The effects of inferior thyroid arteries ligation type on post-thyroidectomy clinical hypocalcemia in nontoxic multinodular goiter

Nontoksik multinodüler guatr olgularında inferior tiroid arterlerin bağlanma tipinin tiroidektomi sonrası klinik hipokalsemi üzerine etkisi

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Özet

Amaç: Tiroidektomi sonrası klinik hipokalsemi üzerinde inferior tiroid arterlerin bağlanma tipinin etkisini araştırmak.

Gereç ve Yöntem: Bu çalışmada, 2006 Haziran ve 2010 Ocak tarihleri arasında tiroidektomi yapılmış 230 hasta incelendi. Grup 1'de bilateral total tiroidektomi sırasında bilateral inferior tiroid arterler trunkal olarak bağlandı (n=104), grup 2'de bağlama periferik olarak yapıldı (n=126). Tüm hastalarda serum kalsiyum, fosfor, alkalen fosfataz düzeyleri preoperatif olarak ölçüldü. Hipokalseminin klinik semptom ve işaretleri de postoperatif değerlendirildi. Eğer hipokalsemi semptomu varsa serum kalsiyum düzeyleri ölçüldü.

Bulgular: Grup 1 ve 2 arasında, postoperatif 1, 2, 3. günlerde klinik hipokalsemide anlamlı farklılıklar vardı ($p<0.05$). Klinik hipokalsemi, postoperatif 1, 2, 3. günlerde sırasıyla 13 (%72.22), 2 (%11.11) ve 3 (%16.66) hastada tespit edildi. Tüm hastalarda, klinik hipokalsemi postoperatif 30. güne kadar düzeldi. Kalıcı hipokalsemi hiçbir hastada gözlenmedi.

Sonuç: Toksik olmayan multinodüler guatr için bilateral total tiroidektomi sırasında inferior tiroid arterlerin bağlanma tipinin tiroidektomi sonrası klinik hipokalsemiyi postoperatif erken dönemde anlamlı olarak etkilediği sonucuna varıldı.

Anahtar sözcükler: inferior tiroid arter, bağlama, klinik hipokalsemi

Abstract

Aim: To investigate the effect of ligation type of the inferior thyroid arteries on occurrence of post-thyroidectomy clinical hypocalcemia.

Methods: This retrospective study was conducted on 230 patients, who had undergone surgery between June 2006 and January 2010. In group 1, bilateral inferior thyroid arteries were ligated truncally during bilateral total thyroidectomy (104 patients), whereas in group 2 ligation was performed peripherally (126 patients). Serum calcium, phosphorus, and alkaline phosphatase levels were measured preoperatively in all patients. Clinical symptoms and signs of hypocalcemia were evaluated postoperatively. Serum calcium levels were measured if there were symptoms of hypocalcemia.

Results: There were statistically significant differences in clinical hypocalcemia between groups 1 and 2 on the 1st, 2nd, and 3rd postoperative days ($p<0.05$). The incidence of transient clinical hypocalcemia was 14.42% in group 1, and 2.38% in group 2. All patients responded well to calcium treatment and clinical hypocalcemia improved within 30 days postoperatively. Permanent hypocalcemia was not observed in any patient.

Conclusion: It was concluded that the type of ligation of the inferior thyroid arteries used during bilateral total thyroidectomy for non-toxic multinodular goiter significantly affects post-thyroidectomy clinical hypocalcemia during the early postoperative period.

Keywords: inferior thyroid artery, ligation, clinical hypocalcemia

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Introduction

Hypoparathyroidism continues to be a frequent and challenging complication following bilateral total thyroidectomy. Transient hypocalcemia has been reported to occur in 20-83% of these patients.[1-5]

Permanent hypocalcemia may rarely develop following thyroidectomy. While excision of the parathyroid glands and vascular insufficiency are known to lead to permanent hypocalcemia, there are a variety of factors which may be responsible for the occurrence of transient hypocalcemia.[1,3-8] One of these factors is vascular insufficiency of parathyroid glands due to the ligation of superior and inferior thyroid arteries. Surgical technique has a great impact on the development of this condition.

Some researchers advance that none of the inferior thyroid arteries (ITAies) should be ligated in thyroidectomies or that, if they need to be ligated, that this be performed at the nearest point of entrance to the thyroid gland, in order to protect the parathyroid branch of the ITAies.[1-3,9-11] In some studies, it was reported that truncal ligation of ITAies did not lead to damage to parathyroid functions.[12-15]

In this study we investigated the effect of type of ligation of bilateral ITAies on post-thyroidectomy clinical hypocalcemia.

Materials and Methods

Two hundred and thirty patients who had undergone bilateral total thyroidectomy for non-toxic multinodular goiter in the Department of General Surgery of the Gaziantep University Faculty of Medicine between June 2006 and January 2010 were included in this retrospective study. To obtain homogenized groups, only patients who were 25 years old or more, who had non-toxic benign thyroid pathology, who did not have preoperative laboratory and clinical hypocalcemia or any skeletal pathology, who had not received preoperative and postoperative blood transfusions, and who had no other pathology or endocrine disease that might affect calcium metabolism, were included in the sample. All patients underwent surgery primarily for bilateral non-toxic multinodular goiter. Patients who had concomitant parathyroid disease or a history of taking drugs that could affect calcium metabolism or in whom unilateral truncal ligation of the inferior thyroid artery was performed were excluded from the study. Patients who had undergone subtotal thyroidectomy, unilateral thyroidectomy, total thyroidectomy and neck dissection as well as cases who had any other thyroid diseases were also excluded. A total of 298 patients were eligible for the study. Thirty eight patients were excluded because of documentation problems and an additional thirty patients because they had not regularly complied with the follow-up program.

The documentation of the patients was studied carefully. The hospital record of each patient contained adequate history and physical examination data. Preoperative vocal cord examinations were performed if the patient had a voice problem. Patients were separated into two groups according to type of ligation of ITAies. Patients in group 1 (n=104) had undergone ligation of the trunks of the inferior thyroid arteries lateral to the recurrent laryngeal nerve. In group 2 (n=126), these arteries were ligated peripherally.

All patients had been informed about the operation and given their informed consent to the procedures prior to the surgery and to the intervention.

The temperature of the operating theatre was 25-26°C. In all patients the operation was performed under general anesthesia. The same anesthetic procedure (in induction: 0.5 mg/kg vecuronium and 2 mg/kg propofol, fentanyl 2 mg/kg; in maintenance: 33% O_2 with 67% N_2O and 1% isoflurane) was used in all patients.

All operations were performed by the same two surgical teams.

A standard technique was used in all operations. The middle thyroid veins were ligated on both sides and cut. The inferior laryngeal nerves were located first if there was no other problem. The superior thyroid vessels were ligated and cut. Bilateral ITAies were ligated truncally on the lateral side of the neck, adjacent to the carotid sheath (Group 1), or peripherally on the nearest site to the thyroid gland (Group 2). The recurrent laryngeal nerves were identified in all patients. The isthmus was separated from the trachea and cut. Resection was made by protecting the posterior capsule of the lobes and the parathyroids. Postoperative fluid balance was provided in all patients.

In each patient the serum calcium, phosphorus, and alkaline phosphatase levels were measured preoperatively. Postoperative serum calcium level was measured if there were symptoms of hypocalcemia. Calcium, phosphorus and alkaline phosphatase levels were evaluated by using a Roche/Hitachi Modular Analytics system (Roche Diagnostics, Indianapolis, USA). The normal serum level ranges for calcium, phosphorus, and alkaline phosphatase are 8.4-10 mg/dL, 2.3-4.7 mg/dL, and 40-150 IU/L respectively.

The patients were evaluated preoperatively for symptoms and signs of clinical hypocalcemia and also on the 1, 2, 3rd and 30th postoperative days. All patients were also examined for presence of paresthesia in the perioral region and in the extremities. Positive findings for Chvostek or Trousseau signs, presence of carpopedal spasm, convulsion and laryngospasm were also recorded in all patients.

Transient clinical hypocalcemia was defined as a serum calcium level lower than 8.4 mg/dL, with symptoms or signs of hypocalcemia that would disappear within 6 months of treatment. Permanent hypocalcaemia was defined as a conditiom requiring continuous treatment of hypocalcemia for a period exceeding 6 months.

In postoperative follow-up, the patients were asked standard questions about symptoms of hypocalcemia. A physical examination was done to investigate signs of

hypocalcemia. All patients were followed for 8-12 (median 10 months) months after the surgery. Postoperative calcium treatment was started if there were symptoms or signs of hypocalcemia.

The Chi square test was used to compare group 1 and group 2 for clinical hypocalcemia. A two-paired t test was used to compare the two groups for clinical hypocalcemia during the 30-day postoperative period.

The results were considered statistically significant if the p value was less than 0.05.

Results

Preoperative serum calcium and phosphorus concentrations were within normal ranges in all patients. Serum calcium levels were between 6.5 and 7.4 mg/dL in patients in groups 1 and 2 who were clinically hypocalcemic postoperatively. Statistically significant differences ($p<0.05$) in calcium levels were noted between preoperative and postoperative 1st, 2nd, 3rd days and the 30th postoperative day levels. Transient clinical hypocalcemia was observed in 15 patients in group 1, and in 3 patients in group 2 whose serum calcium levels were under 8.4 mg/dL during the 1st, 2nd, or 3rd days postoperatively. Perioral and extremities paresthesia and a positive Chvostek sign was observed in these patients. Calcium gluconate was administered by intravenous infusion (1mg/kg/hr) in combination with oral calcium carbonate (1000 mg of elemental calcium twice a day) to these patients, With this treatment, the symptoms completely disappeared and the serum calcium level returned to normal. at the end of a period of 4 to 30 days. Calcium treatment was tapered and discontinued.

The incidence of transient clinical hypocalcemia was 14.42% in group 1, and 2.38% in group 2. There was a statistically significant difference between the two groups in incidence of transient clinical hypocalcemia ($p<0.05$). Transient clinical hypocalcemia improved within 30 days postoperatively (Table). There was a statistically significant difference between the two groups for the period of postoperative clinical hypocalcemia ($p=0.000387$).

Neither permanent hypocalcemia nor recurrent laryngeal nerve damage were observed in any patient.

Histopathology of the specimens showed that parathyroid glands were removed accidentally in three patients in the truncally ligated group.

Discussion

Hypocalcemia is one potential complication of thyroid surgery. To reduce postoperative clinical hypocalcemia in total thyroidectomy, a good knowledge of cervical anatomy is mandatory.[16,17] Both surgical teams who performed the thyroidectomies in this study had an excellent knowledge of cervical anatomy. The prevalence of temporary hypocalcemia is frequently linked to bilateral thyroidectomies. Symptomatic hypocalcemia is rarely seen and the prevalence of permanent hypocalcemia is even rarer. Prevalence rates of post-thyroidectomy hypocalcemia vary depending on type of thyroidectomy, hospital, type of thyroid pathology and surgical experience of the team.[1-5] In this study, postoperative temporary clinical hypocalcemia was diagnosed in 18 (7.82%) patients. These patients recovered between the 4th and 30th postoperative days. Of these eighteen patients, 15 (14.42%) were from the group whose ITAies were ligated truncally and 3 (2.82%) were from the group whose ITAies were ligated peripherally. The difference in the prevalence of clinical hypocalcemia between the two ligation methods was statistically significant. There were no other important factors that might influence the occurrence of clinical hypocalcemia in each group because all patients had similar characteristics (all underwent total thyroidectomy and had the same thyroid pathology). It was thought that temporary vascular insufficiency due to dissection and type of ligation was responsible for the higher prevalence.

It is said that parathyroid glands are supplied mainly by ITAies and parathyroid infarct may occur during thyroidectomy because of the ligated ITAies which may lead to postoperative hypocalcemia.[1-3] Some studies recommend that ITAies should not be ligated from lateral to trunk in order to protect the blood flow and if it is to be ligated in this way, it should be ligated after the point where the parathyroid branch separates. It is stated that in this way vascular structures can be preserved, parathyroid glands can be supplied and at the same time hemostasis is improved.[1,9,11] The advantages of protecting the parathyroid glands from injuries include reduced hospital stay time, shorter period of hypocalcemic symptoms, good patient psychology, and quicker return the work.[16] In this study, patients in group 2 (peripheral ligation of

Table: The period of postoperative clinical hypocalcemia

Groups and Period of Postoperative Clinical Hypocalcemia (Recovery days)	
Group 1 (Truncal Ligation)	**Group 2 (Peripheral Ligation)**
7. days	4. days
9. days	7. days
12. days	6. days
7. days	
10. days	
11. days	
26. days	
8. days	
24. days	
29. days	
19. days	
22. days	
26. days	
17. days	
16. days	

ITAies,) performed significantly better than those in group 1 (truncal ligation of ITAies). The advantages of peripheral ligation of ITAies include a lower rate of hypocalcemia and a reduced period of postoperative clinical hypocalcemia. Many previous studies have reported that parathyroid glands can be supplied by tracheal, esophageal arteries and the vessels and collaterals from nearby tissues thus the functions of parathyroids can not easily be interrupted. Previous studies also state that postoperative serum calcium levels were not affected when ITAies were ligated bilateral truncally from the lateral to the recurrent laryngeal nerves.[12-15] In addition, a decrease in blood flow measurements of the parathyroid glands were reported in patients whose ITAies were ligated using a laser-Doppler flowmeter.[16-18] In this study, it was found that the blood flow of the parathyroids does not depend only on the ITAies, but that they are also supplied by different regions. In this present study we found a statistically significant difference in prevalence of postoperative clinical hypocalcemia and serum calcium levels between patients with truncally ligated ITAies and those with peripherally ligated ITAies. It was therefore concluded that the supply to the parathyroid glands is interrupted and the supply from neighboring tissues is insufficient if ITAies are ligated bilaterally and truncally. Our results indicate that in non-toxic multinodular goiter cases, ligating ITAies from the trunk caused a higher rate of long-period hypocalcemia as compared to ligating peripherally.

To avoid postoperative clinical hypocalcemia in total thyroidectomy, ITAies must be ligated peripherally. The peripherally ligated group will have a lower prevalence of clinical hypocalcemia and a reduced period of hypocalcemia. These advantages will result in reductions in the duration of hospitalization, in the use of medicines, costs, and patient discomfort. It will also facilitate earlier return to work. The procedure is also quicker, allowing the surgeon to treat additional patients.

Resected parathyroids were shown to be an important risk factor for postoperative clinical hypocalcemia.[19] Meticulous dissection is very important in order to protect the parathyroids and to reduce postoperative clinical hypocalcemia.[16] In this study, parathyroid glands were removed accidentally in three patients in the truncally ligated group. In these patients clinical hypocalcemia showed longer duration than the other hypocalcemic cases in the group. We thought that resected parathyroids also had a role in clinical hypocalcemia for these patients. Surgical experience is also very important to avoid parathyroid damage.[17]

In conclusion, this study shows that the probability of postoperative clinical hypocalcemia was reduced in total thyroidectomies for non-toxic multinodular goiter by ligating ITAies peripherally. The period of postoperative clinical hypocalcemia was also shorter when the ITAies were ligated peripherally rather than truncally.

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References

1. Falk SA. Complication of Thyroid Surgery in: Falk SA. Thyroid Disease. New York, Raven Press, 1990;609-619.
2. Solgun L, Kievit J, van der Velde CJH. Complications of thyroid surgery in: Clark OH, Duh QY. Textbook of Endocrine Surgery (1st ed). Philadelphia, Pennsylvania, W.B. Saunders Company, 1997;22:167-173.
3. Wingert DJ, Friesen SR, Lliopoulos JI, Pierce GE, Thomas JH, Hermreck AS. Post-thyroidectomy hypocalcaemia. Am J Surg 1986;152:606-610.
4. Hines JR, Atiyah R, Kliefoth J, Beal JM. Hyperparathyroidism: problems in surgical management. Am J Surg 1982;144:504-510.
5. Jacobs JK, Aland JW, Ballinger JF. Total thyroidectomy: a review of 213 patients. Ann Surg 1983;197:542-549.
6. Percival RC, Hangreaves AW, Kanis JA. The mechanism of hypocalcaemia following thyroidectomy. Acta Endocrinol 1985;109:220-226.
7. Mc Henry CR, Speroff T, Wentworth D, Murphy T. Risk factors for post-thyroidectomy hypocalcaemia. Surgery 1994;116:641-648.
8. Kovacs L, Goth MI, Vörös A, Hubinia E, Szilagyi G, Szabolcs I. Changes of serum calcium level following thyroid surgery-reasons and clinical implications. Exp. Clin. Endocrinol Diabetes 2000;108:364-368.
9. Rossi RL, Cady B. Surgical Anatomy in: Rossi RL, Cady B. Surgery of the thyroid and parathyroid glands (3rd ed). Philadelphia, W.B. Saunders Company, 1991:13-30.
10. Lore John M. An Atlas of head and neck of surgery (3rd ed). Philadelphia, W.B. Saunders Company, 1988:726-800.
11. Schmauss AK, Zech U. Concentration of calcium and phosphorus in patients after thyroidectomy without ligation of the inferior thyroid arteries. Zentralbl Chir 1981;106:1063-1073.
12. Nies C, Sitter H, Zielke H et al. Parathyroid function following ligation of the inferior thyroid arteries during bilateral subtotal thyroidectomy. Br J Surg 1994;81:1757-1759.
13. Dolapçı M, Doğanay M, Reis E, Kama NA. Truncal ligation of inferior thyroid arteries does not affect the incidence of hypocalcaemia after thyroidectomy. Eur J Surg 2000;166:286-288.
14. Pellizo MR, Toniato A, Grigo letto R, Piotto A, Bernante P. Post-thyroidectomy hypocalcaemia and ligation of the inferior thyroid artery trunk. Minerva Chir 1995;50:215-218.
15. Çakmaklı S, Aydıntuğ S, Erdem E. Post-thyroidectomy hypocalcaemia: Does arterial ligation play a significant role? Int Surg 1992;77:284-286.
16. Testini M, Gurrado A, Lissidini G, Nacchiero M. Hypoparathyroidism after total thyroidectomy. Minerva Chir. 2007;62:409-415.
17. Sciume C, Geraci G, Pisello F et al. Complications in thyroid surgery : Symptomatic post-operative hypoparathyroidism incidence, surgical technique, and treatment. Ann Ital Chir. 2006;77:115-122.
18. Johansson K, Ander S, Lennquist S, Smeds S. Human parathyroid blood supply determined by laser-doppler flowmetry. World J Surg 1994;18:417-421.
19. Meyer T, Merkel S, Radespiel-Troeger M, Hohenberger W. Dysfunction of calcium metabolism following resection of the thyroid gland. An analysis of important risk factors. Zentralbl Chir. 2002;127:429-434.