

# *Near Total x Supracricoid Parcial Laryngectomy: Comparative Analysis of Voice*

## *Near Total x Supracricoid Parcial Laryngectomy: Comparative Analysis of Voice*

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### **RESUMO**

- Introdução:** A laringectomia parcial supracricóideia consiste na remoção de ambas as pregas vocais, cartilagem tireóide e de quase todo o espaço pré-epiglótico, mantendo-se a cartilagem cricoídea, o osso hióide e ao menos uma cartilagem aritenóide a fim de preservar as funções laringeas. A Laringectomia Near Total consiste na ressecção de estruturas laringeas correspondentes àquelas da Laringectomia Total, mas preserva uma pequena parte da cartilagem cricóide e 2/3 de uma das pregas vocais, preservando a inteligibilidade da voz dos pacientes.
- Objetivo:** Comparar as características vocais por meio da avaliação perceptivo-auditiva e acústica de pacientes submetidos à laringectomia near total e laringectomia horizontal supracricóideia.
- Método:** A análise perceptivo-auditiva foi realizada por 3 fonoaudiólogos e incluiu a avaliação dos parâmetros: qualidade vocal classificada de acordo com a Escala GRBAS, inteligibilidade de fala, julgada a partir da Escala Analógico-Visual. A análise acústica foi realizada a partir do programa Multi Dimension Voice Program do qual foram extraídos os valores de frequência fundamental, shimmer, jitter, NHR (noise-to-harmonic ratio) e tempo máximo de fonação.
- Resultados:** Não houve diferença estatisticamente significativa em nenhum dos parâmetros avaliados entre as duas cirurgias. Porém, a laringectomia parcial supracricóideia apresentou melhores resultados quanto à qualidade vocal, inteligibilidade de fala, medidas de perturbação e tempo máximo de fonação. Ambas as cirurgias apresentaram valores de frequência fundamental dentro da normalidade, sendo mais reduzidos no grupo de laringectomia Near Total.
- Conclusão:** Ambas as cirurgias possibilitaram uma qualidade vocal e inteligibilidade de fala favoráveis à comunicação oral, porém estes parâmetros apresentaram-se mais adequados para a laringectomia horizontal supracricóideia.
- Palavras-chave:** neoplasias de cabeça e pescoço, laringectomia, qualidade vocal.

### **SUMMARY**

- Introduction:** The supracricoid partial laryngectomy consists of the removal of both the vocal folds, cartilage thyroid and almost all the pre-epiglottic space, maintaining the cricoid cartilage the hyoid bone and at least an arytenoid cartilage in order to preserve the laryngeal functions. The Near-Total Laryngectomy consists of resection of the laryngeal structures corresponding to those of total laryngectomy but preserves a small part of cricoid cartilage and 2/3 of one of the healthy vocal folds, preserving the intelligibility of the patients' voices.
- Aim:** Compare the vocal characteristics by means of the perception-auditory and acoustics evaluation of submitted patients to the Near-Total Laryngectomy and Supracricoid Partial Laryngectomy.
- Methods:** The perception-auditory analysis was fulfilled by three speech language pathologists and included the evaluation of the parameters: vocal quality classified according to GRBAS scale, speech intelligibility, considered from Visual Analogic Scale. The acoustic analysis was carried through from the Multi Dimension Voice Program of which the values of basic frequency had been extracted, shimmer, jitter, NHR (noise-to-harmonic ratio) and maximum phonation time.
- Results:** There wasn't significant statistical difference in none of the parameters evaluated in the two surgeries. However, the Supracricoid Partial Laryngectomy presented better results due to the vocal quality, speech intelligibility, measures of perturbation and maximum phonation time. Both surgeries presented fundamental frequency values within the normality, been more reduced in the group of Near-Total Laryngectomy.
- Conclusion:** Both surgeries made possible a vocal quality and speech intelligibility favorable to the oral communication, however these parameters were presented more adequate for the Supracricoid Partial Laryngectomy.
- Key words:** head and neck neoplasms, laryngectomy, voice quality.

## INTRODUCTION

Supracricoid Partial Laryngectomy (SCPL) was first presented in Vienna, in 1959, by Meyer and Rieder (1). This surgery consists of the removing of the entire supraglottis, the false and true vocal folds and the thyroid cartilage including the paraglottic and pre-epiglottic spaces. The cricoid cartilage, hyoid bone, and at least one aritenoid are preserved. Phonatory and swallowing functions are maintained by the movement of the spared aritenoid to the tongue base. There are two types of reconstruction techniques: cricothyroidopexy (SCPL-CHP) and cricothyroidoepiglottopexy (SCPL-CHEP). The Near-Total Laryngectomy (NTL) was first used by Pearson in 1981 (2). The resection of the laryngeal structures in NTL, corresponds to those in Total Laryngectomy (TL), but preserves a small part of cricoid cartilage and whole (2/3) of the vocal folds (with respective innervation), preserving the intelligibility of the voice in patients. The advantages of both techniques is the high oncologic control (higher than 80%) with the maintenance of the laryngeal functions in 95 % (3). Other studies indicate

acoustic, temporal and perceptive results away from the standard of normality. However, both surgeries showed good results in this study, specially for the speech intelligibility (4, 5, 6, 3, 7). It couldnt be found in literature a temporal acoustic and perceptive comparison between NTL and SCPL. It was only found between NTL and TL (Total Laryngectomy) or a comparison with hemilaryngectomy (8). In the presence of this data the aim of this study was to compare acoustic analysis of voice production in patients after NTL and SCPL.

## PATIENTS AND METHODS

Twenty-eight patients were prospectively reviewed to assess voice parameters. There were 25 men of about average of 60 years old ( $57.8 \pm 10.8$  years). Of all, 16 underwent a SCPL with CHEP and 9 underwent a NTL. All of them were operated in the Department Phonoaudiology of the Instituto do Cancer Arnaldo Vieira de Carvalho, Sao Paulo - Brazil (Table 1). All the patients were undergone a speech treatment in a minimum period of one year.

**Tabela 1.** Distribution of the participants according to sex, age, surgery, TNM, neck dissection (EC), radiotherapy RxT, speech therapy.

Patient	Sex	Age (years)	Type of Surgery	Time of Surgery (years and months)	TNM	EC	RxT	Speech Therapy
1	M	72	NTL	2 years e 4 months	T4N0M0	YES	NO	YES
2	M	56	NTL	1 year e month	T2N2CM0	YES	YES	YES
3	M	71	NTL	1 year e 5 months	T4N1M0	YES	NO	YES
4	M	46	NTL	2 months	T4N2M0	YES	YES	YES
5	M	52	NTL	1 month	T4N2BM0	YES	YES	YES
6	M	47	NTL	2 years e 1 month	T4N2BM0	YES	YES	YES
7	M	70	NTL	1 year e 3 months	T4N0M0	YES	YES	YES
8	M	65	NTL	1 year e 3 months	T4N0M0	YES	YES	YES
9	M	54	NTL	1 year e 2 months	T4N3M0	YES	YES	YES
10	M	53	SCPL CHEP	3 years e 9 months	T2N0M0	NO	NO	YES
11	M	50	SCPL CHEP	1 year e 10 months	T2N0M0	YES	YES	YES
12	M	53	SCPL CHEP	7 years e 4 months	T2N0M0	NO	NO	YES
13	M	69	SCPL CHEP	4 years	T1N0M0	NO	NO	YES
14	M	48	SCPL CHEP	3 months	T2N0M0	YES	NO	YES
15	M	36	SCPL CHEP	11 months	T1N0M0	NO	NO	YES
16	M	78	SCPL CHEP	1 month	T1N0M0	NO	NO	YES
17	M	71	SCPL CHEP	7 years e 3 months	T2N0M0	YES	NO	YES
18	M	66	SCPL CHEP	2 years e 8 months	T1N0M0	NO	NO	YES
19	M	67	SCPL CHEP	5 years e 4 months	T2N0M0	NO	NO	YES
20	M	59	SCPL CHEP	1 year	T1N0M0	NO	NO	YES
21	M	43	SCPL CHEP	1 year e 1 month	T3N0M0	YES	NO	YES
22	M	51	SCPL CHEP	9 months	T1N0M0	NO	NO	YES
23	M	63	SCPL CHEP	5 years	T1N0M0	NO	NO	YES
24	M	50	SCPL CHEP	3 months	T1N0M0	NO	NO	YES
25	M	55	SCPL CHEP	4 months	T2N0M0	NO	NO	YES
26	F	55	SCPL CHEP	11 months	T3N0M0	YES	YES	YES
27	F	48	SCPL CHEP	1 year e 4 months	T2N0M0	NO	NO	YES
28	F	69	SCPL CHEP	8 months	T2N0M0	YES	NO	YES

The other treatments like radiotherapy and chemotherapy could not be considered as criteria for inclusion or exclusion, as well as the frequency during the speech treatment. In this project, patients with previously neurologic alterations or fluency alterations were excluded.

The Institutional Ethics Committee gave scientific and ethical approval without restrictions (073/04) and the subjects written informed that consent was obtained, after explanation of the general nature of this study.

The patients were submitted to a questionnaire that included: patients identification, type of surgery (Near-Total, Supracricoid with CHP or CHEP), clinical staging of laryngeal cancer and other complementary treatments (radiotherapy and / or chemotherapy post-surgery and speech therapy). All patients were submitted to a perceptive temporal and acoustic assessment.

### **Voice Perception Analysis**

The patients voices were recorded in a special silent room with the MDVP (model CSL 4300B from Kay Elemetrics). Each patient stood 15 cm distant from the microphone (Shure SM 48). It was used 10-s of spontaneous conversation based on Boston's test figure (9) for vocal quality and speech intelligibility judgement.

The samples from all patients recordings were assessed by three speech-language pathologists experts in the care of patients with head and neck cancer. The voices recordings were assessed according to G (global); R (roughness); B (breath voice); A (asthenia); and S (strain), GRBAS scale criteria (10). For each criterium and each sample, valuers should judge with a score ranging from 0 (normal) to 3 (severe).

For the analysis of speech intelligibility it was used the Visual Analogic Scale, that presents a scale of punctuation (ranging from 0 to 10), where high values indicates great speech intelligibility, and lower values indicate a deficient intelligibility. The voice samples from each patient were presented at random in a way that the listeners were unaware of the type of surgery that the patients were undergone.

The voice material consisted of pieces of approximately three seconds of the most stable portion of the sustained vowel /a/.

### **Acoustic and Speech Aerodynamic Testing**

Acoustic analysis was carried out using the vowel

/a/. The computerized program Multi Dimension Voice (MDVP) of Kay Elemetrics (model 4300B) was used for acoustic analysis. The following measures were obtained from each patient:

- 1) Fundamental Frequency;
- 2) Jitter: Jitter Percentage (JITT), Frequency Period Perturbation Quocient (PPQ);
- 3) Shimmer: Shimmer Percentage (Shim), Amplitude Perturbation Quocient (APQ), and
- 4) Noise-to-Harmonic Ratio (NHR).

The Maximum Phonation Time (MPT) was extrated from the sustained vowel /a/, in just one expiration, during a three time measure, using the higher value.

Student t and Mann-Whitneys tests were applied to compare averages when appropriate. The agreement among observers was evaluated by means of Kappa coeficient. In order to verify the association among categorical variables were applied the chi-square and likelihood ratio tests. P-values < 0.05 were considered meaningful.

## **RESULTS**

In this report, both groups showed almost same average age, NTL = 59.2 ± 10.4 years old and SCPL = 57.0 ± 11.2 years old (p= 0.631 for the student test).

### **Concordance Values**

In the analysis concordance among the three speech language pathologists for the inquiries: global, roughness, breath voice, asthenia, strain, instability, pitch, loudness and intelligibility showed meaninful concordance between valuers 2 and 3 for the inquiries: pitch, loudness and intelligibility. Between valuers 1 and 3 it was observed agreement for strain and global. It couldnt have any concordance for asthenia, instability, roughness, and breath voice among the valuers (Table 2).

### **Perceptual Analysis**

#### **Voice Perceptive Analysis X Surgery**

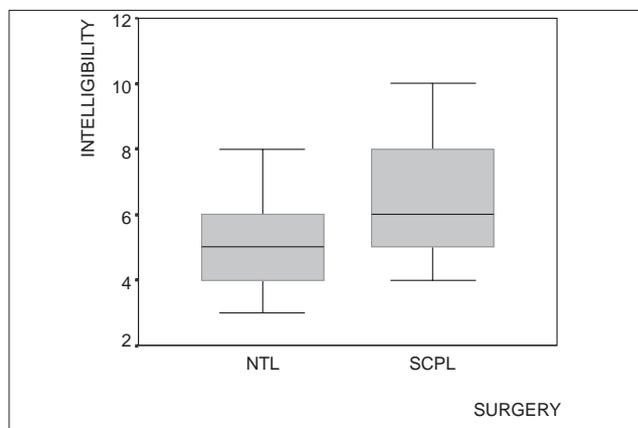
The NTL group of patients presented worse general degree of speech quality than SCPL group of patients. This comparison was not statistically meaningful (p=0.754). according to the general degree of vocal quality the LNT group presented worse results compared to the LCPL group.

**Table 2.** Concordance between the 3 judges (2 to 2): kappa coefficient.

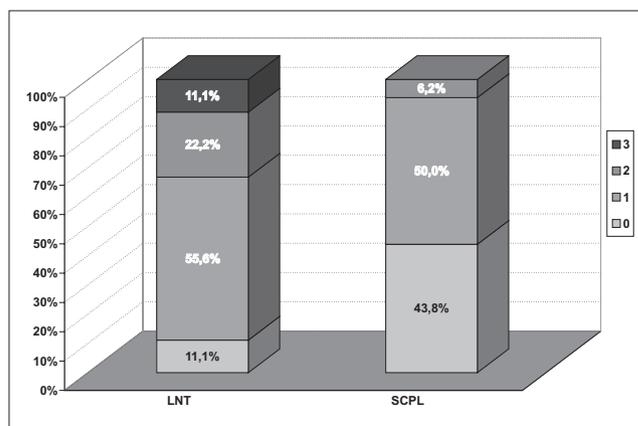
VARIABLE	Kappa	p
<b>Pitch</b>		
Av1 -Av2	0,29	0,070
Av1 -Av3	0,44	0,011
Av2-Av3	0,89	< 0,001*
<b>Loudness</b>		
Av1 -Av2	0,30	0,033
Av1 -Av3	0,38	0,003
Av2-Av3	0,46	0,007*
<b>Intelligibility</b>		
Av1 -Av2	0,07	0,125
Av1 -Av3	0,11	0,067
Av2-Av3	0,14	0,041*
<b>Asthenia</b>		
Av1 -Av2	-0,11	0,743
Av1 -Av3	0	-
Av2-Av3	0	-
<b>Strain</b>		
Av1 -Av2	0,04	0,387
Av1 -Av3	0,35	0,005*
Av2-Av3	0,16	0,125
<b>Instability</b>		
Av1 -Av2	0,09	0,196
Av1 -Av3	- 0,02	0,588
Av2-Av3	0,18	0,104
<b>Global Degree</b>		
Av1 -Av2	-0,01	0,530
Av1 -Av3	0,29	0,015*
Av2-Av3	0,15	0,11
<b>Roughness (hoarse)</b>		
Av1 -Av2	-0,03	0,661
Av1 -Av3	-0,05	0,679
Av2-Av3	-0,10	0,830
<b>Breathness</b>		
Av1 -Av2	0,19	0,061
Av1 -Av3	0,08	0,209
Av2-Av3	-0,04	0,673

\* higher concordance between judges

According to the intelligibility, values 2 and 3 agreed the most in NTL group. The average was 5, and in SCPL it was 6, in such case, the values were statistically meaningful (p=0.021). Due to this results the SCPL group



**Picture 1.** Schematic representation (Box-plot) for intelligibility results in both surgeries.



**Picture 2.** Strain X Surgery.

presented greater intelligibility than the NTL group (Picture 1).

There were predominance of low pitch for SCPL (56.3%) and high pitch for NTL (66.7%) (p= 0.207). For loudness query, the NTL (77.8%) presented adequated loudness values higher than SCPL (62.5 %) (p=0.266).

The NTL presented degrees 0, 1, 2 and 3 for strain compared to SCPL that presented degrees 0, 1 and 2 for strain. Both surgeries presented higher values for degree 1 (p=0.012) (Picture 2).

**Multiparametric Analysis**

In acoustic analysis the average fundamental frequency found for vowel /a/ was 120 Hz for NTL and 141.6 Hz for SCPL (p= 0.343). Referring to the results of shimmer, jitter, APQ, PPQ and NHR, in NTL group. It was

**Table 3.** Comparison between the objective variables in both surgeries.

Variable	NTL		SCPL		p
	(average $\pm$ SD)		(average $\pm$ SD)		
Fo (Hz)	120,6 $\pm$ 41,7	(69,4 - 199,3)	141,6 $\pm$ 57,0	(76,4 - 243,4)	0,343
Jitter (%)	9,6 $\pm$ 6,0	(1,7 - 18,4)	7,8 $\pm$ 6,1	(1,2 - 19,7)	0,491
PPQ (%)	6,9 $\pm$ 4,0	(1,1 - 13,1)	4,9 $\pm$ 3,9	(0,7 - 12,3)	0,242
Shimmer (%)	19,1 $\pm$ 4,1	(12,6 - 26,5)	18,8 $\pm$ 11,1	(5,6 - 50,6)	0,941
APQ (%)	13,9 $\pm$ 3,1	(8,2 - 18,7)	12,3 $\pm$ 5,2	(4,8 - 22,0)	0,419
NHR (dB)	0,57 $\pm$ 0,22	(0,3 - 0,9)	0,52 $\pm$ 0,28	(0,1 - 1,1)	0,639
MPT (s)	9,6 $\pm$ 3,8	(4,0 - 14,0)	11,8 $\pm$ 6,3	(4,0 - 30,0)	0,339

**p:** value for *t* Student's test; **NTL:** *Near Total laryngectomy*; **SCPL:** *Supracricoid partial laryngectomy*; **SD:** *Standard Deviation*; **Hz:** *Hertz*; **s:** *seconds*, **MPT:** *maximum phonation time*.

obtained higher values for LNT than for LHSC. This comparison was not statistically meaningful (Table 3).

The MPT (maximum phonation time) values were 9.6 sec for NTL and 11.8 sec for SCPL ( $p= 0.339$ ). As for fundamental frequency or MPT it was observed bigger values for SCPL, however these results were not statistically meaningful either.

## DISCUSSION

Normally, the vocal quality suffers great impact after the resections of the larynx. In this research, the SCPL presented predominant hoarse, breath voice and instable vocal quality while NTL has predominance of strain vocal quality.

Although this difference was not statistically meaningful, probably due to the size of the sample, it could have occurred because most of the patients submitted to the Near-Total Laryngectomy had undergone radiotherapy and neck dissection, being that, such facts had occurred with minor frequency in the other group. Literature describes (4) that radiotherapy associated with neck dissection can reduce the mobility and the vibration of the remaining structures, and consequently generate a more strain vocal quality.

MAKIEFF and ZACHAREK (3, 11) evidenced from the moderate to severe breath-hoarse vocal quality ratings rendered for all of the patients submitted to the SPCL. According to literature (7), NTL presents predominantly hoarse vocal quality, but some patients presented vocal variations.

Comparing both groups, it could be observed greater strain and worse global degree in NTL. Patients undergone to SPCL presented predominance for low pitch and for NTL, a high pitch. Both surgeries resulted in adequate loudness, so it can be concluded that both surgery technics with speech therapy warrant a good shut of the remaining structures.

This research demonstrated that both surgery technics promoted adequate speech intelligibility. SCPL group presented better results than NTL group.

According to the literature (4, 5, 6) the listeners tend to fulfill the assessment of speech intelligibility influenced many times by speech quality, speech rhythm and loudness. This way, it can infer that listeners of this report have tendency to classify speech intelligibility for NTL group with reduced scores due to the strain vocal quality presented by these patients. In contrast, hoarse vocal quality associated to a high pitch, that was detected in this work, in patients submitted to the SPCL, the literature has pointed it as a voice of great social acceptance. (12).

During this research, higher values were found for the average fundamental frequency of sustained vowel /a/ in SPCL (141.6 Hz) when compared to NTL group (120.6 hz), without statistical significance. A previous study found in SCPL fundamental frequency with values like 150 Hz (4). Premalatha (8) reported values for NTL as 96.04 Hz for fundamental frequency. Infante (13), reported high values for fundamental frequency in NTL, when compared with normality.

The Jitter, APQ and NHR sustained vowel /a/

presented higher values for NTL, without statistical significance. Laccourreye (14) reported values for NTL: Jitter - 6.82 %, Shimmer - 19.84% and NHR - 0.66 %. Literature has demonstrated that high values for fundamental frequency (f0) and for acoustic parameters are related to the strain and vibrant tissue reduction (4). One more time to emphasize consequences of radiotherapy is that the hardness of the tissues can result of a lesser quantity of the vibrant tissue. Besides that, the neck dissection is more aggressive in NTL than in SCPL turning the region into a more rigid one.

In this research, the acoustic values for Jitter, Shimmer, PPQ, APQ and NHR showed alterations compared to the normality for both groups. On the other hand, the fundamental frequency acoustic parameter was found within the normality standard for both surgery techniques.

In relation to MPT, SCPL presented higher values compared to NTL. According to the literature, SCPL shows 17 sec while MPT and NTL presents 6.7 sec (5.8). This difference might be related to the inefficient shutting of the stoma for NTL patients, as both used pulmonary air flow. Maximum phonation time was, on average, half of the time of normal laryngeal speakers, due to excessive transglottal airflow.

It was observed through this study a low level of concordance among the 3 valuers. Valuers 2 and 3 agreed for pitch, loudness and intelligibility and the valuers 1 and 3 agreed for strain and global.

KREIMAN et al (15) observed that listeners with bigger experience in voice have a great variability in the perception of pathological voices, while lay listeners who are not exposed to pathologic voices, consider them with the same strategy used for normal voices. So lay listeners present less variability in pathologic voice analysis. Authors attributed this variability to the previous experience of the valuers. The authors concluded that perfect agreement and reliability are not achieved, not even from a theoretical viewpoint. The valuers that contributed for this report, demonstrated low concordance, valuers 2 and 3 showed concordance with pitch, loudness and intelligibility, and valuers 1 and 3 with strain and global score.

The main limitations of our study had been in relation to the reduced number of patients for each type of surgery; heterogeneity among the groups (surgery time, radiotherapy treatment). This way, we stand out the need of more studies with bigger samples for truly detect statistically if there is difference between the surgeries or if both promote the same vocal impact.

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## CONCLUSION

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In this present research it is not presented any statistical difference in the vocal parameters studied in spite the vocal behavior between the surgeries. The SCPL presented better results for speech intelligibility and for vocal quality and perturbation measure when compared to the NTL.

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## ANEXO A

INSTITUTO DO CÂNCER ARNALDO VIEIRA DE CARVALHO  
SERVIÇO DE FONOAUDIOLOGIA  
TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

O Câncer tumor maligno de cabeça e pescoço é muito comum em pessoas que bebem e fumam por muito tempo. O tratamento para estes tumores é realizado por meio de cirurgia, radioterapia e quimioterapia ou ambos associados. Nessas cirurgias pode haver retirado de todos ou parte da laringe.

Tanto a laringectomia parcial supracricóidea quanto a laringectomia near total, gerando modificações na voz como a rouquidão. Por este motivo, você está sendo convidado a participar de um estudo para avaliar sua voz (análise acústica e auditiva da voz). Para isso, você falará 3 vogais /a/, /i/ e /u/ que serão gravadas em um computador. A avaliação será realizada por três fonoaudiólogos especialistas nesta área.

Os resultados obtidos serão identificados por códigos formado por números e letras e, portanto, sua privacidade e identidade serão preservadas. A eventual inclusão dos resultados em publicação científica será feita de modo a manter o seu anonimato.

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Você receberá uma cópia deste documento e o original será arquivado em seu prontuário.

Caso você tenha questões a fazer sobre este acordo ou alguma dúvida que não tenha sido esclarecida pelo seu fonoaudiólogo, por gentileza, entre em contato com a Comissão de Ética.

Assinatura do (a) paciente ou Representante Legal: \_\_\_\_\_

Nome do (a) paciente: \_\_\_\_\_

RG do Prontuário Médico: \_\_\_\_\_

Fonoaudiólogo Responsável: \_\_\_\_\_