



Adenoidal Nasopharyngeal Ratio and Its Correlation with Tympanometry in Children with Otitis Media with Effusion: A Prospective Clinical Study

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Abstract

Aim: To determine the association between adenoidal nasopharyngeal ratio (AN ratio) and tympanogram in children before and after medical therapy.

Materials and Methods: A prospective clinical study conducted from June 2014 to May 2015. comprising of 75 children between 4-12 years of age who were clinically diagnosed to have adenoids and Otitis media with effusion and were undergoing medical management in the Department of ENT, Academy of Medical Sciences, Pariyaram, Kerala, India. The adenoidal nasopharyngeal ratio (AN ratio) was calculated with digital X- ray of nasopharynx and correlated with tympanometric values before and after medical treatment of otitis media with effusion. The relationship between AN ratio and tympanograms were evaluated regarding AN ratio 0.70. The Chi square test was used to analyze the correlation between AN ratio and tympanometric values. The children who did not show response to medical treatment after a period of 12 weeks were subjected to surgery in the form of adenoidectomy, with or without grommet insertion.

Results: Digital x-ray nasopharynx lateral view of 75 children showed a mean over all Adenoidal nasopharyngeal ratio (AN ratio) of 0.729 Vs 0.615 before and after medical therapy. B and C type tympanograms were seen in children with Eustachian tube dysfunction resulting from enlarged adenoids with AN ratio more than 0.70. After initiating medical therapy, children with AN ratio greater than 0.70 with B and C type tympanograms did not show statistically significant improvement in middle ear pressures ($P < 0.001$) compared to those children with AN Ratio less than 0.70 and C type tympanograms. Thus although medical treatment was effective in shrinking the size of adenoid tissue, it did not result in statistically significant change in tympanometric values ($P < 0.001$). Children who were non responders to medical management with persisting fluid in the middle ear (with Type B tympanogram) were considered for adenoidectomy and grommet insertion.

Conclusion: *Otitis media with effusion (OME) is the most frequent causes of silent hearing impairment in young children with adenoid hyperplasia which needs a close vigil. Correlating adenoid nasopharyngeal ratio and tympanometric findings we found that even though medical management causes reduction in size of adenoids, it is not sufficient in a child with OME. Hence younger children with AN ratio more than 0.70 and B type tympanogram are the definitive candidates for surgical management. Hopefully this study will facilitate to detect early those children with OME who will not be benefited by medical management alone.*

Keywords: *Adenoidal nasopharyngeal ratio; Tympanogram, X ray Nasopharynx lateral view; Eustachian tube dysfunction; Adenoidectomy.*

INTRODUCTION

Otitis media with effusion (OME) due to adenoid hypertrophy is one of the most common chronic otological problems dealt by otorhinolaryngologists. It is defined as the chronic accumulation of mucus within the middle ear and sometimes the mastoid air cell system. The time that the fluid has to be present for the condition to be chronic is usually taken as 12 weeks¹. The prevalence of OME is bimodal with a first and largest peak of approximately 20% at 2 years of age and a second peak of approximately 16% at around 5 years of age¹. In temperate countries, twice as many children have OME in the winter as opposed to the summer.

Tympanometry with an impedance meter has been advocated since the 1970s as a reliable method of detecting OME and is perhaps the most common reference standard diagnostic method because of its availability and semi-objective nature¹.

The diagnosis of adenoid hypertrophy is made either by posterior rhinoscopy, rigid or flexible nasopharyngoscopy or by soft tissue lateral radiograph of nasopharynx. Roentgenographic assessment is still used for assessment of extent of adenoidal obstruction as it is considered as an acceptable, objective, non-invasive technique which is universally available. The high incidence of OME in this part of the State and lack of similar study on this subject in our setting in this Institution made us conduct this study.

Several methods have been implicated to evaluate adenoidal nasopharyngeal ratio (AN ratio) in children with enlarged adenoids. The AN ratio was first described by Fujioka et al⁹ in 1979 who measured it using lateral radiograph in 1398 normal children aged 1 month to 16 years. It has

been demonstrated both by radiological techniques and middle ear pressure studies that adenoids do obstruct the Eustachian tube and adenoidectomy relieves obstruction.¹

In 1987, Elwany et al measured AN ratio in children selected for adenoidectomy and assessed the predictive reliability in determining candidacy for adenoidectomy. The mean AN ratio for erect position of children selected for adenoidectomy was 0.71. Erol Egeli et al in 2002 evaluated the correlation between AN ratio and tympanogram in children and concluded that early ventilation tube insertion may be an alternative therapy for middle ear effusions not improving by 3 weeks of medical therapy¹³. In a study by Gunel et al¹⁵ it was concluded that it is pertinent to perform middle ear pressure assessment and tympanometry in children before adenoidectomy even without parental suspicion of hearing loss.

The influence of enlarged adenoids on tympanometry was investigated by various authors and a large amount of information is available in this regard. In this study we investigated the effects of AN ratio using lateral radiograph in 75 children in this part of the country (North Kerala, India) and compared with tympanometric values. Here, a humble attempt has been made to find out the significance of AN ratio, variation of AN ratio with relation to age and correlation between AN ratio and tympanogram to decide upon the option of adenoidectomy in children with OME.

MATERIALS AND METHODS

The present study was based on the analysis of 75 patients in the age group 4–12 years attending the Department of ENT, Academy of Medical

Sciences, Pariyaram, Kerala from 2014 to 2015. An ethical committee clearance was obtained prior to commencement of the study.

Children who presented with the symptoms of nasal obstruction, nasal discharge, mouth breathing, snoring and hyponasal speech were included in this study. An informed consent was obtained from subjects/ parents willing to participate in the study. Children with perforation of tympanic membrane, external auditory canal anomalies and disease, cleft palate and cleft lip, previous ear or palatal surgeries were excluded. Children with nasal obstruction due to other causes septal deviation, allergic rhinitis, nasal injury, acute infections of tonsils and adenoids were also excluded from the study.

Each case was clinically evaluated by taking a thorough history, general physical, and complete local ENT examination, otoscopic examination. All children were subjected to X ray soft tissue nasopharynx lateral view in erect lateral position with the x ray beam centered to external auditory meatus and the child breathing through the nose with teeth occlusion. The head was fixed with cephalostat. The exposure was made by 70kV with an exposure time of 0.6 seconds. A tympanometry was also done on the same day for each patient using GSI Tymptstar CE 0344 Impedance Audiometer.

AN ratio was calculated as per Fujioka et al method. All radiographs were interpreted by two observers consisting of a radiologist and a otorhinolaryngologist. AN ratio obtained was correlated with pre and post treatment tympanometric values. The data thus obtained was statistically analysed.

Measurement of AN ratio (Fujioka et al method):

In this method the adenoidal measurement (A) represents the distance from the point of maximal convexity of the adenoid shadow to a line along the anterior margin of the basiocciput. The nasopharyngeal measurement (N) is the distance between the posterior border of the hard plate and the antero-inferior edge of the sphenobasioccipital synchondrosis. The AN ratio is

obtained by dividing the measurement for A by the value for N.

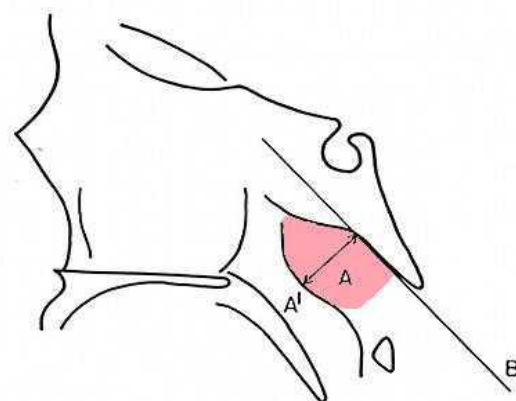


Fig no.1 Adenoidal measurements

A represents distance from A^1 , point of maximum convexity, along inferior margin of adenoid shadow to line B drawn along straight part of anterior margin of basiocciput. A is measured along line perpendicular from point A^1 to its intersection with line B.

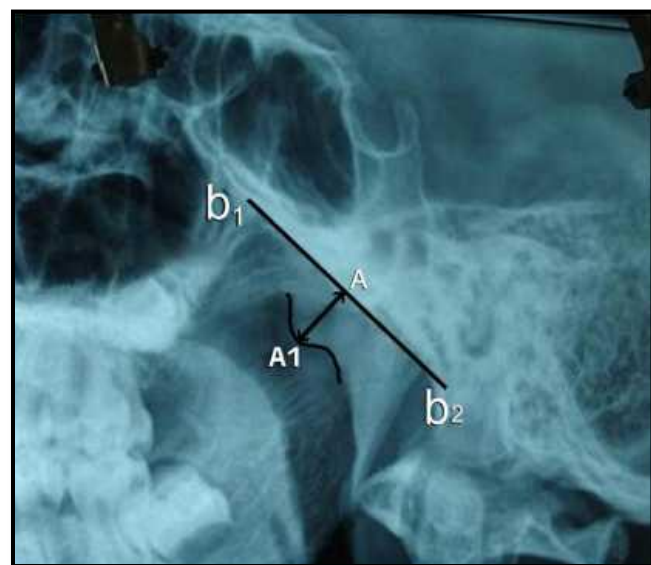


Fig no 2: X-ray showing adenoidal measurement "A" represents distance from A1, point of maximal convexity, along inferior margin of adenoid shadow to line b1 b2, drawn along straight part of anterior margin of basiocciput. "A" is measured along line perpendicular from point A1 to its intersection with b1 b2.

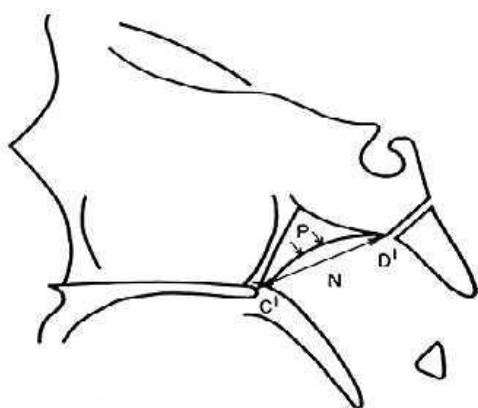


Fig No 3: Nasopharyngeal measurement.

N is distance between C¹, posterior superior edge of soft palate and D¹, anteroinferior edge of sphenobasioccipital synchondrosis. When synchondrosis is not clearly visualized, point D¹ can be determined as site of crossing posteroinferior margin of lateral pterygoid plates P and floor of bony nasopharynx.

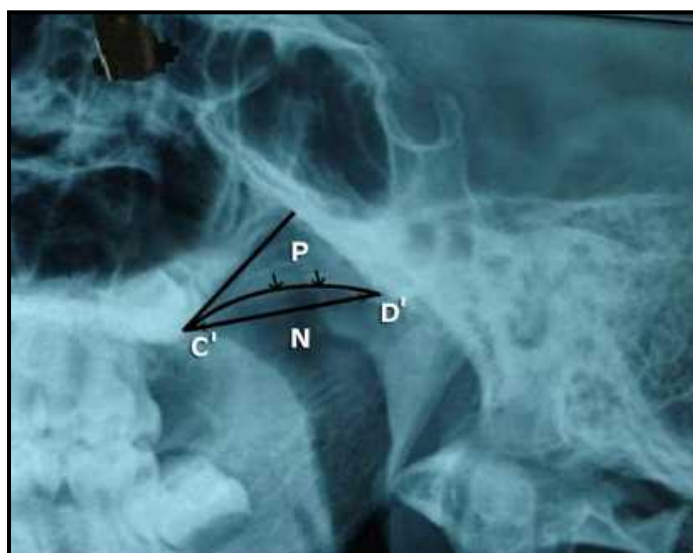


Fig No 4: X-ray showing nasopharyngeal measurements

“N” is distance between C¹, posterior superior edge of hard palate and D¹antero-inferior edge of sphenobasioccipital synchondrosis. When synchondrosis is not clearly visualized, point D1 can be determined as site of crossing posteroinferior margin of lateral pterygoid plates P and floor of bony nasopharynx.

AN Ratio is calculated by deviding ‘A’ by ‘N’.

After 12 weeks of medical therapy, X ray nasopharynx was repeated and AN ratio was calculated.

Tympanometry was done in all children prior to starting medical therapy and after 12 weeks of medical therapy using GSI Tymptstar CE 0344 Impedance Audiometer model.

All children were treated with a 10 day course of broad spectrum antibiotic, Topical and systemic decongestants, Antihistamines, mucolytics and steroid nasal spray for a period of 12 weeks. Tympanometry was repeated after 12 weeks of medical therapy and findings were recorded.

Children with high ANR who persistently showed B type tympanogram after medical therapy indicating persistent fluid were considered as nonresponders and were taken up for adenoidectomy and grommet insertion.

RESULTS

Demographic profile

Study population consisted of 75 children (48 males and 27 females; mean age at presentation 7.8 (+_1) years; range 4-12 years; Male to females ratio 1.8:1). Out of 75 children, 33 (44%) were in the age group of 4-6 years, 29 (38.6%) were in the age group 7-9 years and 13 (17.3%) belonged to the age group of 10-12 years. 32 children (42.7%) belonged to lower socio economic group; 30 (40%) belonged to middle socioeconomic status whereas 13 children (17.3%) were from upper socio economic status. The presenting symptoms were nasal obstruction in 97.3%, nasal discharge in 88%, mouth breathing in 81%, decreased hearing in 53.3%, snoring in 42%, hyponasal speech in 24%, sleep disturbances in 25.3% and intermittent earache in 16%.

Table: 1 Percentage distribution of sample according to age group:

Age group	Number	Percentage
4-6 years	33	44
7-9 years	29	38.7
10-12 years	13	17.3
Total	75	100

Table: 2 Sex distribution of sample according to age group

Sex	Age group			Total
	4-6 yrs	7-9 yrs	10-12 yrs	
Males	24	14	10	48
Number				
% within sex	50	29.2	20.8	100%
Females	9	15	3	27
Number				
% within sex	33.3	55.6	11.1	100%
Total	33	29	13	75
Number				
% within sex	44	38.7	17.3	100%

Clinical Profile

On examination 59 (78.6%) of our children had bilateral reduced nasal patency on cold spatula test. 42 (56%) had features of adenoid facies and 25 (33.3%) had associated significant tonsillar hypertrophy.

On otoscopic examination of 150 ears, 82 (54.6%) were dull retracted tympanic membranes; 28(18.6%) showed fluid level, 4 (2.6%) tympanic membranes showed air bubbles, and 36 (24%) were normal.

Radiological profile

On measuring the adenoid nasopharyngeal ratio (ANR), 41(54.7%) children were found to have ANR between 0.701- 0.800; 19 (25.3 %) had ANR between 0.601- 0.700; 10 (13.3%) had ANR between 0.501-0.600 and 5 (6.7%) showed ANR between 0.801-0.900.

Table 3 Percentage distribution of AN Ratio (N= 75) before medical therapy.

ANR	Number of cases	Percentage
0.501-0.600	10	13.3
0.601-0.700	19	25.3
0.701-0.800	41	54.7
0.801-0.900	5	6.7
Total	75	100

Table 4: Mean ANR according to age group before medical therapy

Age group	Number	Mean ANR	SD
4-6 years	33	0.73091	0.063344
7-9 years	29	0.70598	0.061678
10-12 years	13	0.60564	0.015260
Total	75	0.70037	0.074253

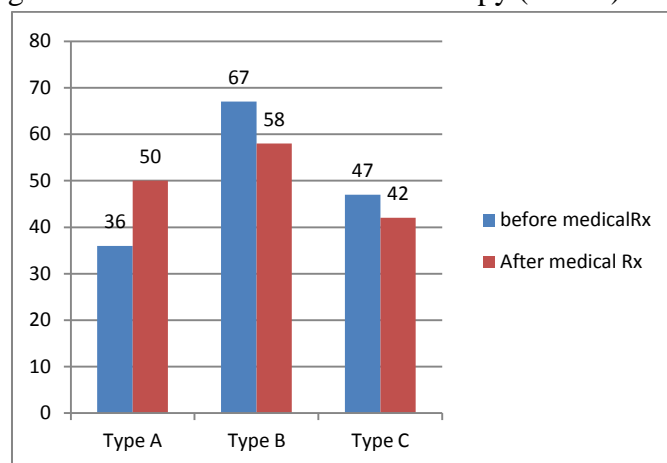
The mean AN Ratio in each age group is given in table:4

The mean AN ratio after 12 weeks of medical therapy were 0.71402 in the age group 4-6 years, 0.62416 in 7-9 years and 0.50310 in 10-12 years age group.

Tympanometric profile

Pre treatment tympanometric values of the right and left ears are shown in Table 2 & Table 3 .

Figure: 1 Distribution of pattern of tympanograms before and after medical therapy.(n=150)



Types of tympanograms

There were maximum number of B type tympanograms prior to medical therapy 67(44.7%) followed by 47 (31.3%) type C and 36 (24%) type A tympanograms. (Figure1). Most of the children with Type B tympanograms did not show statistically significant change after 12 weeks medical management (P <0.001) with combination of antibiotics (Moxclav 50-100 mg/kg body wt for 14 days), mucolytics, decongestants and anti histamines for a total of 12 weeks.

Surgical profile

In children who did not show significant response to medical management for a period of 12 weeks were subjected to surgery. Presence of fluid on myringotomy was considered as the gold standard confirmatory finding in children with OME.

Statistical Analysis

The correlation between AN ratio and tympanometric values are analyzed using chi

square test. Wilcoxon test was used to compare the mean AN ratio and mean middle ear pressures

before and after medical therapy.

Table : 5 Tympanogram types according to AN ratios before and after medical treatment

Before medical therapy				S	After medical therapy			S
AN ratio	n < 0.70	n > 0.70	total%		n < 0.70	n > 0.70	total%	
Tympanogram Type A	24	12	36(24%)		22	28	50(33.3%)	
Tympanogram Type B	10	57	67(44.7%)		8	50	58(38.7%)	
Tympanogram Type C	29	18	47(31.3%)		30	12	42(28%)	
Total	63	87	150(100%)	P<0.001	60	90	150(100%)	P > 0.45

S- Significance

Tympanometric assessment was done on all the 150 ears of 75 children with adenoid hyperplasia to measure middle ear pressures as a parameter of assessing eustachian function.

In children with AN ratio < 7.0, prior to medical therapy the number of tympanogram types were found as 24 Type A, 10 Type B and 29 type C whereas 12 Type A, 57 type B and 18 type C were found in children with AN ratio > 0.70. These values were compared with post treatment tympanograms regarding the AN ratios (Table : 5). There was statistically significant difference between the types of tympanograms in patients with AN ratio greater than 0.70 compared with the group with AN ratio less than 0.70 prior to medical therapy (P < 0.001). Our study showed the mean intratympanic pressures (types A and C) before treatment of -134.5 dapa and after therapy it was -102.06 dapa showing significant improvement (P < 0.001).

B type tympanogram indicating middle ear fluid was maximum in children with obstructive hypertrophy of adenoids with AN ratio > 0.70. Here we found no significant difference between the groups with AN ratios higher and the group with AN ratios lower than 0.70 after medical therapy (P > 0.45) in respect to the type of tympanograms. No significant difference before and after medical therapy was observed in the group with AN ratio > 0.70 according to types of tympanograms.

DISCUSSION

Myringotomy and grommet insertion with or without adenoidectomy is currently the most

common surgical procedure in children that requires general anaesthesia². As per the revised Clinical Practical Guidelines for OME (2004) published jointly by the American Academy of Family Physicians, the American Academy of Otolaryngology–Head and Neck Surgery, and the American Academy of Pediatrics, Surgical candidates are children with (1) OME lasting 4 months or longer with persistent hearing loss or other signs or symptoms; (2) recurrent or persistent OME associated with increased risk of developmental problems regardless of hearing status; and (3) OME and structural damage to the TM or middle ear. Tympanostomy tube insertion is the initial preferred procedure. Adenoidectomy should not be performed except for a specific indication (i.e. nasal obstruction, chronic adenoiditis)². Hence the importance of careful surgical selection of children for adenoidectomy in OME. The nasopharynx is subjected to great variations in size and shape during infancy and childhood.

The nasopharyngeal tonsil (adenoids) can be identified at four to six weeks gestation, lying within the mucous membrane of the roof and posterior wall of the nasopharynx². Growth continues rapidly during infancy and plateaus between 2 and 14 years of age². The adenoid appears to be at its largest in the seven year old age group. However, clinical symptoms are more common in a younger age group, due to the relative small volume of the nasopharynx and the increased frequency of upper respiratory tract infections².

The benefit of adenoidectomy in the management of otitis media with effusion (OME) has

traditionally been ascribed to the relief of anatomical obstruction of the Eustachian tube². It is also suggested that recurrent acute or chronic inflammation of the adenoid and increased bacterial load results in squamous cell metaplasia and reduced mucociliary clearance in children with OME².

Currently, there is little consensus on the best method of evaluating the adenoid size and the degree of nasopharyngeal airway obstruction, during pre-operative evaluation for adenoidectomy⁵. Nasopharyngoscopy is an invasive and expensive procedure where as rhinomanometry is poorly tolerated by children and hence is not routinely used. On the other hand, lateral neck radiograph does provide an excellent view of the adenoids and is a well-tolerated procedure by children⁶.

On lateral cephalometric radiographs, the adenoidal tissues are located at about the level of the hard plate and behind the superior border of the soft palate¹². Its growth modifies the contour of the posterior pharyngeal wall and may possibly obliterate the total nasopharyngeal cavity¹². Since growth of adenoid tissue itself occurs in a progressively changing area with resultant changes in pharyngeal contours, AN ratio can be used for standardization to assess the available space in nasopharynx.

In a study by Babek Saedi et al it was concluded that even though both radiography and nasal endoscopy could define the relationship between adenoid hypertrophy and associated symptoms and are complementary to each other, radiography could serve as a better planning tool⁵. In a similar study by Mary Kurien et al it was observed that X- ray of neck besides being a noninvasive procedure still remains to be a very reliable and valid diagnostic test in the evaluation of adenoid hyperplasia^{6,7}.

The adenoidal-nasopharyngeal ratio (ANR) was first proposed as a predictive method by Fujioka et al⁶. Subsequently AN ratio was considered as a practical and convenient method of assessing the

size of adenoidal mass in relation to the nasopharyngeal space⁶.

In our study, the adenoidal nasopharyngeal ratio (AN ratio) was calculated with digital X- ray of nasopharynx as per Fujioka method and correlated with tympanometric values before and after medical treatment. We adopted this method for calculating AN ratio because these landmarks could be easily made out on digital X ray soft tissue of nasopharynx clearly. All our children were free of acute infections like acute tonsillitis, adenoiditis and rhinosinusitis.

In our study majority of the children were in the age group 4-6 years (44%) and 7-9 years (38.7%) with a mean age of 7.8. According to ErolEgeli et al mean age was 7.7 in 64 children aged between 6-9 years; In Karan Sharma et al study the mean age of 300 patients were 5.96.

Fujioka¹⁰ et al in their study on randomly selected normal children found that the mean AN ratio increased from 0.55 at the age of 1 year 3 months and reached its highest value of 0.59 at the age of 4 years 6 months and then decreased to 0.52 at the age of 12 years 6 months.

Elwany⁷ reported that the ANRs of normal children and possible adenoidectomy candidates were 0.58 and 0.71, respectively. Mahboubi et al found the ANRs of 27 adenoidectomy candidates to be 0.71 and 0.69 in the erect and supine positions, respectively. Gangadhara Somayaji et al in their study adopted Yusuf et al method for calculating AN ratio and the mean AN ratios were 0.754, 0.733 and 0.605 in 4-6 years, 7-9 years and 10-12 years respectively. Our study showed mean AN ratio of 0.730 in 4-6 years 0.705 in 7-9 years and 0.605 in 10-12 years. All our children were free of acute infections like acute tonsillitis, adenoiditis and rhinosinusitis.

In a study by FT Orji et al¹⁹, there was significant correlation between AN ratio and age where younger children were observed to have more severe symptoms.

Our study also showed maximum number of B type tympanograms in the age group 4-6 years with mean AN ratio of 0.73 showing significant

correlation ($P < 0.001$). Erol Egeli¹³ et al in their study found the mean AN ratio of 0.64 before medical therapy and 0.56 after therapy. Our study also showed comparable values with an overall AN ratio of 0.729 before medical therapy and 0.615 after medical therapy showing a statistically significant difference ($P < 0.001$). This indicates there is significant reduction in size of adenoids following medical therapy.

Karan Sharma et al in their study analysed 300 children aged 3-12 years undergoing treatment for chronic OME and found 34.5% , 50.17% and 15.33% Type A, Type B and Type C tympanograms respectively in children with adenoid hypertrophy¹⁵. Our study showed 44.7% , 31.3% and 24% B, C and A type tympanograms respectively before medical treatment. After medical therapy we again found predominance of Type B tympanograms 38.7% followed by 28% type C and 33.3% type A tympanograms. There were 75 (50%) B and C type tympanograms before starting medical therapy and 62 (41.3%) after medical therapy and were treated surgically. In the present study, the maximum number of B and C type tympanograms were seen in children with ANR > 0.70 signifying a positive correlation between AN Ratio and type of tympanogram. We found that the number of B and C type tympanograms were significantly greater in children with AN ratio higher than 0.70 as compared to the ones with ratio lower than 0.70 showing a statistical significance in respect of tympanograms between the groups.

CONCLUSION

From the present study we conclude that in children with AN ratio greater than 0.70 with B and C type tympanograms, chance of resolution of OME with medical management alone is unlikely. In such children with OME, we recommend early surgical intervention in the form of adenoidectomy and grommet insertion.

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