

## Health & Research Journal

Vol 7, No 2 (2021)

Volume 7 Issue 2 April - June 2021



Volume 7 Issue 2 April - June 2021

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Published in cooperation with the Postgraduate Program "Intensive Care Units", the Hellenic Society of Nursing Research and Education and the Helerga

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doi: [10.12681/healthresj.26809](https://doi.org/10.12681/healthresj.26809)

### To cite this article:

Sampani, C., Kalemikerakis, I., Kalogianni, A., & Papageorgiou, D. (2021). The effect of percutaneous and surgical tracheotomy on thyroid hormones levels. *Health & Research Journal*, 7(2), 85–93. <https://doi.org/10.12681/healthresj.26809>

## RESEARCH ARTICLE

## THE EFFECT OF PERCUTANEOUS AND SURGICAL TRACHEOTOMY ON THYROID HORMONES LEVELS

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**Abstract**

**Background:** The need for prolonged mechanical ventilation is one of the most serious cases of a disease in patients in intensive care units. Tracheostomy is often considered as a solution when mechanical ventilation is expected to be used for prolonged periods or for improvement of the respiratory state as this approach provides protection of the airways, facilitates access to remove secretions, improves patient convenience and promotes the development of care inside and outside the Intensive Care Unit (ICU).

**Aim:** The aim of the present study was to evaluate the impact of surgical and percutaneous tracheotomy on thyroid hormones and to compare them.

**Material & Methods:** This is a non-randomized clinical trial. The studied sample consisted of 87 patients from the Intensive Care Unit of a General Hospital of Athens who underwent percutaneous or surgical tracheotomy.

**Results:** Thyroid-stimulating hormone levels were increased in surgical group compared to percutaneous group at 2 hours post procedure but the difference was not found statistically significant. The rise in post-operative levels of fT3 compared to preoperative was found statistically significant for surgical tracheostomy group. Elevated fT4 levels were found in both groups.

**Conclusions:** The effect of surgical versus percutaneous tracheostomy on thyroid hormone was analyzed and it was found that both procedures may affect the level of thyroid hormones, being significant in the surgical group.

**Keywords:** Thyroid hormones, surgical tracheotomy, percutaneous tracheotomy, complications, intensive care.

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Cite as: Sampani, C., Kalemikerakis, I., Kalogianni, A., Papageorgiou, D. (2021). The effect of percutaneous and surgical tracheotomy on thyroid hormones levels. *Health and Research Journal*,7(2),85-93. <https://ejournals.epublishing.ekt.gr/index.php/HealthRes/>

## INTRODUCTION

Tracheotomy refers to the surgical opening of the anterior wall of the trachea. Instead, the term tracheostomy consists of opening and placing a special tube inside the trachea to ventilate the patient, bypassing the upper airway. It is the artificial orifice in the anterior wall of the trachea below the cricoid cartilage, between 2-3 cartilages.

Surgical tracheostomy is the incision of the pre-tracheal tissues and the insertion of a tracheostomy tube under direct vision of the trachea. In contrast, percutaneous tracheostomy is the insertion of a tracheal cannula through a blunt cross-section of the pre-tracheal tissues, using a guide with the Seldinger technique.<sup>1</sup>

Tracheostomy is a surgery with a long history. It was conceived as a method in the effort to release the airway and keep the breath in a state of suffocation, which was the primary and main indication of its application. The first references to tracheostomy are found in Ancient Egypt, around 3000 BC in Egyptian tablets. According to legend, Alexander the Great used his sword to open a soldier's airway from a bone in his neck.<sup>2</sup>

Tracheotomy aims to eliminate upper airway obstruction, prevent complications from aspiration and enhance pulmonary function. This is a life-saving process. Today, due to developments in intensive care units and the widespread use of mechanical ventilators, tracheotomy is one of the most widely performed operations. The technique of surgical tracheotomy is an old procedure, but the technique of percutaneous tracheotomy is a growing technique. Both techniques have some advantages and disadvantages.<sup>1</sup>

Traditionally, surgical tracheostomy is performed by surgeons in the operating room and in many hospitals it remains so. In the last 50 years, however, several methods have been introduced to make tracheostomy a bed rest procedure thus minimizing patient transfer to the surgical bed. Some of these methods were not established due to serious complications. The most popular technique today is the Percutaneous Dilational Tracheostomy (PDT) described by Ciaglia in 1985.<sup>3</sup>

This technique uses serial dilators above a guide wire with the Seldinger technique and under bronchoscopic guidance. Ciaglia later introduced a simple conical dilator to replace serial dilators, further simplifying the technique.<sup>4</sup>

The effects of surgical and percutaneous techniques on thyroid hormones are analyzed. There are changes in the levels of triiodothyronine (fT3), thyroxine (fT4) and thyroid hormone (TSH) after both procedures.

With regard to the effects of the thyroid gland, such as regulation of basal metabolism, endocrine, cardiac and circulatory systems, the increase in thyroid hormones due to tracheotomy should not be forgotten and must be taken into account during the procedure, (even this is only a possibility), and these patients should be monitored more closely during a specific period after tracheostomy.<sup>5</sup>

The tracheotomy is a lifesaving operation but is performed in neighborhood of vital organs. The thyroid gland together with important vessels is in close relation to the operation side. Any process made in that area like deep palpation, will be important due to the effects on thyroid gland and so on cardiac and systemic circulation. The relationship between circulatory, metabolic and endocrine systems is regulated and affected by thyroid gland. In the study on pigs with hyperthyroidism, the raise in heart rate and contractility by the blockage with beta-adrenergic agents, has shown that thyroid hormones have a direct effect on the heart.<sup>6</sup>

With the increase in thyroid hormones, the sympathetic system activity increases either. It raises the myosin enzyme synthesis and contraction. In addition, the thyroid hormone activates the Na+2 pump in heart tissue as in other tissues. It increases catecholamine sensitivity and amount of beta adrenergic receptors. It can raise the cardiac output by increasing myocardial inotropes, the heart rate and by dilating the peripheral arteries.<sup>7</sup>

## AIM

The aim of the present study was to evaluate the impact of surgical and percutaneous tracheotomy on thyroid hormones.

## METHODOLOGY

### **Study design**

This is a non-randomized clinical trial.

### **Sample of the study**

The studied sample consisted of 87 patients from the Intensive Care Unit of a General Hospital of Athens who underwent percutaneous or surgical tracheotomy. Data collection and analysis took place between 2017 and 2018.

### **Inclusion criteria**

- age > 18 years
- patients with critical illness in ICU
- need for mechanical ventilation for  $\geq 2$  weeks
- hemodynamic stability

### **Exclusion criteria**

- <18 years old
- infection at the tracheostomy site
- abnormal neck anatomy
- known or suspected difficult endotracheal intubation
- unstable cervical spine
- patients with blood clotting problems
- hemodynamic instability
- history of previous tracheostomy

### **Data collection**

A special designed data collection form was used. Specifically, the application of intervention, percutaneous or surgical tracheotomy and thyroid hormone measurement in two phases were recorded. In particular, measurements were recorded one hour before the intervention and three hours later.

### **Ethics**

All data were anonymous and an informed consent was obtained by patients' family members so as approval from hospital's Human Research Ethics Committee.

### **Statistical analysis**

Continuous variables are presented as mean values  $\pm$  standard deviation and categorical variables as frequencies.  $\chi^2$  independence test and student's t-test were used.

The level of statistical significance was set at  $p < 0.005$ . Data analysis was performed using SPSS ver. 20 (SPSS Inc, Chicago,

IL, USA).

## RESULTS

### *Descriptive analysis*

Of the 87 patients enrolled in the study, 56.3% ( $n = 49$ ) were men and 43.7% ( $n = 38$ ) were women. 51.7% ( $n = 45$ ) of participants had percutaneous tracheotomy while 48.3% ( $n = 42$ ) had surgical. The mean T3 before tracheotomy for all patients was 0.61 ng / ml and 1.31 ng / ml after tracheotomy. Correspondingly, the mean TSH value was 1.59  $\mu$ iu / ml before tracheotomy and 2.56  $\mu$ iu / ml after. Finally, the mean FT4 was calculated 10.02 pmol / l for all patients before tracheotomy and 12.67 pmol / l after (Table 1).

### *Comparisons-Correlations*

Table 2 shows the relationship between the gender of the patients and the type of tracheotomy.

There was no statistically significant relationship between gender and type of tracheotomy ( $p > 0.05$ ). Specifically, percutaneous and open tracheotomies have no relation to whether the patient is male or female.

T3 levels at preoperative measurement did not appear to differ statistically significantly between percutaneous and surgical tracheotomy ( $p > 0.05$ ). In contrast, there was a statistically significant difference between the levels of T3 in the postoperative measurement between percutaneous and surgical tracheotomy ( $p < 0.05$ ). Specifically, subjects who underwent percutaneous tracheotomy showed higher T3 levels during the postoperative measurement than those who underwent surgical tracheotomy (Table 3).

Comparisons between preoperative and postoperative measurement showed statistically significant differences in both percutaneous and surgical tracheotomy ( $p < 0.05$ ). In more detail, patients undergoing percutaneous tracheotomy showed higher T3 levels in postoperative measurement than preoperative measurement as did patients undergoing surgical tracheotomy (Table 3).

The analysis of TSH levels is presented in Table 4.

TSH levels at preoperative measurement appeared to be statis-

tically significantly different between percutaneous and surgical tracheotomy ( $p < 0.05$ ). At preoperative measurement, subjects who underwent percutaneous tracheotomy showed higher TSH levels than subjects who underwent surgical tracheotomy. In contrast, post-operative TSH levels did not appear to differ statistically significantly between percutaneous and surgical tracheotomy ( $p > 0.05$ ).

Comparison of TSH levels between preoperative and postoperative measurement showed statistically significant differences in both percutaneous and surgical tracheotomy ( $p < 0.05$ ). Specifically, patients undergoing percutaneous tracheotomy and those undergoing surgical tracheotomy showed higher TSH levels during postoperative compared to preoperative measurement.

Finally, analysis of FT4 levels showed no statistically significant difference between preoperative FT4 levels and percutaneous and surgical tracheotomy ( $p > 0.05$ ). However, there was a statistically significant difference between FT4 levels during the postoperative measurement between percutaneous and surgical tracheotomy ( $p < 0.05$ ). Specifically, patients undergoing percutaneous tracheotomy showed lower levels of FT4 at postoperative measurement than patients undergoing surgical tracheotomy (Table 5).

There were also statistically significant differences between FT4 levels in preoperative and postoperative measurement in both percutaneous and surgical tracheotomy ( $p < 0.05$ ). Patients undergoing percutaneous tracheotomy showed higher FT4 levels at postoperative measurement than preoperative measurement as did patients undergoing surgical tracheotomy (Table 5).

## DISCUSSION

### *Summary of the findings*

Based on the data analysis, it can be concluded that the most important findings of the present study are:

- There was no statistically significant relationship between gender and type of tracheotomy ( $p > 0.05$ ).
- Postoperatively, subjects who underwent percutaneous tra-

cheotomy showed higher T3 levels than those who underwent surgical tracheotomy.

- During the preoperative measurement, subjects who underwent percutaneous tracheotomy showed higher TSH levels than those who underwent surgical tracheotomy.
- Post-operative measurement showed no statistically significant difference in TSH levels between percutaneous and surgical tracheotomy ( $p > 0.05$ ).
- Patients undergoing percutaneous tracheotomy and those undergoing surgical tracheotomy showed higher TSH levels during postoperative compared to preoperative measurement.
- Patients undergoing percutaneous tracheotomy showed lower FT4 levels at postoperative measurement than patients undergoing tracheotomy.

### *Theoretical rendering of the findings*

The tracheotomy was performed from ancient times. Along with the longer history of surgical tracheostomy, percutaneous tracheotomy is a newer practice. Both techniques have advantages and disadvantages.

Throat surgeries cause surgical stress, increasing the amounts of fT3 and fT4. These processes can be the cause of various clinical symptoms by changing hormone levels, even causing thyroid crisis.<sup>8</sup>

Due to the anatomy of the area where the tracheostomy is performed, it may be necessary to insert the thyroid gland. In such a situation, thyroid hormone rejection or even thyroid toxicity may occur. The conditions that can cause thyroid crisis are excessive palpation of the thyroid tissue, thyroid injury and trauma, previous thyroid surgery, iodine therapy, surgical anxiety and infection.<sup>9</sup>

In 2001, Michaiaki et al.<sup>10</sup> reported a study aimed at demonstrating changes in thyroid hormone levels in non-thyroid surgery. Preoperative, intraoperative and postoperative change in TSH, fT3 and fT4 levels from 19 patients who underwent surgical cholecystectomy and surgery for morbid obesity. Preoperative levels of fT4 began to rise by the 30th minute and reached a statistically significant level at 1 hour.

Alpay et al.,<sup>11</sup> measured the levels of fT3, fT4, TSH and thy-

roglobulin before and after thyroid biopsy with a suction needle in their 2007 study. Increased hormone levels were not found statistically significant.

In the 2006 Berge Ede study, intraoperative changes in the levels of FT4, FT3 and TSH were investigated in 125 patients who had traumatic thyroid palpation in thyroid surgery and found that FT4 levels were significant.<sup>12</sup>

In another study by Yetim et al.,<sup>13</sup> to evaluate the effects of surgical and percutaneous tracheotomy on thyroid hormones, sixty patients with respiratory problems undergoing surgical tracheotomy and percutaneous tracheotomy. The effects of surgical and percutaneous tracheotomy on free thyroxine (FT4), serum thyroglobulin (TG) levels and thyroid hormone (TSH) levels were found to be statistically significant. Although free triiodothyronine (FT3) slightly increased in both groups, it was not statistically significant.

Today, percutaneous tracheotomy and conventional surgical tracheotomy have been widely used in intensive care units in patients who are expected to be associated with mechanical ventilation for a long time. Due to the anatomy of the surgical tissue, tracheotomy can cause damage to the adjacent thyroid gland and tracheal rings. Surgeons should keep in mind that serum thyroid hormone levels may increase postoperatively. In particular, patients with heart rhythm problems should be monitored after surgical and percutaneous tracheotomy due to the systemic effects of thyroid hormones.<sup>14</sup>

In recent literature, clinical trials or systematic reviews in which alterations of thyroid hormones due to tracheostomy referred to were not detected.

### ***Suggestions for future research***

Regarding the effects of the thyroid gland, such as regulation of basal metabolism, endocrine, cardiac and circulatory systems, the increase in thyroid hormone due to tracheostomy should not be forgotten and should be considered during the procedure.

Because elevated thyroid hormone levels can cause side effects such as cardiac arrhythmias especially in patients with heart

rhythm disturbances, these patients should be observed more carefully during a certain period after tracheostomy.

Tracheostomy is performed mainly in critically ill patients, many of whom do not survive. This makes it difficult to study the long-term complications of tracheostomy. No studies have attempted to identify these complications and study future survivors after tracheostomy. However, data on the frequency, type of tracheostomy, and severity of complications are limited. Further prospective, controlled and randomized studies with strictly defined and standardized criteria will provide further information on the degree of complication and compatibility of existing percutaneous methods.<sup>15</sup>

### ***Suggestions for clinical practice***

Based on the findings of this study, some suggestions should be made for the clinical practice of nurses working with tracheostomy patients.

The most common emergencies are pipe blockage and accidental intubation, but sometimes there may be bleeding from the mouth.<sup>16</sup>

Bleeding may occur early or late as a complication. Early bleeding is usually a result of the procedure. Late bleeding may be due to anonymous artery infection: it is a medical condition.

Nurses should ensure that emergency equipment is available and fully equipped.<sup>17</sup>

There are also a number of international publications on tracheostomy care and management for nonspecialists.

These are important areas because most patients are discharged from intensive care units to rehabilitation centers or at home with tracheotomy and short- or long-term airway management can cause significant stress and burden on carers.

The few publications that have discussed the role of nursing indicate that carers-nurses feel anxious when taking care of traumatized patients and this affects their adequacy.<sup>14</sup>

Training is often recommended for anyone involved in tracheostomy care. Specialized education can boost nursing confidence and in combination with structured education, teaching can be beneficial.

Further investigation is needed to determine the impact of

training on staff practice, confidence and assimilation of the guidelines.<sup>18</sup>

### **Limitations of the study**

Possible limitations of our study may include a small sample of patients as well as access to an ICU in a single hospital. Adverse anatomy has been recognized as a limitation of percutaneous technique in most studies, which reflects current practice and the importance of identifying anatomical landmarks for this procedure.

### **CONCLUSIONS**

As the intervention was implemented for both genders, over 18 years, in patients with a need for prolonged mechanical ventilation, the results indicate that there is no statistically significant relationship between gender and type of tracheotomy. However, in percutaneous tracheostomy there is a greater increase in T3 than in postoperative surgery. Elevated TSH values were observed in surgical tracheostomy with no statistically significant difference.

The findings of the present work may have direct implications in the field of study with patients with tracheostomy. Therefore, the findings of the study should be a matter of concern for nurses and health professionals in general working with patients with tracheostomy, leading to targeted interventions. Therefore, further analysis and comparison of tracheostomy methods in thyroid hormone change is imperative.

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## ANNEX

**Table 1.** Sample distribution by gender, type of tracheotomy and T3, TSH and FT4 measurements (before and after)

Variables		n	%
<b>Gender</b>	Male	49	56,3
	Female	38	43,7
	Percutaneous	45	51,7
	Surgical	42	48,3
		<b>Mean±SD</b>	
<b>T3 ng/ml preoperative measurement</b>		0,61±0,33	
<b>T3 ng/ml postoperative measurement</b>		1,31±4,54	
<b>TSH µiu/ml preoperative measurement</b>		1,59±1,19	
<b>TSH µiu/ml postoperative measurement</b>		2,56±1,44	
<b>FT4 pmol/l preoperative measurement</b>		10,02±2,16	
<b>FT4 pmol/l postoperative measurement</b>		12,67±3,08	

**Table 2.** Evaluation of groups by gender

		<b>Type of tracheotomy</b>		
		Percutaneous	Surgical	
		n (%)	n (%)	p
<b>Gender</b>	Male	27 (60%)	22 (52,4%)	0,474
	Female	18 (40%)	20 (47,6%)	

**Table 3.** Evaluation of the groups according to T3

	<b>T3</b>		
	Percutaneous	Surgical	p
	Mean±SD	Mean±SD	
Preoperative measurement	0,55±0,30	0,68±0,35	0,095
Postoperative measurement	1,64±6,32	0,95±0,36	<b>0,002</b>
p	<b>&lt;0,001</b>	<b>&lt;0,001</b>	

**Table 4.** Evaluation of groups according to TSH.

	<b>TSH</b>		
	Percutaneous	Surgical	p
	Mean±SD	Mean±SD	
Preoperative measurement	1,93±1,29	1,22±0,96	<b>0,003</b>
Postoperative measurement	2,50±1,50	2,63±1,39	0,619
p	<b>&lt;0,001</b>	<b>0,014</b>	

**Table 5.** Evaluation of groups according to FT4.

	<b>FT4</b>		
	Percutaneous	Surgical	p
	Mean±SD	Mean±SD	
Preoperative measurement	9,71±2,07	10,36±2,23	0,161
Postoperative measurement	10,81±2,06	14,67±2,72	<b>&lt;0,001</b>
p	<b>&lt;0,001</b>	<b>&lt;0,001</b>	