

Pharyngeal Bolus Transit During Swallowing Before and Short-Term After Thyroidectomy

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ABSTRACT

Background: Thyroid nodules are common in the population and may be associated with dysphagia. The surgical treatment of these nodules is a risk for lesion of cranial nerves branches with the possibility of swallowing and voice impairment. Dysphagia may be a complaint after the surgery even without nerves lesions. The objective of this investigation was to evaluate the pharyngeal bolus transit before and short-term after surgical treatment of thyroid nodules. **Methods:** Thirty-eight consecutive patients with thyroid nodules had videofluoroscopic evaluation of swallowing timing before the surgery. Dysphagia was a complaint in 20 (53%). In 21 (55%) the nodules were benign. Twenty-seven (71%) were submitted to total thyroidectomy. In 26 the swallow was also evaluated one to five days (median two days) after the surgery. The control group comprised 21 healthy volunteers. In videofluoroscopy patients and volunteers swallowed, in duplicate and random sequence, 5 mL and 10 mL of boluses of two consistencies, moderately thick and

extremely thick. Results: Before the surgery patients had a delay in upper esophageal sphincter opening after the bolus arrived at the sphincter. After the surgery the patients had a shorter swallowing reaction time with 5 mL moderately thick bolus and shorter pharyngeal clearance with 10 mL extremely thick bolus. **Conclusion:** Before thyroid surgery patients with thyroid nodules had a delay in the upper esophageal sphincter opening related to bolus reach the sphincter. Few days after thyroidectomy there is an improvement of pharyngeal clearance of an extremely thick bolus.

Keywords: Deglutition, Deglutition disorders, Thyroid diseases, Thyroidectomy, Pharynx

INTRODUCTION

Thyroid nodules are common in the population, most of which are benign [1-3]. These nodules may impair the swallowing mechanism and cause dysphagia [3-6]. Small thyroid nodules do not cause swallowing disorders, with nodules higher than 3 cm associated with compressive symptoms [3]. The thyroid is anatomically near the larynx, trachea, muscles, and cervical and cranial nerves [7]. Thyroidectomy may cause damage to pharyngeal and laryngeal structures and functions, with the possibility to consequent dysphagia [8], regardless of recurrent or superior laryngeal nerve injury [8,9]. Although dysphagia may be a transient complaint, there is in a few patients the risk of pneumonia and dehydration after thyroidectomy [10].

Results assessed shortly – less than one week – after thyroidectomy to treat patients with thyroid nodules rarely cover the swallowing dynamics. Most post-thyroidectomy evaluations are related to the voice and quality of life and include references to dysphagia one week or more after the surgery [11,12]. Dysphagia is a possible complaint after thyroidectomy [13-15], possibly related to superior and recurrent laryngeal nerves dysfunction. However, it can appear even after uncomplicated thyroidectomy [14,16], with onset soon after thyroidectomy and improvement over time [13,15].

The objective of this investigation was to evaluate, with videofluoroscopy, the bolus transit through the pharynx in patients with thyroid nodules before and shortly – one to five days – after thyroidectomy. The hypothesis was that thyroid nodules and thyroidectomy affect the duration of the pharyngeal transit of the bolus.

MATERIAL AND METHOD

Thirty-eight consecutive patients undergoing surgical treatment of thyroid nodules from 2007 to 2008 were evaluated – 32 women and six men, aged 19 to 73 years, mean 47 (11) years, at the Head and Neck Surgery clinics of the University Hospital of Ribeirão Preto, the tertiary hospital of the Ribeirão Preto Medical School. In 21 (55%), the nodules were benign, and in 17 (45%), they were malign. Twenty-seven (71%) were submitted to total thyroidectomy, while 11 (29%), to partial thyroidectomy. Two patients had cervical dissection. No patients had invasion outside the thyroid. All of them had their swallowing evaluated before the surgery, and 26 after the surgery as well, with laryngoscopy and videofluoroscopy. The videofluoroscopy was performed from one to 15 days (median three days) before the surgery and one to five days (median two days) after the surgery – when the patients had no surgical complications and were receiving oral feeding. Before the thyroid surgery, they had not been submitted to any head and neck or digestive tract surgery, neither had they had vocal fold paralysis, neurologic

or cardiac diseases. The day before and the day after the surgery, the patients were evaluated regarding dysphagia, odynophagia, choking, coughing, and fear to swallow, and their thyroid hormones were quantified.

The control group comprised 21 healthy individuals – 18 women and three men, aged 18 to 74 years, mean 44 (16) years. They had no symptoms, previous head and neck or digestive tract surgery, vocal fold immobility, or neurologic or cardiac diseases. The investigation was approved by the Human Research Committee of the Medical School and University Hospital of Ribeirão Preto (IRB number: HCRP 11466/2006). All the participants signed the informed consent form. The anonymity of the patients was preserved.

The videofluoroscopy was performed with the radiological instrument Arcomax Phillips, model BV 300 (Veenpluis, the Netherlands) and the digital image processing system Ever Focus, model EDSR 100 V1.2 (Taipei, Taiwan) with a DVR (Ever Focus) monitor running 30 frames/second, and a digital clock indicating the time in seconds and the number of frames on each video frame. In the evaluation, each subject was seated on a chair, with their side turned to the image intensifier. Lateral images were obtained from the mouth, pharynx, and proximal esophagus. Both patients and controls swallowed, in duplicate, 5 mL and 10 mL of liquid and paste bolus. The liquid bolus contained barium sulfate 100% (Bariogel® 100%, Cristália Laboratory, Itapira, São Paulo, Brazil), and the paste bolus was prepared with the addition of 3 g of Nutilis thickener (Cuyk Nutricia BV, Cuyk, The Netherlands) to 50 ml liquid barium 100%. The consistency of the liquid bolus was level 3 (moderately thick) and that of the paste bolus was level 4 (extremely thick) in the gravity flow test proposed by the International Dysphagia Diet Standardization Initiative (IDDSI) [17].

The following features were timed: (A) onset of propulsive tongue tip movement at the maxillary incisors, (B) arrival of the leading edge of the bolus at the mandible, (C) arrival of the bolus tail at the mandible, (D) onset and offset of hyoid movement, (E) bolus arrival at the upper esophageal sphincter (UES), (F) onset and offset of UES opening.

The duration of the following movements during swallowing was measured:

1. Oral transit (OT): from tongue tip at incisors to arrival of the bolus tail at the mandible.
2. Pharyngeal transit (PT): from bolus tail at the mandible to the offset of UES opening.
3. Pharyngeal clearance (PC): from the arrival of the leading edge of the bolus at the mandible to the offset of UES opening.
4. Swallowing reaction time (SRT): from the arrival of the leading edge of the bolus at the mandible to the onset of hyoid movement.
5. UES opening (UESO): from the bolus arrival at UES to UES opening onset.
6. UES transit (UEST): time interval between the onset and offset of UES opening.
7. Hyoid movement (HM): time interval between onset and offset of hyoid movement.
8. Oropharyngeal transit (OPT): from tongue tip at incisors to the offset of UES opening.

A linear model with mixed effects was used for statistical analysis [18]. The analyses were performed with the PROC MIXED procedure of SAS 9.0 software. Results are presented as mean and standard deviation (SD), in milliseconds (ms). The significance level was set at 0.05.

RESULTS

All the 38 patients underwent a preoperative evaluation, of whom 26 (68.4%) were also submitted to postoperative evaluation – 19 (72%) had a total thyroidectomy. The other 12 were not evaluated because these patients either did not want to repeat the exam or has already been discharged from the hospital. The mean nodular volume of the largest nodule of each patient, measured with ultrasound, was 22.6 (45.5) cm³. The mean orotracheal intubation time during the surgery was 134.2 (34.7) minutes. The laryngoscopy performed before the surgery did not show any abnormality, while after the surgery one patient had vocal fold immobility.

Before the surgery, 20 patients (53%) had dysphagia, 20 (53%) had choking and coughing instances, and 7 (18%) feared to swallow; none had odynophagia. Short-term after the surgery, 15 patients (58%) had odynophagia, 9 (35%) had dysphagia, 8 (31%) had choking and coughing instances, and 7 (27%) feared to swallow. At the time of the preoperative evaluation, six patients (16%) had increased thyroid hormone levels, while 32 (84%) had normal levels. After the surgery, 18 patients (69%) had increased levels, while 8 (31%) had normal levels. Regarding postoperative complications, one patient developed a hematoma, one developed hypocalcemia, and one had vocal fold immobility.

Patients with thyroid nodules had a delay in the UES opening after the bolus arrived at the sphincter, with 5 mL moderately thick bolus [controls: 70 (70) ms; patients: 130 (260) ms, $p=0.01$, Table 1] and extremely thick bolus [5 mL – controls: 50 (30) ms, patients: 100 (90) ms; 10 mL – controls: 50 (30) ms, patients: 80 (50) ms, $p=0.01$, Table 2]. The pharyngeal clearance of 10 mL extremely thick bolus took longer in patients with thyroid nodules than in controls [controls: 810 (450) ms; patients: 1030 (710) ms, $p=0.01$, Table 2].

After the thyroidectomy, the swallowing reaction time (SRT) with 5 mL moderately thick bolus was shorter [before: 250 (170) ms, after: 210 (270) ms, $p=0.03$, Table 3], the UES transit with 5 mL extremely thick bolus took longer [before: 410 (100) ms, after: 440 (120) ms, $p=0.01$, Table 4], and the pharyngeal clearance with 10 mL extremely thick bolus was shorter [before: 990 (570) ms, after: 830 (350) ms, $p=0.01$, Table 4]. There was no airway aspiration either before or after the surgery.

DISCUSSION

Dysphagia has been reported by 0% to 3% of the patients with thyroid nodules before surgical treatment [8,9]. We found a higher number of patients with dysphagia (53%). Dysphagia as a symptom is highly influenced by cultural variables [19], which may change the frequency of the symptoms in different populations. Swallowing impairment sensation has been reported in 50% of the patients one week after thyroid surgery, and in 36% of them three months after the surgery [9]; swallowing symptoms has been reported in 15% [8], from 22% to 34% of patients one year after the treatment [11], with a significant improvement after one year [12], in 87% of patients with abnormal laryngeal mobility, and in 44% of patients with normal laryngeal mobility seven days after the surgery, with a decrease in frequency 60 days after the thyroidectomy [15]. In this investigation, as swallowing was evaluated sooner after the surgery, the patients had symptoms such as pain, coughing, and swallowing discomfort. The proportion of patients with difficulty swallowing (dysphagia and odynophagia) was high. After the surgery odynophagia was a complaint in 58% of patients.

The results of the videofluoroscopy suggest that patients with thyroid nodules have a delayed UESO response and take longer for the bolus to transit through the pharynx. Both the delay in sphincter response and increase in pharynx clearance time is small. However, they may cause the transit to be perceived when swallowing (especially extremely thick bolus), which is a possible cause of dysphagia. After thyroidectomy there is decrease in upper esophageal sphincter pressure and incoordination [20], early dysphagia, delayed triggering of the swallow reflex and residue in pharynx [21].

No important change in the videofluoroscopic examination of the pharyngeal phase of swallowing was found shortly after the thyroidectomy. The early response of the pharynx to the presence of bolus, decrease in pharyngeal clearance time, and increase in UES transit time do not seem to justify the patients' possible symptoms. In the absence of surgical complications, dysphagia has unclear causes. It can appear early in the postoperative period and is usually transient, being spontaneously solved in the first year [14,16]. Changes in bolus transit perception after swallowing may appear soon after the surgery or days and weeks later. Patients can find it difficult to swallow without any association with changes in transit, as demonstrated in the esophagus [22]. Food stasis in the oropharynx and hypopharynx [15] may be associated with the longer pharyngeal clearance of extremely thick bolus, however it was not found in the videofluoroscopic examinations.

Dysphagia after thyroidectomy may be underreported [23]. Also, the diagnostic methods failed to demonstrate the changes in swallowing that could explain dysphagia [14] – results similar to what was found in this investigation. However, the ultrasound evaluation demonstrated that the laryngotracheal elevation is impaired, which may be the cause of dysphagia, and that the swallowing symptom score was correlated with the length of laryngopharyngeal elevation during swallowing [24].

Aging is a factor that increases the possibility of changes in swallowing after thyroidectomy [25]. Changes in pharyngeal swallowing were seen one week after the surgery, with improvement after three months [13]. Temporal measurements in thyroidectomy patients do not differ over time [13], which suggests that there is no progressive swallowing impairment after the surgery.

This investigation has limitations. Only two volumes of moderately thick and extremely thick bolus were evaluated, and the amplitude of movements was not evaluated. Also, there was no long-term clinical follow-up or videofluoroscopy, which could demonstrate whether any swallowing changes are present after weeks or months and whether the symptoms improve. The sample of patients include benign and malignant diseases, total and partial thyroidectomy that may cause heterogeneity of the patients evaluated. However, the results of oropharyngeal transit were compared in the same individuals before and after the thyroidectomy.

In conclusion, patients with thyroid nodules had a small delay in the UES transit onset and a possible longer pharyngeal clearance with extremely thick bolus. The results suggested that there is no important change in the pharyngeal bolus transit short-term after the thyroidectomy.

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Table 1. Movement and transit time, in milliseconds, in patients with thyroid nodules (n=38) and controls (n=21) after swallowing 5 mL and 10 mL of moderately thick barium. Mean (SD)

	5mL		10mL	
	Controls	Patients	Controls	Patients
OT	570 (270)	600 (370)	560 (290)	620 (400)
PT	410 (130)	440 (140)	410 (130)	410 (100)
PC	680 (260)	740 (270)	700 (150)	770 (350)
SRT	250 (230)	240 (180)	310 (210)	299 (270)
UESO	70 (70)	130 (260)*	70 (70)	100 (230)
UEST	410 (120)	450 (110)	480 (100)	470 (100)
HM	960 (320)	960 (300)	1010 (440)	900 (420)
OPT	1020 (320)	1070 (390)	970 (260)	1030 (430)

OT – Oral transit PT – Pharyngeal transit PC – Pharyngeal clearance SRT – Swallowing reaction time UESO – Bolus at UES to UES transit onset UEST – UES transit duration HM – Hyoid movement OPT – Oral-pharyngeal transit UES: upper esophageal sphincter
*p=0.01 vs controls

Table 2. Movement and transit time, in milliseconds, in patients with thyroid nodules (n=38) and controls (n=21) after swallowing 5mL and 10mL of extremely thick barium. Mean (SD)

	5mL		10mL	
	Controls	Patients	Controls	Patients
OT	900 (860)	860 (610)	820 (640)	890 (770)
PT	440 (120)	500 (460)	440 (130)	530 (490)
PC	800 (690)	880 (470)	810 (450)	1030 (710)*
SRT	230 (140)	250 (220)	280 (230)	380 (1010)
UESO	50 (30)	100 (90)*	50 (30)	80 (50)*
UEST	420 (100)	400 (100)	450 (130)	530 (480)
HM	920 (290)	880 (350)	980 (470)	950 (470)
OPT	1360 (910)	1310 (650)	1270 (630)	1450 (1030)

OT – Oral transit PT – Pharyngeal transit PC – Pharyngeal clearance SRT – Swallowing reaction time UESO – Bolus at UES to UES transit onset UEST – UES transit duration HM – Hyoid movement OPT – Oral-pharyngeal transit UES: upper esophageal sphincter
***p=0.01 vs controls**

Table 3. Movement and transit time, in milliseconds, in patients with thyroid nodules (n=26) before and shortly after thyroidectomy, swallowing 5 mL and 10 mL of moderately thick barium. Mean (SD)

	5mL		10mL	
	Before	After	Before	After
OT	640 (390)	690 (420)	590 (450)	670 (460)
PT	430 (160)	440 (120)	420 (100)	430 (90)
PC	750 (300)	780 (210)	790 (400)	790 (230)
SRT	250 (170)	210 (270)*	260 (230)	240 (130)
UESO	120 (260)	90 (110)	130 (280)	90 (90)
UEST	440 (100)	450 (110)	470 (90)	490 (90)
HM	950 (300)	840 (270)	840 (360)	860 (310)
OPT	1090 (420)	1160 (430)	1010 (440)	1120 (460)

OT – Oral transit PT – Pharyngeal transit PC – Pharyngeal clearance SRT – Swallowing Reaction Time UESO – Bolus at UES to UES transit onset UEST – UES transit duration HM – Hyoid movement OPT – Oral-pharyngeal transit UES: upper esophageal sphincter *p=0.03 vs before

Table 4. Movement and transit time, in milliseconds, in patients with thyroid nodules (n=26) before and shortly after thyroidectomy, swallowing 5mL and 10mL of extremely thick barium.
Mean (SD)

	5mL		10mL	
	Before	After	Before	After
OT	840 (480)	870 (520)	0.93 (0.71)	0.76 (0.48)
PT	460 (160)	460 (110)	0.44 (0.10)	0.45 (0.13)
PC	850 (410)	830 (300)	990 (570)	830 (350)*
SRT	270 (250)	210 (180)	400 (1130)	220 (140)
UESO	90 (90)	80 (60)	90 (60)	80 (60)
UEST	410 (100)	440 (120)*	450 (100)	470 (130)
HM	920 (400)	870 (300)	870 (330)	900 (310)
OPT	1300 (540)	1320 (440)	1400 (0760)	1250 (470)

OT – Oral transit PT – Pharyngeal transit PC – Pharyngeal clearance SRT – Swallowing Reaction Time UESO – Bolus at UES to UES transit onset UEST – UES transit duration HM – Hyoid movement OPT – Oral-pharyngeal transit UES: upper esophageal sphincter *p=0.01 vs before