Laryngopharyngeal Reflux (LPR) Correlation to Middle Ear Disorders

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Abstract

Laryngopharyngeal reflux (LPR) is a condition where the reflux of gastric contents reaches the laryngopharynx. Several studies have learned that LPR can cause disturbances in the organs around the larynx pharynx and one of the organs affected is the ear. LPR complications in the middle ear can reduce the quality of life of sufferers. Appropriate diagnostic methods are needed to provide appropriate therapy for this complication. To analyze the relationship between Laryngopharyngeal Reflux (LPR) and middle ear disorders. This study was an analytic observational study using a purposive sampling approach where the assessment of correlation tests between variables was tested with SPSS. Results: Demographic data of LPR patients are dominated by female gender (56%) with an age range of 19 - 59 years (80%). The maximum Reflux Symptom Index (RSI) score in LPR patients is 33 and the maximum Reflux Finding Score (RFS) score in LPR patients is 25. An abnormal Tympanogram Width (Tw) picture was found in 64% of LPR patients. Abnormal compliance picture was found in 36% of patients with LPR and abnormal middle ear pressure picture occurred in 12% of patients with LPR. Abnormal middle ear disorders were found in 88% of patients with LPR. Correlation test assessment between RSI score and Tw parameter and correlation between RFS score and middle ear pressure. There was a positive correlation between LPR and middle ear disorders. There is a positive correlation between LPR and middle ear disorders.

Keywords: Middle Ear Disorders; Laryngoesophageal Reflux; LPR; Tympanogram Width.

INTRODUCTION

Laryngopharyngeal reflux (LPR) is a condition where the reflux of gastric juices consisting of gastric acid, pepsin, bile and trypsin reaches the laryngopharynx. LPR is a complex condition that involves reflex and reflux mechanisms but a clear understanding of its pathophysiological mechanisms is still unclear. (Rosen, 2023) The majority of symptoms complained of in patients with LPR are hoarseness and a feeling of blockage in the throat. (Brown et al., 2025)

According to epidemiological data from 1991, a study conducted by Shuifang Xiao et al, 10% of outpatients at the ENT clinic showed that symptoms associated with LPR. (Xiao et al., 2020). In 2007, a study with a questionnaire method conducted by Connor et al. showed symptoms in the throat due to reflux reached 26.9% of all cases in the ENT field. In addition, an epidemiological study conducted in China found an increase in LPR cases in the outpatient clinic, which reached 10.5% of the total ENT cases. (Lechien et al., 2024)

Several studies have learned that LPR can cause disturbances in the organs around the larynx pharynx and one of the organs affected is the ear. (Rosen, 2023) Chronic inflammatory conditions that can be caused by LPR can cause disorders of the middle ear. Tympanometry examination is one of the main supporting examinations to evaluate middle ear function.

Studies on the relationship between LPR and middle ear disorders are still very limited. Considering the high number of LPR cases that occur and its complications in the middle ear that can reduce the quality of life of sufferers, researchers feel the need to conduct a study of the effect of LPR on middle ear disorders which is useful as a diagnostic consideration in order to provide appropriate therapy.

MATERIALS AND METHODS

Study design

This study is an analytical observational study using a purposive sampling approach. The research was conducted at the Ear, Nose and Throat (ENT) Clinic at Dr. Saiful Anwar Hospital in the period 1st January 2024 – 30th August 2024. The study population was all patients who came for treatment at the ENT Clinic at Dr. Saiful Anwar Hospital during the study period. The subjects involved in the study were all patients who suffered from LPR and did not suffer from LPR who

could undergo tympanometry examination at the ENT Clinic at Dr. Saiful Anwar Hospital during the study period. Patients were declared to have LPR if the results of the RSI score were > 13 based on symptom history, RFS score> 7 based on the results of the examination using Fiberlaryngoscopy (FOL) at the ENT Clinic at Saiful Anwar Hospital. Patients were declared to suffer from middle ear disorders if the tympanogram results showed abnormal results in one of the variables studied.

Population and sample
The subjects involved in the study were all patients who suffered from LPR and did not suffer from LPR who could do tympanometry examination at the ENT Clinic at Dr. Saiful Anwar Hospital for the period 1st January 2024- 30 th August 2024.

Data collection
The inclusion criteria for this study were patients who met the LPR criteria, were > 18 years of age at the time of the examination and could be subjected to FOL examination and tympanometry examination within the study time period. Patients with medical record data recorded completely and clearly. The control inclusion criteria in this study were patients with RSI scores and RFS scores that did not meet the diagnostic criteria for LPR. Exclusion criteria in this study are patients with comorbidities that can cause middle ear disorders such as upper respiratory tract infections in the last 1 month, have a history of surgery on the head and neck, a history of malignancy, allergies or asthma. Patients who have received therapy that can affect the results of research such as anti-reflux (Proton Pump Inhibitors / PPIs or antihistamines), decongestants or steroids. Patients whose FOL or tympanometry examination was performed outside Saiful Anwar Hospital

Data analysis
The data is processed using the SPSS 25.0 application. The correlation assessment on both research variables was carried out by testing the normality of the data with the Shapiro Wilk normality test method. If the result is > 0.05 then the data is normal, otherwise if the test value is <0.05 then the data is said to be abnormal. After going through the data normality test, the correlation assessment of the two variables (numeric-numeric) can be done with the Pearson Product Moment test if both variables have normal normality test results, while for variables that have abnormal normality test results, the correlation test that can be used is the Spearman Rank test. If the result is > 0.05 there is no correlation between variables. The other test we used in this study was the Chi Square test to find the relationship between LPR and middle ear disorders. The test value gives a value of 0.00 which if <0.05 means that the two variables in the study are correlated.

Ethical statement
This study followed the ethical principles of the Declaration of Helsinki, Belmont Report. Dr. Saiful Anwar General Hospital Ethics Committee reviewed and approved the research protocol on November 11th, 2024, with reference number [400 / 335 / K.3 / 102.7 / 2024]. The hospital ethics committee approved this study due to its use of hospital medical records. Before participation, all respondents were provided with complete information regarding the purpose of the study, procedures, potential risks, and possible benefits. Participation in this study is voluntary, and participants have the right to withdraw from the study at any time without any consequences. The medical information obtained during this study is kept confidential and is only used for research purposes. All data is stored and anonymized in accordance with established data security protocols.

Patient Characteristics
Medical record data collection was carried out using purposive sampling method with a total sample size of 44 patients where 25 patients met the inclusion criteria for research subjects with LPR and 19 patients as control subjects. Of the total respondents with LPR, female patients (53%) were more dominant than male patients (47%). In the research sample, the youngest age was 28 years old with the majority of respondents with LPR aged 19 - 59 years, which is 80% of the total research sample. According to this study, the maximum RSI score value was 33 and the minimum RSI score value was 14. The mean value of the RSI score in this study was 21.76 with a standard deviation of 5.56. The mean RFS score in this study was 16.92 with a standard deviation of 5.57 (Table S1).

The image of the middle ear in this study was evaluated using tympanometry and presented in tabular form (Table S2.). In this study an abnormal compliance picture was found in 36% of the total respondents with LPR. The picture of abnormal middle ear pressure was found in 3 respondents from the total respondents. The picture of abnormal Tympanogram Width or Tw which shows disturbances in the middle ear occurs in more than 50% of the research sample, namely in 16 research samples. In this study, the prevalence of middle ear disorders in LPR patients was found to be 22 (88%) of 25 total research samples.

The correlation test results in this study found a relationship between the RSI score and Tw with a Correlation Coefficient value of 0.502. (Table S3). In addition, this study found a relationship between RFS scores and middle ear pressure images based on tympanograms. Based on the Spearman correlation test on the RFS score on middle ear pressure, there was a correlation with a Correlation Coefficient value of 0.028. (Table S4). Spearman's correlation test on RFS score to middle ear pressure obtained correlation results with a Correlation Coefficient value of 0.440 where the

correlation results are included in the moderate correlation category. This study did not find a correlation between RSI scores on compliance and middle ear pressure. In addition, this study also did not find a correlation between RFS scores on Tw and middle ear compliance. (Table S5-S8)

The relationship between LPR and middle ear disorders was tested using the Chi Square test by first conducting a normality test on the data to be tested. The test value gave a value of 0.00 which if <0.05 means that the two variables in the study are correlated (Table S9,S10). The magnitude of the correlation strength of the two variables is attached in table S6 where the value on the Contingency Coefficient is 0.657 where according to Sugiyono et al. (Table S11) this value is included in the strong correlation category.

DISCUSSION

The results of this study indicate that the female gender is more dominant in experiencing LPR compared to men. The findings of this study are in accordance with research conducted by Ida Ayu, et al. where in prevalence the female sex experiences LPR more often than men. (Widiantari et al., 2019) In addition, research conducted by Fengling, et al. also found that women experience LPR more often than men. Some factors that can influence the relationship between LPR and hormone regulation in women. (Huang et al., 2022) where the hormones estrogen and progesterone are suspected to cause an increase in nitric oxide (NO) synthesis which causes a decrease in smooth muscle tone because it has a muscle relaxing effect. This leads to decreased contraction of the oesophageal sphincter, increasing the risk of reflux. (Saleh et al., 2023)

The age of LPR sufferers is dominated by productive age, namely with the age range of 19-59 years in this study. This is in accordance with research conducted by Lechien J, et al. who found that the average patient was 40 years old where the first episode may begin at a young age as acute symptoms then recur into chronic symptoms. However, because the symptoms of LPR are often not typical, assessing the prevalence of LPR is quite difficult. (Saleh et al., 2023)

The high rate of middle ear disorders in patients with LPR in this study indicates that organ damage caused by LPR is not limited to the laryngeal pharyngeal organs but can also have an impact on surrounding organs, one of which is the ear. Eustachian tube disorders caused by chronic reflux cause middle ear disorders. Middle ear disorders can begin with inflammation of the tympanic cavity mucosa until the formation of secretions in the middle ear. The condition where sterile fluid forms in the tympanic cavum with an intact tympanic membrane is called Otitis Media Effusion (OME). (Lechien, 2022)

One of the tympanometric parameters that is rarely used in assessing the condition of the middle ear is Tw. It is known that the Tw parameter has a high sensitivity and sensitivity value of 90% and 91% as an early predictor of middle ear disorders so that it can be considered for use in identifying middle ear disorders. The Tw assessment itself can identify in quantity the widening of the tympanogram curve which indicates the presence of early phase middle ear disorders before the occurrence of more severe conditions such as the formation of effusion fluid in the tympanic cavum. The wider the Tw result, the greater the likelihood of middle ear effusion. (Zakaria et al., 2020)

This study found a positive correlation between RSI score and Tw parameter on tympanometry examination. The results of this study indicate that the relationship between RSI score and Tw as one of the initial parameters of middle ear disorders can be considered. The use of Tw assessment as one of the parameters in detecting the early phase of middle ear disorders is often not done because Tw results are not automatically measured by the tympanogram tool. (Flood, 2016) To date, there are no similar studies that specifically assess the relationship between LPR and Tw parameters.

The study showed a positive correlation between RFS score and middle ear pressure with a moderate category. This may be due to the fact that in patients with RFS scores > 7, there have been changes in the anatomical structure of the laryngopharynx and surrounding organs, one of which is the Eustacian tube. Tubal dysfunction can cause a decrease in middle ear pressure where the tympanogram results in a pressure < -100 daPa. (Flood, 2016)

Based on the results of the correlation test conducted in this study, a strong correlation was found between LPR and middle ear disorders. The test results mean that if a patient has LPR, they have a risk of developing middle ear disorders as an extralaryngeal complication of LPR disease. The results of this study are in accordance with research conducted by Zhen, et al. where the study found that patients with high RSI scores showed tubotympanometry results that lead to middle ear disorders. (Karyanta et al., 2019) The results of this study further support the hypothesis that LPR can cause middle ear disorders.

The mechanism of middle ear disorders is most likely due to dysfunction in the euthanized tube caused by reflux of gastric contents. In a study conducted by Pang et al., saw that in patients with LPR there was a disturbance of acid-base balance in the middle ear due to reflux material that reached the middle ear organs. (Pang et al., 2020) In addition, due to the complexity of reflux material in LPR, it causes inflammation of the mucosa lining the Eustachian tube and middle ear. The inflammatory reaction causes obstruction of the tube resulting in impaired fluid drainage in the middle ear. Another factor that can cause reflux in the middle ear is anatomical factors, where anatomically, there is no resistance that can stop the influx of fluid from the laryngopharyngeal organs to the Eustachian tube so that

the spread of reflux material is more likely to occur. (Brar et al., 2022)

Seeing the correlation between LPR and middle ear disorders in LPR patients, the results of this study can be taken into consideration in the management of patients with impaired tubal function or OME who do not respond to definitive therapy. (Han et al., 2018) In a case study conducted by Joanna, et al. where the study evaluated the effectiveness of PPI therapy for 4 - 8 weeks in children with OME compared to placebo. This study saw clinical and symptomatic improvement in OME patients who were given PPI therapy. However, other risk factors for OME should be considered further. (Hanrahan et al., 2024)

Some of the limitations in this study are the limited number of research samples for which correlation tests were carried out so that an assessment of the magnitude of the influence of the two variables could not be carried out. Another weakness of this study is that the researchers excluded patients with ear disorders in the selection of research subjects, where there is still a possibility that the ear disorders are caused by the chronic LPR disease process. Some research suggestions that can be considered to overcome the limitations in this study are data collection with a longer duration so that the number of research samples is larger, confirming the diagnosis of LPR by using objective support examinations such as 24 hour dual probe pH monitoring, using other parameters in detecting disorders of the Eustachian tube such as Eustachian Tube Function (ETF) examination.

CONCLUSIONS

There is a correlation between the RSI score and the tympanometric parameter Tympanogram Width (Tw) and there is a correlation between the RFS score and middle ear pressure. This study observed a strong positive correlation between LPR and middle ear disorders.

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Competing Interests: The authors declare that there are no competing interests

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Table S1. Characteristics of LPR patients with middle ear disorders at ENT Clinic Saiful Anwar Hospital on January 2024-August 2024.

Characteristics	Minimum Score	Maximum Score	Average Score
RSI score	14	33	21.76 ± 5.56
RFS score	8	25	16.92 ± 5.57
Middle Ear Compliance	0.15	1.9	0.76 ± 0.56
Middle Ear Pressure	- 180	2	-43.20 ± 50.17
Tympanogram Width	56	400	166.88 ± 76.42

Table S2. Middle Ear Characteristic in LPR patients based on Tympanometry examination at the ENT Clinic Saiful Anwar Hospital on January 2024-August 2024.

Variables	Right Ear		Left Ear	
Middle Ear Compliance	**n**	**%**	**n**	**%**
< 0.3	9	36	8	32
0.3 - 1.6	14	56	16	64
>1.6	2	8	1	4
Total	25	100	25	100
Middle Ear Pressure	**n**	**%**	**n**	**%**
< -100	2	8	3	12
> - 100	23	92	22	13
Total	25	100	25	100
Tympanogram Width (Tw)	**n**	**%**	**n**	**%**
> 114	16	64	16	64
51-114	9	36	9	36
Total	25	100	25	100
Middle Ear Disease	**n**		**%**	
Yes	22		88	
No	3		22	
Total	25		100	

Table S3. Spearman Correlation Test of Reflux Symptom Index (RSI) score and Tympanogram Width (Tw) Middle Ear.

Correlations			RSI	Tympanogram Width
Spearman's rho	RSI	Correlation Coefficient	1,000	.502 [*]
		Sig. (2-tailed)	.	.011
		N	25	25
	Tympanogram Width	Correlation Coefficient	.502 [*]	1,000
		Sig. (2-tailed)	.011	.
		N	25	25

Table S4. Spearman Correlation Test of Reflux Finding Score (RFS) and Middle Ear Pressure.

Correlations			RSI	Pressure ear middle
Spearman's rho	RSI Score	Correlation Coefficient	1,000	.440 [*]
		Sig. (2-tailed)	.	.028
		N	25	25
	Pressure Middle Ear	Correlation Coefficient	.440 [*]	1,000
		Sig. (2-tailed)	.028	.
		N	25	25

Table S5. Spearman Correlation Test of Reflux Symptom Index (RSI) score and Middle Ear Pressure.

Correlations			RSI	Pressure ear middle
Spearman's rho	RSI Score	Correlation Coefficient	1,000	-.121
		Sig. (2-tailed)	.	.564
		N	25	25
	Pressure ear middle	Correlation Coefficient	-.121	1,000
		Sig. (2-tailed)	.564	.
		N	25	25

Table S6. Spearman Correlation Test of Reflux Symptom Index (RSI) score and Middle Ear Compliance.

		Correlations	RSI	*Compliance*
Spearman's rho	RSI	Correlation Coefficient	1,000	.048
		Sig. (2-tailed)	.	.818
		N	25	25
	Compliance	Correlation Coefficient	.048	1,000
		Sig. (2-tailed)	.818	.
		N	25	25

Table S7. Spearman Correlation Test of Reflux Finding Score (RFS) and Middle Ear Compliance.

		Correlations	RFS	Compliance
Spearman's rho	RFS	Correlation Coefficient	1,000	-.375
		Sig. (2-tailed)	.	.065
		N	25	25
	Compliance	Correlation Coefficient	-.375	1,000
		Sig. (2-tailed)	.065	.
		N	25	25

Table S8. Spearman Correlation Test of Reflux Finding Score (RFS) (RFS) and Tw.

		Correlations	RFS	Tympanogram Width
Spearman's rho	RFS	Correlation Coefficient	1,000	-.354
		Sig. (2-tailed)	.	.082
		N	25	25
	Tympanogram Width	Correlation Coefficient	-.354	1,000
		Sig. (2-tailed)	.082	.

Table S9. Chi Square Correlation Test of LPR and Middle Ear Disorders.

Chi-Square Tests	Value	df	Asymp . Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	33.440 [a]	1	.000		
Continuity Correction [b]	30,013	1	.000		
Likelihood Ratio	42,651	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	32,680	1	.000		
N of Valid Cases	44				

Table S10. Chi Square Correlation Test Result of LPR and Middle Ear Disorders.

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Symmetric Measures		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.657	.000
N of Valid Cases		44	

Table S11. Interpretation of Correlation Coefficient for Chi Square Test [35] .

Correlation Coefficient Value	Relationship Level
0.80 – 1.00	Very strong
0.60 – 0.799	Strong
0.40 – 0.599	Currently
0.20 – 0.399	Low
0.00 – 0.199	Very Low