Poch L, Sancho JJ, Ruiz S, Sitges-Serra A. Importance of in situ preservation of parathyroid glands during total thyroidectomy. Br J Surg. 2015;102:359-367.

23. Prim MP, de Diego JI, Hardisson D, et al. Factors related to nerve injury and hypocalcemia in thyroid gland surgery. Otalaryngol Head Neck Surg. 2001;124:111–114.

24. Thomus O, Machens A, Sekulla C, et al. Multivariate analysis of risk factors for postoperative complications in benign goiter surgery: Prospective multicenter study in Germany. World J Surg. 2000;24:1335–341.

25. Lin DT, Patel SG, Shaha AR, et al. Incidence of inadvertent parathyroid removal during thyroidectomy. Laryngoscope. 2002;112:608-611.

26. Herranz-Gonzalez J, Gavilán J, Martinez-Vidal J, et al. Complications following thyroid surgery. Arch Otalaryngol Head Neck Surg. 1991;117:516-518.

27. Van Heerden JA, Groh MA, Grant CS. Early postoperative morbidity after surgical treatment of thyroid carcinoma. Surgery. 1987;101:224–227.

28. Shemen LJ, Strong EW. Complications after total thyroidectomy. Otalaryngol Head Neck Surg. 1989;101:472-475.

29. Konan A, Usman A, Sayek I. Paratiroid hastalikları. In: Sayek I (ed) Temel Cerrahi, 4th Edn. Ankara: Gunes Kitabevi; 2013. p. 1935-55

30. Edafe O, Antakia R, Laskar N, et al. Systematic review and meta-analysis of predictors of post-thyroidectomy hypocalcemia. Br J Surg. 2014;101:307-320.

31. Ahmed N, Aurangzeb M, Muslim M, et al. Routine parathyroid auto transplantation during total thyroidectomy: A procedure with predictable outcome. J Pak Med Assoc. 2013;63:190–193.

32. Oran E, Yetkin G, Mihmanli M, et al. The risk of hypocalcemia in patients with parathyroid autotransplantation during thyroidectomy. Ulus Cer Derg. 2015;32:6-10.

33. Kalyoncu D, Gonullu D, Gedik ML, et al. Analysis of the factors that have an effect on hypocalcemia following thyroidectomy. Ulus Cer Derg. 2013;29:171-176.