Main Article

An Insight into Usefulness of Anterior Rhinomanometry as Marker in Adenoid Hypertrophy

https://doi.org/10.47210/bjohns.2022.v30i3.884

Vamsi Krishna Teja,[1] Lakshmi Kalavathi C,[2] Krishna V Chaitanya,[1] Sai Mourya Iytha,[1] Ramamohan Pathapati[3]

ABSTRACT

Introduction

Prospective observational study in 34 patients from December 2018 till November 2022 in tertiary care hospital to objectively assess diagnostic utility of anterior rhinomanometry in symptomatic patients undergoing adenoidectomy preoperatively and postoperatively and subjectively compare changes in quality of life.

Materials and Methods

Patients with clinical history of adenoid hypertrophy managed clinically for 2 months, posted for adenotonsillectomy were performed anterior rhinomanometry using M/s GENESIS MEDICAL SYSTEMS NASOBALANCE – P [5] to calculate both baseline and post decongestion resistance values. Postoperatively anterior rhinomanometry is performed after 12 weeks and compared with preoperative nasal resistance values. Quality of life measured by visual analogue scale.

Results

Comparison of preop post decongestion and postop pre decongestion of nasal resistance following adenoidectomy revealed nasal resistance significantly reduced ($p<0.05$). When nasal resistance preoperatively compared with X ray nasopharynx there was proportionate increase in nasal resistance as soft tissue narrowing of airway increases.

Conclusion

Visual analogue scale reveals improvement of quality of life in 28/34 = 82.35% patients. Comparison of Pre and post decongestion values following adenoidectomy in isolated asymptomatic patients revealed p value is insignificant which is established by anterior rhinomanometry suggesting values of nasal airway resistance remained similar in isolated adenoid hypertrophy patients.

Keywords

Rhinomanometry; Adenoid; Hypertrophy; Adenoiditis; Nasal Obstruction

Anterior rhinomanometry is a noninvasive procedure and measures nasal obstruction objectively.[1] Significance of rhinomanometry in the evaluation of nasal blockage and adenoid enlargement has been debated in the literature. Several studies have found a strong link between nasal obstruction symptoms and the degree of adenoid hypertrophy.

Adenoids grow rapidly in nasopharynx leading to obstructive symptoms in children. Nasal respiratory obstruction is a prevalent problem frequently linked to adenoid hypertrophy.[2] Nasopharyngeal blockage is determined by the size and shape of the nasopharyngeal space, as well as the adenoids and palatal airway. Adenoid hypertrophy can cause various pathological manifestations like otitis media with effusion, rhinosinusitis, adenoiditis and obstructive sleep apnea.[3]

1 - Department of ENT, Narayana Medical College Nellore.
2 - Department of Pathology, ACSR Govt Medical College Nellore.
3 - Department of Pharmacology, Narayana Medical College Nellore.

Corresponding author:
Dr Lakshmi Kalavathi C
email: drclk30@gmail.com

The size of the adenoids and their impact on the nasopharyngeal airway can be determined using a variety of approaches. Different objective diagnosing modalities like mirror examination, palpation, nasal endoscopy, lateral neck radiography are available for diagnosing adenoid hypertrophy. The combination of diagnostic nasal endoscopy examination and radiological examination helps to diagnose adenoid hypertrophy.[4]

The goal of our research was to objectively assess diagnostic utility of anterior rhinomanometry in symptomatic patients undergoing adenoidectomy pre operatively and postoperatively by assessment of nasal blockage in adenoid hypertrophy with relief of nasal obstruction in patients undergoing adenoidectomy and subjectively compare the changes in their quality of life by visual analogue scale.

Materials and Methods

This prospective clinical study was performed in department of ENT, in our institution from December 2018 till November 2022 for a period of four years. A study population of 34 children in the age group from 9 to 16 years who presented to the ENT OPD with clinical history suggestive of adenoid hypertrophy with complaints of nasal blockage, mouth breathing, and difficulty to sleep during nights, with or without ear pain were included in the study. Patients with nasal polyps, nasopharyngeal atresia, gross deviated nasal septum, allergic rhinitis, juvenile nasopharyngeal angiofibroma and other systemic manifestations were excluded from the study.

Diagnostic Nasal Endoscopy was performed in all these patients to further confirm the diagnosis. These children enrolled in the study were managed clinically for 2 months on medical management and then posted for adenotonsillectomy. Prior to one day before surgery objective evaluation of the patient is performed with anterior rhinomanometry using GENESIS MEDICAL SYSTEMS NASOBALANCE – P[5] to calculate both baseline and post decongestion resistance values. X ray nasopharynx soft tissue lateral view was performed in all these patients to observe the obstruction being caused by

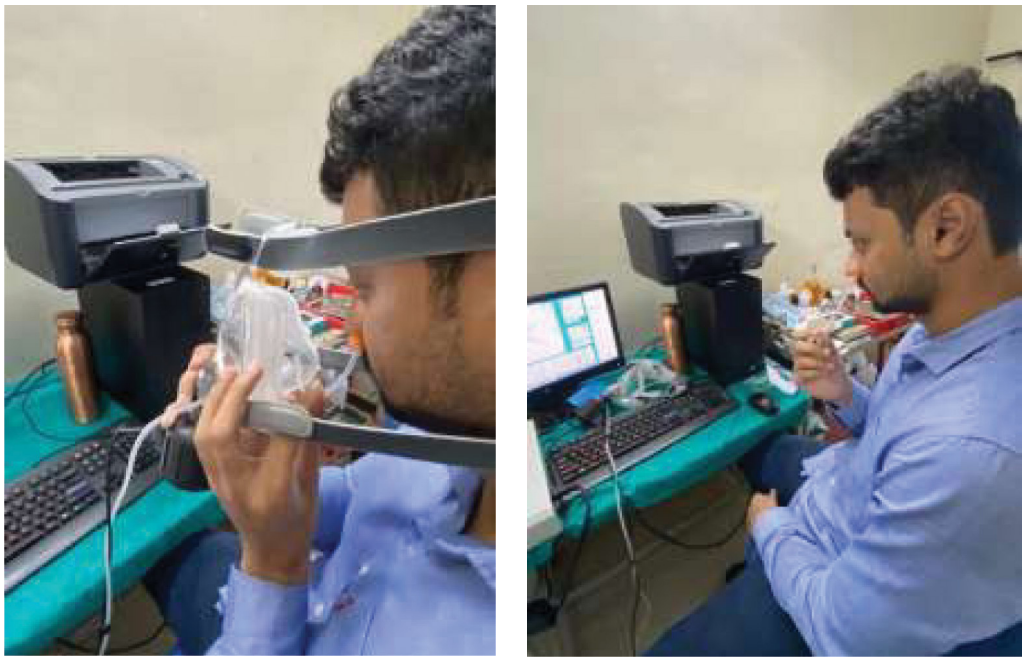
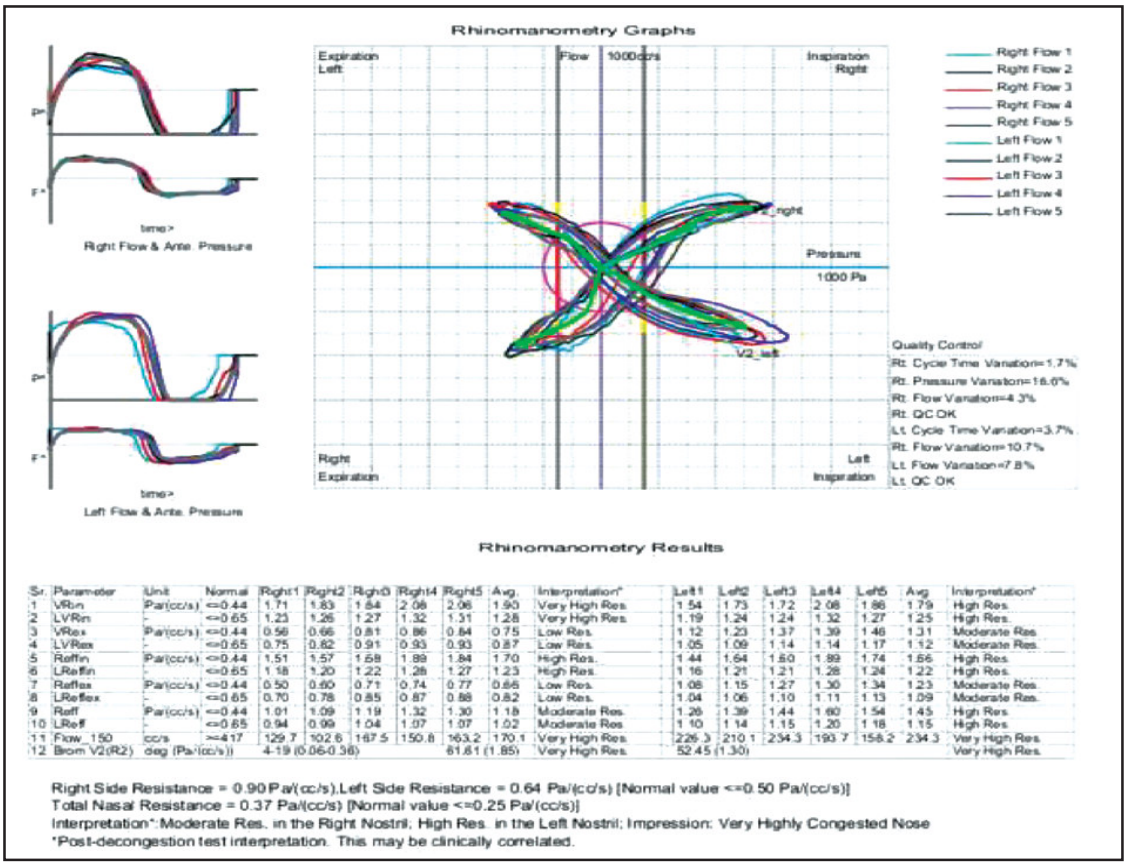


Fig. 1, 2. Procedure of Anterior Rhinomanometry - Transparent face mask, similar to that used for administering general anesthesia is used, incorporating a pneumotachograph and connected to an amplifier and a recorder

soft tissue hypertrophy due to adenoid hypertrophy. These values were compared with the anterior rhinomanometry values pre operatively.

For performing the procedure of anterior rhinomanometry, the patient is asked to blow his nose and clear the nostrils prior to the procedure, sit in an upright position, and the pressure sensing tube is placed in one nostril while the contralateral nostril is left opened. Mask is placed which snuggly fits the patients face without any leaks and the initial measurements were recorded prior to decongestion of nose. Both nasal cavities tested separately before and after decongestion. An example of usage of nasal mask for the procedure of anterior rhinomanometry is shown in figure 1 and 2.

After obtaining initial values by anterior rhinomanometry prior to decongestion both the nostrils were sprayed with 2 puffs each of 0.5 mg/ml jets of oxymetazoline nasal spray and post decongestion measurements were recorded ten minutes after spraying the decongestant nasal spray. Nasal decongestant spray helps to lower turbinate edema caused by transitory circumstances like allergic changes. Synchronous recording of flow & pressure difference are recorded prior to decongestion and after decongestion. Graphic representation with nasal air flow on the ordinate axis, the pressure gradient on the abscissa axis are recorded and plotted for inspiration and expiration in both the nostrils independently. Similarly the graphs are interpreted for the resistance if any during the respiratory cycle. A sample of these graphs obtained on anterior rhinomanometry is shown in the figure 3.



Sr.	Parameter	Unit	Normal	Right1	Right2	Right3	Right4	Right5	Avg.	Interpretation*	Left1	Left2	Left3	Left4	Left5	Avg	Interpretation*
1	VRin	Pa/(cc/s)	<=0.44	1.71	1.83	1.84	2.08	2.08	1.90	Very High Res.	1.54	1.73	1.72	2.08	1.86	1.79	High Res.
2	LVRin	-	<=0.65	1.23	1.26	1.27	1.32	1.31	1.28	Very High Res.	1.19	1.24	1.24	1.32	1.27	1.25	High Res.
3	VRex	Pa/(cc/s)	<=0.44	0.56	0.66	0.81	0.86	0.84	0.75	Low Res.	1.12	1.23	1.37	1.39	1.46	1.31	Moderate Res.
4	LVRex	-	<=0.65	0.75	0.82	0.91	0.93	0.93	0.87	Low Res.	1.05	1.09	1.14	1.14	1.17	1.12	Moderate Res.
5	Reffin	Pa/(cc/s)	<=0.44	1.51	1.57	1.68	1.89	1.84	1.70	High Res.	1.44	1.64	1.60	1.89	1.74	1.66	High Res.
6	LReffin	-	<=0.65	1.18	1.20	1.22	1.28	1.27	1.23	High Res.	1.16	1.21	1.21	1.28	1.24	1.22	High Res.
7	Reflex	Pa/(cc/s)	<=0.44	0.50	0.60	0.71	0.74	0.77	0.66	Low Res.	1.08	1.15	1.27	1.30	1.34	1.23	Moderate Res.
8	LReflex	-	<=0.65	0.70	0.78	0.85	0.87	0.88	0.82	Low Res.	1.04	1.06	1.10	1.11	1.13	1.09	Moderate Res.
9	Reff	Pa/(cc/s)	<=0.44	1.01	1.09	1.19	1.32	1.30	1.18	Moderate Res.	1.26	1.39	1.44	1.60	1.54	1.45	High Res.
10	LReff	-	<=0.65	0.94	0.99	1.04	1.07	1.07	1.02	Moderate Res.	1.10	1.14	1.15	1.20	1.18	1.15	High Res.
11	Flow_150	cc/s	>=417	129.7	102.6	167.5	150.8	163.2	170.1	Very High Res.	226.3	210.1	234.3	193.7	158.2	234.3	Very High Res.
12	Brom V2(R2)	deg (Pa/(cc/s))		4-19 (6.06-0.36)				61.61 (1.85)		Very High Res.	52.45 (1.30)						Very High Res.

Fig. 3. Rhinomanometric recording of transnasal pressure against flow during breathing at rest through right and left nostril

Adenoidectomy is performed in all these patients by curette method. Powered instrumentation was used as and where required. Adequate clearance of the airway is evaluated using nasal endoscopy on the operation table. These surgical specimens were subjected to histo pathological examination.

Postoperatively anterior rhinomanometry is performed in all these patients after 12 weeks following adenoidectomy and the values were compared with preoperative nasal resistance values. Nasal obstruction and nasal airway resistance were assessed preoperatively and postoperatively with visual analogue score subjectively and compared with rhinomanometric nasal resistance values objectively.

Results

In our study a total number of 34 children in the age group of 9 to 16 years were included. Values of anterior rhinomanometry in patients with adenoid hypertrophy Pre operatively and post operatively following surgery were mentioned in the table I mentioned below. Also in our study we tried to compare the anterior rhinomanometry values radiologically with X ray soft tissue lateral view of nasopharynx pre operatively. The distance from midpoint of maximal adenoid hypertrophy in nasopharynx and the level of airway narrowing is calculated to assess the degree of adenoid hypertrophy and these values were recorded to calculate the percentage of narrowing. We considered pre op post decongestion values as reference point to compare with the X ray of nasopharynx before sending the patient for X ray. It was observed from the study that there was proportionate increase in nasal resistance as the soft tissue narrowing of airway increases. These results were tabulated in the table I mentioned below.

Among study group population of 34 children, an improvement in airflow following surgery was observed in all the patients following surgery. When this improvement of airflow of the patients is compared with quality of life following surgery using visual analogue scale, we observed that there is an improvement of quality of life in 28/34 = 82.35% patients after 12 weeks after the surgery during the follow up suggesting us there are certainly other parameters which are to be considered prior to the adenoidectomy surgery for improvement of quality of life. These results were also mentioned in the table I mentioned below.

Table I: Values of anterior rhinomanometry in patients with adenoid hypertrophy and following surgery and values of pre op airflow and their comparison with nasal airway and size of adenoid hypertrophy ratio by soft tissue lateral view X ray nasopharynx

PREOPERATIVE BASELINE RESISTANCE			PRE OP POST DECONGESTION RESISTANCE			POST OPERATIVE BASELINE RESISTANCE			POST OP POST DECONGESTION RESISTANCE			X RAY %	PRE OP AIR FLOW		POST OP AIRFOW		VAS SCORE	
RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL		RIG-HT	LEFT	RIG-HT	LEFT	PR-E OP	PO-ST OP
0.8	0.77	0.4	0.4	0.51	0.22	0.31	0.45	0.18	0.31	0.43	0.19	75	155	140	305	260	2	6
0.42	0.41	0.2	0.42	0.49	0.22	0.45	0.43	0.22	0.38	0.41	0.23	30	165	150	315	270	0	4
0.82	0.81	0.41	0.3	0.87	0.22	0.26	0.92	0.21	0.25	0.94	0.2	70	150	135	300	255	0	4
0.76	1.7	0.51	0.64	0.69	0.33	0.5	0.51	0.25	0.57	0.53	0.29	75	152	137	302	257	1	5
0.39	1.02	0.31	0.54	0.52	0.26	0.5	0.46	0.24	0.42	0.46	0.25	65	190	175	340	295	4	4
0.57	0.65	0.3	0.42	0.44	0.21	0.38	0.31	0.1	0.29	0.29	0.16	45	142	127	292	247	0	4

Table I: Contd.

Table I (Contd.): Values of Anterior Rhinomanometry in Patients with Adenoid Hypertrophy and following Surgery and Values of Pre OP Airflow and their comparison with Nasal airway and size of Adenoid Hypertrophy Ratio by Soft Tissue lateral View X Ray Nasopharynx

PREOPERATIVE BASELINE RESISTANCE			PRE OP POST DECONGESTION RESISTANCE			POST OPERATIVE BASELINE RESISTANCE			POST OP POST DECONGESTION RESISTANCE			X RAY %	PRE OP AIR FLOW		POST OP AIRFOW		VAS SCORE	
RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL	RIG-HT	LEFT	TOT-AL		RIG-HT	LEFT	RIG-HT	LEFT	PR-E OP	PO-ST OP
0.64	0.76	0.35	0.43	0.45	0.21	0.39	0.53	0.23	0.5	0.49	0.26	30	132	117	282	237	0	3
0.7	1.09	0.42	0.56	0.56	0.28	0.5	0.42	0.23	0.42	0.41	0.22	55	150	135	300	255	0	4
1.01	0.99	0.5	0.52	0.36	0.21	0.47	0.39	0.21	0.45	0.36	0.21	60	82	67	232	187	0	4
1.16	0.75	0.46	0.6	0.8	0.34	0.46	0.46	0.23	0.54	0.76	0.34	60	180	165	330	285	6	6
0.77	1.01	0.44	0.52	0.68	0.29	0.47	0.5	0.24	0.55	0.62	0.29	45	153	138	303	258	3	7
1.08	0.47	0.33	0.44	0.5	0.23	0.5	0.49	0.25	0.53	0.46	0.23	35	167	152	317	272	1	5
0.64	0.64	0.32	0.48	0.46	0.23	0.47	0.49	0.24	0.49	0.5	0.22	50	205	190	355	310	1	5
0.66	0.69	0.34	0.38	0.3	0.16	0.41	0.4	0.2	0.39	0.38	0.16	65	53	38	203	158	2	6
0.76	1.02	0.44	0.6	0.32	0.23	0.31	0.45	0.18	0.55	0.3	0.23	70	95	80	245	200	6	5
1.01	0.99	0.51	0.56	0.38	0.25	0.51	0.45	0.24	0.55	0.44	0.21	70	195	180	345	300	1	5
0.81	0.78	0.41	0.39	0.49	0.20	0.29	0.43	0.16	0.30	0.41	0.17	75	97	82	247	202	3	3
0.4	0.39	0.22	0.42	0.47	0.24	0.43	0.42	0.19	0.36	0.39	0.21	75	145	141	292	250	3	6
0.83	0.79	0.43	0.32	0.85	0.23	0.27	0.91	0.21	0.25	0.91	0.2	45	155	142	311	275	1	3
0.74	1.69	0.54	0.6	0.69	0.37	0.54	0.49	0.26	0.54	0.52	0.27	75	151	126	293	245	0	5
0.37	1.01	0.29	0.51	0.50	0.25	0.5	0.43	0.23	0.42	0.43	0.24	75	152	129	307	251	1	5
0.56	0.63	0.31	0.41	0.45	0.2	0.37	0.31	0.11	0.27	0.29	0.16	60	190	186	323	293	2	5
0.62	0.75	0.34	0.42	0.44	0.21	0.39	0.52	0.22	0.51	0.49	0.25	45	142	128	292	242	2	4
0.71	1.10	0.43	0.55	0.57	0.27	0.51	0.43	0.23	0.43	0.41	0.23	30	132	125	281	234	1	4
1.01	0.96	0.51	0.53	0.37	0.22	0.46	0.37	0.2	0.46	0.33	0.19	60	150	119	300	252	4	5
1.14	0.76	0.47	0.61	0.81	0.32	0.43	0.44	0.21	0.51	0.71	0.31	60	102	101	232	184	3	7
0.79	1.03	0.47	0.53	0.71	0.33	0.44	0.54	0.26	0.55	0.62	0.29	65	180	163	332	279	1	5
1.07	0.45	0.31	0.42	0.51	0.24	0.51	0.49	0.26	0.5	0.46	0.21	40	143	138	301	249	3	6
0.64	0.64	0.32	0.48	0.46	0.23	0.47	0.49	0.24	0.49	0.5	0.22	35	165	123	313	289	2	6
0.66	0.67	0.32	0.34	0.31	0.16	0.4	0.42	0.2	0.39	0.38	0.16	50	205	178	352	306	2	7
0.75	1.07	0.49	0.65	0.32	0.23	0.34	0.45	0.19	0.53	0.3	0.23	65	87	56	159	157	1	5
1.01	0.97	0.5	0.54	0.36	0.24	0.51	0.45	0.23	0.57	0.41	0.2	70	95	82	246	196	5	4
0.81	0.76	0.41	0.44	0.55	0.24	0.31	0.43	0.19	0.32	0.41	0.19	70	195	181	342	306	2	6
0.49	0.47	0.26	0.45	0.49	0.26	0.47	0.43	0.21	0.36	0.41	0.23	75	97	102	243	208	1	5

From table I a comparison of pre op pre decongestion and post op pre decongestion of nasal resistance following adenoidectomy was made using anterior rhinomanometry and using the values mentioned. Standard deviation and Standard error of mean were calculated in table II where a standard deviation of 0.0908 preoperatively and 0.370 postoperatively was observed. Also a standard error of mean of 0.0155 was observed preoperatively and 0.063 postoperatively from the data. It was observed from the study that comparison of pre op pre decongestion and post op pre decongestion of nasal resistance following adenoidectomy, nasal resistance was significantly reduced ($p<0.05$) as mentioned in calculations in table II below.

Table II: Pre op pre decongestion and post op pre decongestion nasal resistance

VARIABLES	PRE OP	POST OP
Minimum	0.20	0.11
Maximum	0.54	0.26
Mean	0.379	0.213
Standard Deviation	0.0908	0.370
Standard error of mean	0.0155	0.0063
95% of Confidence interval	-0.1996 to -0.1324	
Standard error	0.017	
P value	< 0.0001	

In our study we tried to compare from the values of anterior rhinomanometry in table I between the values of pre op post decongestion values of anterior rhinomanometry with post op post decongestion values of nasal resistance using anterior rhinomanometry and a standard deviation values of 0.0481 and 0.0441 were obtained pre operatively and post operatively. Also for this group of patients a standard error of mean of 0.0075 was reported post operatively. These results were mentioned in the table III below. Also from the above data it reveals that nasal resistance was significantly reduced ($p<0.05$) following adenoidectomy as evident objectively from anterior rhinomanometry with a calculated p value of 0.0357 which is significant. These results were shown in table III below which suggest that anterior rhinomanometry can be an used as diagnostic test in assessment of results of adenoidectomy.

Table III: Pre op post decongestion and post op post decongestion nasal resistance

VARIABLES	PRE OP	POST OP
Minimum	0.16	0.16
Maximum	0.37	0.34
Mean	0.245	0.221
Standard Deviation	0.0481	0.0441
Standard error of mean	0.0082	0.0075
95% of Confidence interval	-0.0463 to -0.0017	
Standard error	0.011	
P value	0.0357	

Also from the data of anterior rhinomanometry in table I we compared the values of post op pre decongestion values of nasal resistance with and post op post decongestion nasal resistance results reveal that there is no significance improvement following decongestion with the values of anterior rhinomanometry in adenoid hypertrophy. These results were calculated and mentioned in the table IV mentioned below. These results suggest to us that once adenoid tissue is removed surgically and in isolated asymptomatic patients of adenoid hypertrophy there is not much role of associated symptoms following surgery which is established by anterior rhinomanometry.

Table IV: Pre op pre decongestion and post op post decongestion nasal resistance significance

VARIABLES	PRE OP	POST OP
Minimum	**0.10**	**0.16**
Maximum	**0.26**	**0.34**
Mean	**0.213**	**0.221**
Standard Deviation	**0.0370**	**0.0441**
Standard error of mean	**0.0063**	**0.0075**
95% of Confidence interval	**-0.0463 to -0.0017**	
Standard error	**0.010**	
P value	**0.4207**	

Discussion

Available literature reveal that rhinomanometry after nasal decongestion is more specific to evaluate nasal obstruction.[6] At four to six years of age, the size and form of the adenoid reaches its maximum size, which it maintains for nine to ten years before gradually shrinking. In children with isolated adenoid hypertrophy anterior rhinomanometry helps to avoid unnecessary surgical procedures causing temporary nasal obstruction. In our study we assessed nasal obstruction using nasal resistance as reference following anterior rhinomanometry objectively before and after the adenoidectomy surgery. We observed significant reduction in nasal resistance value in post decongestion after adenoidectomy thus relieving nasal obstruction. Anterior rhinomanometry can be considered as reliable alternative over X ray lateral view of soft tissue of nasopharynx and CT scan of neck and nasopharynx avoiding hazardous radiations in diagnosing adenoid hypertrophy in children.

It was observed from the study that there was proportionate increase in nasal resistance as the narrowing of airway increases and these values were not being affected by spraying of decongestant. This could also probably be because the posterior location of the adenoids and this tissue not being affected by edema. Hence we recommend anterior rhinomanometry to be added to current diagnostic criteria as an effective diagnostic marker in the diagnosis of adenoid hypertrophy.

In our study we considered patients of isolated adenoid hypertrophy and compared post op pre decongestion values of nasal resistance with post op post decongestion values and we observed that there is not much difference in these values with an insignificant p value > 0.05. Also as adenoid hypertrophy occludes posterior nares, base line pre decongested rhinomanometric test values do not significantly reduces after topical application of nasal decongestants. As all the patients in our study were isolated patients with adenoid hypertrophy alone we can prefer to use anterior rhinomanometry to differentiate patients of isolated adenoid hypertrophy from patients with associated diseases of the nose to predict the prognosis of patients following adenoidectomy.

In post adenoidectomy patients our study shows that rhinomanometry test taken after application of topical nasal decongestant suggests there is no significant

reduction in nasal resistance value compared to post op pre decongestion values. As adenoid hypertrophy occludes posterior nares, base line pre decongested rhinomanometric test values do not significantly reduces after topical application of nasal decongestants as is evident from our study.

Many validated questionnaires are developed to evaluate subjective nasal complaints and their effect on quality of life. In the present study we tried to assess the degree of subjective nasal obstruction in patients with adenoid hypertrophy before and after adenoidectomy by using a visual analogue scale (VAS)[8] and compare it with objective response of the patient using anterior rhinomanometry. It is observed from our study that patients with a very good response on visual analogue scale has a good response score in anterior rhinomanometry and in patients with a poor response for visual analogue scale the nasal resistance in anterior rhinomanometry is comparatively on a higher limit as evident from the data in our study mentioned in table I and table IV.

One of the major limitations of our study is that there is a confinement of age limitations from 9 years to 16 years because of the non availability of snuggly fitting face mask for children. Also due to prevailing clinical conditions of the pandemic we were able to perform the study in limited number of patients only after taking all the necessary precautions. In future we prefer to continue the study involving population in the age groups of 3 years and above.

Funding Agencies: No funding agencies

Conflicts of Interest: The authors declare that they have no conflict of interest

Ethics Committee Clearance:

The study has been approved by the Institutional ethics committee and has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent:

Informed consent was obtained from all individual participants included in the study.

References

1. Davis SS, Eccles R. Nasal congestion: mechanisms, measurement and medications. Core information for the clinician. Clinical Otolaryngology & Allied Sciences. 2004 Dec;29(6):659-66
2. Cassano P, Gelardi M, Cassano M, Fiorella ML, Fiorella R. Adenoid tissue rhinopharyngeal obstruction grading based on fiberendoscopic findings: a novel approach to therapeutic management. International Journal of Pediatric Otorhinolaryngology. 2003 Dec 1;67(12):1303-9
3. Marseglia GL, Caimmi D, Pagella F, Matti E, Labó E, Licari A, Salpietro A, Pelizzo G, Castellazzi AM. Adenoids during childhood: the facts. International Journal of Immunopathology and Pharmacology. 2011 Oct;24(4_suppl):1-5
4. Lertsburapa K, Schroeder Jr JW, Sullivan C. Assessment of adenoid size: A comparison of lateral radiographic measurements, radiologist assessment, and nasal endoscopy. International journal of pediatric otorhinolaryngology. 2010 Nov 1;74 (11):1281-5
5. https://www.genesismedicals.com/
6. Zicari AM, Magliulo G, Rugiano A, Ragusa G, Celani C, Carbone MP, Occasi F, Duse M. The role of rhinomanometry after nasal decongestant test in the assessment of adenoid hypertrophy in children. International journal of pediatric otorhinolaryngology. 2012 Mar 1;76(3):352-6
7. Sørensen H, Solow B, Greve E. Assessment of the nasopharyngeal airway: a rhinomanometric and radiographic study in children with adenoids. Acta Oto-Laryngologica. 1980 Jan 1;89(3-6):227-32
8. Klimek L, Bergmann KC, Biedermann T, Bousquet J, Hellings P, Jung K, Merk H, Olze H, Schlenter W, Stock P, Ring J. Visual analogue scales (VAS): Measuring instruments for the documentation of symptoms and therapy monitoring in cases of allergic rhinitis in everyday health care. Allergo journal international. 2017 Feb;26(1):16-24.