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## The Assessment of the Influence of the Method for Obtaining Hemostasis on the Occurrence of Postoperative Complications After Thyroid Surgery

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article; G – other

### Abstract

**Background.** The need to obtain successful surgical hemostasis had a significant impact on the development of electrosurgery. Innovative technical solutions necessitate the continuous training of surgeons in the use of more modern technologies. The diversity of solutions is also associated with the need to adapt the methods for obtaining hemostasis to the type of operation. Each time, the introduction of new technologies requires a critical evaluation of the results of surgical treatment. The most important measure of quality in thyroid surgery is the presence of chronic complications, such as the recurrent laryngeal nerve palsy and parathyroid insufficiency. Transient disorders also have a significant impact on the patient's comfort and quality of life. The report is preliminary in nature and it requires further investigation.

**Objectives.** The aim of the study was to evaluate the effect of three methods for obtaining hemostasis on the occurrence of hypoparathyroidism, recurrent laryngeal nerve palsy, bleeding and the surgical site infection after thyroid surgery.

**Material and Methods.** A retrospective analysis included patients who underwent thyroidectomy (n = 654). Three methods of hemostasis were used. The first group (n = 339) had blood vessels tied off. In the second (n = 192) bipolar electrocoagulation was used and in the third one (n = 123) bipolar electrocoagulation with integrated cutting mechanism.

**Results.** The transient hypoparathyroidism was found in 1.4% patients in the first group, 8.3% in the second and 27.6% in the third one. Chronic hypoparathyroidism was found in 0.29% in the first group, 0% in the second group and 2.4% in the third group. Significantly statistical differences were found in the incidence of transient hypoparathyroidism.

**Conclusions.** Significant statistical differences were found in incidences of transient hypoparathyroidism in the group where bipolar electrosurgery was used (*Adv Clin Exp Med* 2015, 24, 2, 275–278).

**Key words:** thyroidectomy, hemostasis, complications.

The most important measure of the quality of thyroid surgery is the occurrence of complications, such as the recurrent laryngeal nerve palsy and parathyroid insufficiency, which have a significant impact on the quality of life [1]. The shortening of treatment time, reduction of bleeding during the surgery and the reduction of surgical damage to the tissue as well as the reduction of foreign material in the surgical wound are important issues. The development of surgical techniques involving

precise dissection of tissues promotes the reduction of the negative impact of the operation [2]. The surgeon's actions are supported by the developing electrosurgical systems.

Traditional methods of obtaining hemostasis include tying off and ligation of the cut vessels. The effectiveness of this method depends on the type of suture used and the skill of the surgeon. It is time-consuming and associated with leaving foreign material in the surgical wound. Another method is

the use of ultrasound. Ultrasonic vibrations make the end effectors of the device operate at a frequency of 55,500 cycles per second. The result is the induction of coagulation and cavitation, which allow the delicate tissue dissection with the simultaneous sealing of the majority of blood vessels [3, 4]. The procedure is accompanied by the heating of the dissected tissue. Hemostasis can also be achieved using an electric current of high frequency generating a thermal effect on the tissues. High temperatures cause denaturation of intracellular and extracellular proteins [5]. At temperatures of up to 45°C, the thermal effect of operating tissue is reversible. At higher temperatures, the proteins are denatured and lose their structural integrity. Above 90°C, the cell liquid evaporates, and at the temperature of 200°C tissue charring is observed. Currently, surgeons have a large range of equipment available to them for electrosurgery. For example, monopolar electrodes can be used. This device involves the flow of current between the return electrode applied to distant parts of the body and the working one in the operating field, around which heat is generated. Depending on the current parameters, the effect of cutting or sealing the blood vessels is achieved. The second type is bipolar electrodes. The arms of the surgical tool constitute electrodes and the current flows between them, causing the effect of coagulation and hemostasis. These types of electrodes can be completed with an individually actuated scalpel moving along the arms and cutting the tissue located between them. These methods of hemostasis and tissue cutting can be used in thyroid surgery. [6] The use of electrosurgery during thyroidectomy requires special attention because of two aspects. The first is the heat-affected zone around the electrode and the second is the surgery topography: the adjacency of parathyroid glands and their vessels and the recurrent laryngeal nerve to the surface of the thyroid gland. This requires special surgical technique involving the retraction of these anatomical structures and the thyroid from each other at a distance greater than the isothermal value of  $\geq 45^{\circ}\text{C}$ .

Innovative technical solutions necessitate the need for continuous training of surgeons in the use of new technologies. The diversity is also associated with the need to adapt the methods for obtaining hemostasis to the type of operation. Each introduction of new technologies requires a critical evaluation of the results of surgical treatment.

## Objectives

The aim of the study was to evaluate the effect of 3 methods for obtaining hemostasis on the occurrence of hypoparathyroidism, recurrent

laryngeal nerve palsy, bleeding and the surgical site infection after thyroid surgery.

## Material and Methods

The retrospective analysis included patients who underwent thyroid operations in the Department of General Surgery, Provincial Hospital in Suwałki in the period 1998–2011 ( $n = 654$ ). The criteria for grouping patients involved the use of the three methods of hemostasis. The division into groups was dictated by the development of techniques used in the Department of General Surgery and the gradual replenishment of surgical equipment by the hospital board. Patients in the first group ( $n = 339$ ) had large blood vessels tied off and ligated and the electrocoagulation of small blood vessels administered. Electrosurgery was not used in the dissection of parathyroid and the recurrent laryngeal nerve. In the second group ( $n = 192$ ), bipolar electrocoagulation was introduced, making it possible to seal blood vessels up to 7 mm. The obtained weld length was 15.5 cm. Activation took place after pressing the foot switch. In the third group ( $n = 123$ ), a similar system of bipolar electrocoagulation was used by the same manufacturer, with an integrated cutting mechanism in the form of a knife sliding along the jaws to cut the coagulated vessel. The start took place after the activation of a switch mounted in the arms of the tool. The declaration of the temperature reached at the outer surfaces of the jaws was an important piece of information provided by the manufacturer. During the operation, no neuromonitoring was used.

Postoperative hypoparathyroidism or recurrent laryngeal nerve palsy lasting 6 months or longer was described as chronic complication.

The results were statistically analyzed by assessing the incidence of postoperative parathyroid function disorder, depending on the hemostasis method. All calculations were performed using STATISTICA 10 (StatSoft, Tulsa OK, United States). The level of statistical significance was set at  $p \leq 0.05$ . The incidence of various complications and performing various ranges of thyroid resection in the analyzed periods were presented in the form of time, figure and percentage series. The significance of changes in these parameters was evaluated in each period based on the Pearson's  $\chi^2$  test or Fisher's exact test. The variables, whose growth rate was significant in time, were included in the multiple regression model evaluating the effect of the frequency of the selected ranges of thyroid resection on the risk of a particular type of complications.

## Results

The incidence of transient hypocalcemia increased significantly when time periods were compared (1998–2006 vs 2007–2009:  $p < 0.001$ , Pearson's  $\chi^2$  test, 2007–2009 vs 2010–2012:  $p < 0.001$ , Fisher's exact test; 1998–2006 vs 2010–2012:  $p < 0.001$ , Fisher's exact test). The incidence of chronic hypocalcemia in the period 2010–2012 was higher (on the borderline of statistical significance) as compared to the period from 1998 to 2006 ( $p = 0.060$ , Fisher's exact test) and 2007–2009 ( $p = 0.059$ , Fisher's exact test). For other complications, there was no significant difference in the incidence in the compared periods (Table 1).

The frequency of total thyroidectomy [1] was significantly increased in the time period comparison (1998–2006 vs 2007–2009:  $p = 0.002$ , Pearson's  $\chi^2$  test, 2007–2009 vs 2010–2012:  $p < 0.001$ , Fisher's exact test, 1998–2006 vs 2010–2012:  $p < 0.001$ , Fisher's exact test). At the same time, a systematic decrease in the frequency of subtotal thyroidectomy was observed [3] (1998–2006 vs 2007–2009:  $p = 0.003$ , Pearson's  $\chi^2$  test; 2007–2009 vs 2010–2012:  $p < 0.001$ , Fisher's exact test; 1998–2006 vs 2010–2012:  $p < 0.001$ , Fisher's exact test). There were no significant differences in the incidence of other ranges of thyroid resection performed in the analyzed periods (Table 2).

In the multiple regression model, it was shown that the growth rate of the total thyroidectomy and reduction in the frequency of subtotal thyroidectomy showed a significant association with the growing incidence of temporary and chronic parathyroid failure in the subsequent years ( $R^2 = 0.313$ ,  $p < 0.001$ ).

A temporary failure of the parathyroid gland was found in 1.4% ( $n = 5$ ) patients in group I, 8.3% ( $n = 16$ ) in the second group and 27.6% ( $n = 34$ ) in the third group of patients. Chronic hypothyroidism was found in 0.29% ( $n = 1$ ) in the first group, 0% in the second group and 2.4% ( $n = 3$ ) in the third group of patients.

Significant statistical differences in the incidence of postoperative transient hypoparathyroidism were found in different research groups. The difference in the incidence of chronic hypoparathyroidism was at the borderline of statistical significance. There was no significant difference in the occurrence of other postoperative complications.

## Discussion

The temperature of the tissues around the end effectors of the device depends on the method used to obtain the effect of hemostasis and cutting the tissues. The highest temperatures, above  $110^\circ\text{C}$ , are caused by the use of ultrasound. Lower

**Table 1.** The incidence of complications

Period	Permanent RLN paresis		Transient RLN paresis		Transient hypoparathyroidism		Permanent hypoparathyroidism		Bleeding		Surgical site infection	
	n	%	n	%	n	%	n	%	n	%	n	%
1998–2006	2	0.6	5	1.5	5	1.5	1	0.3	4	1.2	2	0.6
2007–2009	0	0.0	2	1.0	16	8.3	0	0.0	7	3.6	1	0.5
2010–2012	1	0.8	1	0.8	34	27.6	3	2.4	2	1.6	0	0.0
P-value	0.509		0.818		0.000		0.014		0.140		0.701	

**Table 2.** The frequency of ranges of thyroid resection

Period	Total thyroidectomy		Total lobectomy		Subtotal lobectomy		Subtotal thyroidectomy		One side total lobectomy with subtotal second side lobectomy		Other	
	n	%	n	%	n	%	n	%	n	%	n	%
1998–2006	35	10.3	31	9.1	13	3.8	182	53.4	77	22.6	3	0.9
2007–2009	39	20.3	12	6.3	9	4.7	77	40.1	55	28.6	0	0.0
2010–2012	82	66.7	5	4.1	0	0.0	14	11.4	22	17.9	0	0.0
P-value	0.000		0.142		0.062		0.000		0.784		0.246	

temperatures, about 90°C, are achieved when monopolar electrosurgery is used. The lowest temperatures occur during the use of bipolar electrocoagulation [7]. The temperature range involves the extent of permanent damage to the tissues. This has a significant impact on the methodology of the use of electrosurgery in the vicinity of temperature-sensitive tissues. The range of bipolar electrocoagulation safety is > 5 mm [8]. In the case of thyroid surgery, the parathyroid tissue, with its vascularization, and the recurrent laryngeal nerves are the sensitive tissues. Our study did not use ultrasound and the use of monopolar electrocoagulation was limited to coating and sealing small vessels distant from thermally sensitive anatomical structures. Therefore, it can be assumed that the data for the first group focused on classical dissection. Regardless of the impact of heat, the tissue preparation

and a very good knowledge of the topography of the operated area are very important. The literature data on complications is not clear. The occurrence of more hypoparathyroidism in the postoperative period while using bipolar coagulation has already been described [9]. There are also papers showing no statistically significant differences in the incidence of complications after thyroidectomy using various systems of obtaining hemostasis and tissue cutting [10, 11]. This can indicate that the surgical technique is important in the occurrence of complications and not in the type of the equipment used.

The authors have concluded that bipolar coagulation method of obtaining hemostasis in the surgery of the thyroid gland has a statistically significant effect on the incidence of postoperative transient hypoparathyroidism.

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