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Assessment of Role of Palatal Dimensions on Speech in Cleft Lip And Palate Patients Treated with And Without Presurgical Orthopaedics.

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Abstract: *To evaluate and compare the speech in unilateral and bilateral cleft lip and palate children treated with and without presurgicalorthopaedics based on their palatal dimensions.Perceptual and digital evaluation of speech in cleft lip and palate childrencompared with there palatal dimensions.Twenty subjects with a history of cleft lip and palate or velopharyngeal dysfunction and speech disorder.Group differences in speech parameters were compared between those who did and those who did not receive the presurgicalnaso alveolar moulding appliance. The results were compared perceptually and digitally by two speech pathologists. The collected data was analyzed and subjected to Independent sample T test and Inter reliability Analysis.On evaluation of the maxillary arch,anterior arch width, antero-posterior arch length and Palatal depth was increased and Alveolar cleft width was significantly decreased in PNAM cases compared to cases treated without PNAM.The speech parameters like hyper nasality,audible nasal air emission were found to be significantly reduced in PNAM cases compared to cases treated without PNAM but consonant production error and voice disorder showed no improvement.Also,the speech understandability and acceptability was remarkably increased with PNAM. All the findings of the study indicated better speech and growth in maxillary arch form and symmetry in PNAM treated cases as compared to Non PNAM. Additionally,further research is needed to analyse other benefits of PNAM other than improvement in speech.*

Keywords:*Cleft lip and palate, Palatal dimensions, Prenasal alveolar moulding, Speech*

I. Introduction

Speech is the most important function that an individual performs for social as well as psychological benefits. Any errors in speech ultimately affect the growth and development physically and psychologically. Error‘s in speech production could be due to abnormalities in oronasal structure/function, orofacial structure and growth, learned neuromotor patterns during early infancy and/or disturbed psychosocial development. Untimely and improper surgeries pose a significant and lifelong communicative and aesthetic challenge in cleft lip and palate patients. A wide variety of speech sound errors are noticed in individuals with cleft lip and/or cleft palate such as atypical consonant productions, abnormal nasal airflow, altered laryngeal voice quality, nasal or facial grimaces[1]. The pressure consonants (stops, fricatives and affricates) are more affected than the other sounds. Protocol based technique for cleft palate repair which includes, one-stage repair of cleft palate at the age of 9–12 months seems to have a more positive influence on speech development than the two-stage procedure[2]. Variations in the maxillary arch especially the palatal dimensions, also influences the speech to a greater extent in cleft lip and palate individuals as it affects the tongue to palate contact for the production of various consonants.. The underlying objective of PNAM is to reduce the severity of the cleft deformity in all areas thereby making surgical correction easier and results of repair better. The cleft team of the Cleft Unit at Sharad Pawar Dental College in collaboration with AVBRH, Sawangi(M) follows a protocol since 2006 which is as, if a child with cleft lip and palate (unilateral or bilateral) till age 3 months if visits, is treated with presurgical orthopaedics i.ePresurgicalNasoalveolarMolding (PNAM) if indicated followed by lip repair at around 6-7 months of age and palate repair at around 12-14 months of age. In this centre, Modified Millards technique and Triangular technique is done to repair the cleft lip while for cleft palate 2-Step palatoplasty and V-Y palatoplasty procedure is done. The patient treated since 2006 are under follow up and are evaluated for benefits and complications of the surgeries and treatment done.

Therefore, the objective of this study was to evaluate and compare the speech in unilateral and bilateral cleft lip and palate children treated with and without presurgical orthopaedics and also their palatal dimensions.

II. Materials And Method

The following study was carried out in the Department of Orthodontics and DentofacialOrthopedics, Sharad Pawar Dental College in collaboration with Department of ENT, Acharya VinobhaBhave Rural Hospital, (AVBRH) Sawangi, Wardha. The study consisted of twenty samples, with ten unilateral or bilateral cleft lip and cleft palate children among which seven were unilateral and three were bilateral cleft lip and palate childrenwho were treated with presurgicalorthopedicsi.e pre nasal alveolar moulding appliance by modified graysons technique below the age of 2 months as PNAM treated group and ten unilateral or bilateral cleft lip and cleft palate children among which seven were unilateral and three were bilateral cleft lip and palate children who were not treated with PNAM. The speech outcome for these cases were also compared based on their palatal dimensions values taken from the study "Evaluation of nasal symmetry,Maxillary arch & facial form in unilateral cleft lip and palate children treated with & without Presurgicalnasoalveolar moulding as compared to normal children" [3].

Inclusion criteria-Complete cleft lip and palate cases treated
i)With and without presurgicalorthopaedics
ii) Operated below twenty months of age(lip repair at around 6-7 months of age and palate repair at around 12-14 months of age)
iii) Age group 3-10 years(mean age=6.5 years)
iv) Non syndromic patients(underwent medical examination)

The purpose and methodology of the study was explained and written consent was obtained from the subjects.Patients speech was recorded using Cenix digital audio recorder (Figure 1) in a closed room asking patient to speak their name, father's name, school name for children below 5 years and a poem, counting from sixty to seventy and counting from one to ten in the regional language for children of more than 5 years so as to have alternate vowel and consonant speech (Figure 2 and 3).The recorded speech was analyzed using computer (HP Windows 7),Digital Audio recorder (Cenix Mp3 P 2340) and Praat speech analysis software installed in the computer (Figure 4). The speech was assessed by two methods-digital software analysis (Figure 5) and by perceptual assessment done by two listenersi.e by speech language pathologists (SLP's) personnel trained in cleft speech.

The speech was analyzed for all the patients with parameters like

- ✓ Hypernasality or Hyponasality
- ✓ Audible Nasal Emission/Nasal Turbulence
- ✓ Consonant production errors,
- ✓ Voice disorder
- ✓ Speech understandability.
- ✓ Speech acceptability

which are referred as a universal or global parameters for assessing speech in cleft palate patients[4].
A four point scale was used for all the parameters to be evaluated .

0 = within normal limits
1 = mild
2 = moderate
3 = severe
X= not recorded

Evaluation of Maxillary cast: (Figure 6 and 7)
The cast were evaluated at the age of 5 years and the following points were marked and measured using Vernier Calliper and Korkhaus palatal depth indicator[3].
- Incisive papilla – I
- Distal to Canine bulge – C, C1
- Tuberosity (distal point to second deciduous molars) – T, T1
- Perpendicular from point I to the tuberosity line – P
- Most mesial point of the alveolar segment – A1, A2
- Palatal depth-measured from the most deepest point in the palate.

III. Results

The Statistical Analysis was carried out and the following tests were applied:

- Independent sample T test, Inter reliability Analysis

A)Comparison Of Mean Scores Of All Measurements Of Maxillary Arch Between Pnam And Non- Pnam Group((Table 1)- T Test

1)Alveolar cleft width- in Non PNAM group, the mean was [1.01±0.38] whereas in PNAM group, the mean was [0.69±0.19],(P value =0.02)suggesting that Alveolar cleft width was reduced in cases treated with PNAM compared to those treated with cases treated without PNAM.

2)Anterior arch width- in Non PNAM group, the mean was [2.65±0.2877] whereas in PNAM group, the mean was [2.72±0.3011],(P value=0.50) suggesting that the Anterior arch width was not found to be increased in cases treated with PNAM compared to cases treated without PNAM.

3)Posterior arch width - in Non PNAM group, the mean was [3.67±0.3199] whereas in PNAM group, the mean was [3.96±0.0843],(P value=0.01)suggesting that the Posterior arch widthwas found to be increased in cases treated with PNAM compared to those treated with NON PNAM

4)Ant-Post arch length - in Non PNAM group, the mean was [2.50±0.4967] whereas in PNAM group the mean was [2.59±0.3247](P value=0.63)suggesting that Ant-Post arch length was found to be increased in cases treated with PNAM compared to cases treated without PNAM.

5)Palatal depth- in Non PNAM group,the mean was [0.4250±0.2522] whereas in PNAM group the mean was [0.7500±0.20548)],(P value=0.05) suggesting that,it was found to be more in cases treated with PNAM compared to cases treated without PNAM.

Evaluation of speech parameters

B)Comparison Of Mean Scores Of All Parameters By Listener 1 Between Non-Pnam&Pnam Group(Table 2)

1)Hyper nasality- in Non PNAM group the mean was [1.6000± 0.69921] whereas in PNAM group, the mean was [0.6000±0.51640](P value =0.02) suggesting that Hypernasality was seen to be reduced in cases treated with PNAM compared to cases treated without PNAM.

2)Nasal air emission- in Non PNAM group the mean was [0.6000±0.51640] whereas in PNAM it was [0.1000±0.31623](P value=0.01) suggesting that Nasal air emission was markedly reduced in cases treated with PNAM compared to cases treated without PNAM.

3)Consonant production Error- in Non PNAM group, the mean was [0.8000±0.42164]whereas in PNAM group, the mean was [0.5000±0.52705](P value =0.17) suggesting that Consonant production Error was reduced in cases treated with PNAM compared to cases treated without PNAM.

4)Voice disorder- in Non PNAM group, the mean was [0.4000±0.51640] whereas in PNAM group the mean was [0.6000±0.51640](P value=0.39) suggesting that voice disorder was seen more in cases treated with PNAM compared to cases treated without PNAM.

5)Speech Understandibility- in Non PNAM group, the mean was [0.6000±0.69921] whereas in PNAM group the mean was [1.4000±0.51640] (P value =0.00)suggesting that the cases treated with PNAM had more understandable speech compared to cases without PNAM

6)Speech Acceptability- in Non PNAM group, the mean was [0.6000±0.69921] whereas the mean in PNAM group was [1.3000±0.48350](P value =0.00)suggesting that the cases treated with PNAM had more acceptable speech compared to cases without PNAM

(C) Comparison Of Mean Scores Of All Parameters By Listener 2 Between Non-Pnam&Pnam Group(Table 3)

1)Hyper nasality- in Non PNAM group, the mean was [1.8000±0.63246] whereas in PNAM group, the mean was [0.6000±.51640](P value =0.00)suggesting that Hyper nasalitywas reduced in cases treated with PNAM compared to those treated without PNAM.

2)Nasal air emission- in Non PNAM group, the mean was [0.1000±0.31623] whereas in PNAM group, the mean was [0.3000±0.48305](P value =0.28) suggesting that Nasal air emission was found to be more in cases treated with PNAM compared to those treated without PNAM.

3)Consonant production Error- in Non PNAM group, the mean was [0.2000±0.42164] whereas in PNAM group, the mean was [0±0.52705](P value =0.75)suggesting that consonant production error was found to be more in cases treated with PNAM compared to those treated without PNAM

4)Voice disorder- in Non PNAM group, the mean was [0.6000±0.51640] whereas in PNAM group the mean was [0.8000±0.42164](P value =0.35)suggesting that Voice disorder was found to be more in cases treated with PNAM compared to cases treated without PNAM.

5)Speech Understandibility- in Non PNAM group,the mean was [0.6000±0.69921] whereas in PNAM group the mean was [1.5000±0.52705](P value =0.00) suggesting that the speech understandability was better in cases treated with PNAM compared to cases treated without PNAM.

6)Speech Acceptability- in Non PNAM group, the mean was [0.6000±0.69921] whereas in PNAM group the mean was [1.5000±0.52705](P value =0.00**)** suggesting that the speech was more acceptable in cases treated with PNAM compared to cases treated without PNAM.

(D) Interexaminer Reliability Between Both The Listeners In Non PnamAnd Pnam Group(Table 4)

1) Hypernasality showed 0.37 correlation in Non PNAM and 0.29 correlation in PNAM with a reliability of 0.8(Good agreement) suggesting that the listeners 1 & 2 agreed that hypernasality reduced in PNAM treated cases compared to cases treated without PNAM.

2) Nasal air emission showed 0.32 correlation in Non PNAM and 0.28 correlation in PNAM with a reliability of 0.4(Moderate agreement) suggesting that the listeners 1 & 2 agreed that nasal emission reduced in PNAM treated cases compared to cases treated without PNAM.

3) Consonant productionerrorshowed0.45 correlation in Non PNAM and 0.49 correlation in PNAM with a reliability of 0.4.(Moderate Agreement) suggesting that the listeners 1 & 2 agreed that consonant production did not improve with PNAM group compared to cases treated without PNAM

4) Voice disorder showed 0.44 correlation in Non PNAM and 0.42 correlation in PNAM with a reliability of 0.2(Mild Agreement) suggesting that the listeners 1& 2 agreed that voice disorder was same and did not improve in PNAM groups as compared to cases treated without PNAM.

5) Speech Understandibility, showed 0.36 correlation in Non PNAM and 0.40 correlation in PNAM with a reliability of 0.4(Moderate Agreement) suggesting that the listeners 1& 2 felt that cases treated with PNAM has got much understandable speech compared to cases treated without PNAM.

6) Speech Acceptability, showed 0.39 correlation in Non PNAM and 0.43 correlation in PNAM with a reliability of 0.4(Moderate Agreement) suggested that listeners 1 & 2agreed that cases treated with PNAM has got much acceptable speech compared to cases treated without PNAM.

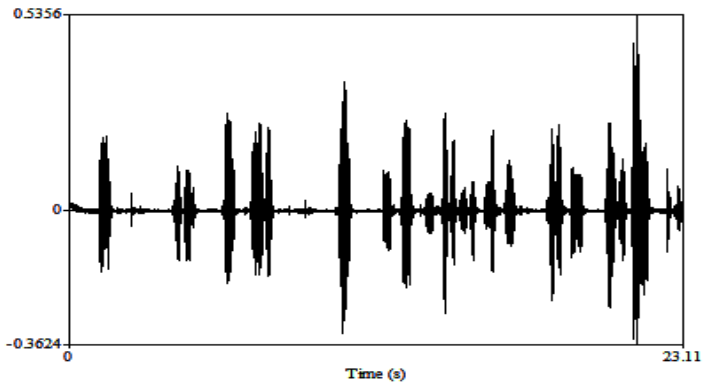
IV. Figure's and Tables

Figure 1: Digital Audio Recorder (Cenix Mp3 P 2340)

Figure 2: Recording of Speech of a Patient with a Digital Recorder

Figure 3: Recording of Speech in Speech Therapy Unit

Figure 4: Speech analysis using the Praat software installed in the Computer



Graph in Non Cleft individual

PNAM treated Patient Non PNAM treated Patient

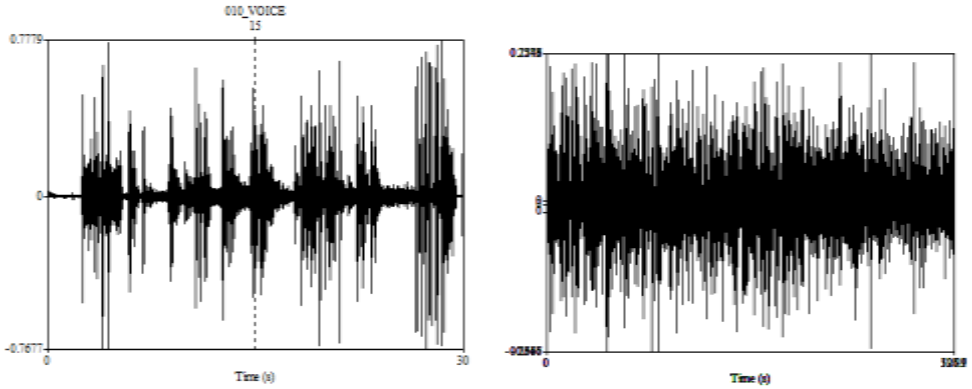


Figure 5: Software graphs of Non cleft individual, PNAM treated patients and Non PNAM treated patients Evaluation of maxillary cast

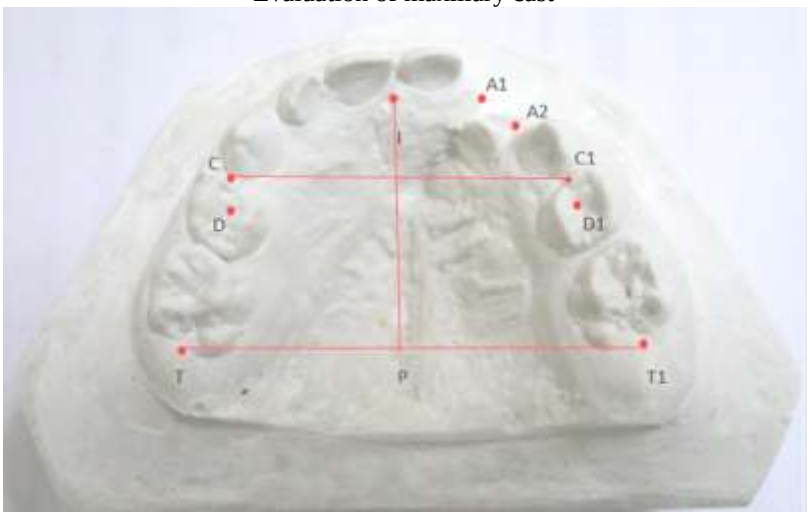


Figure 6- evaluation of PNAM treated patients cast

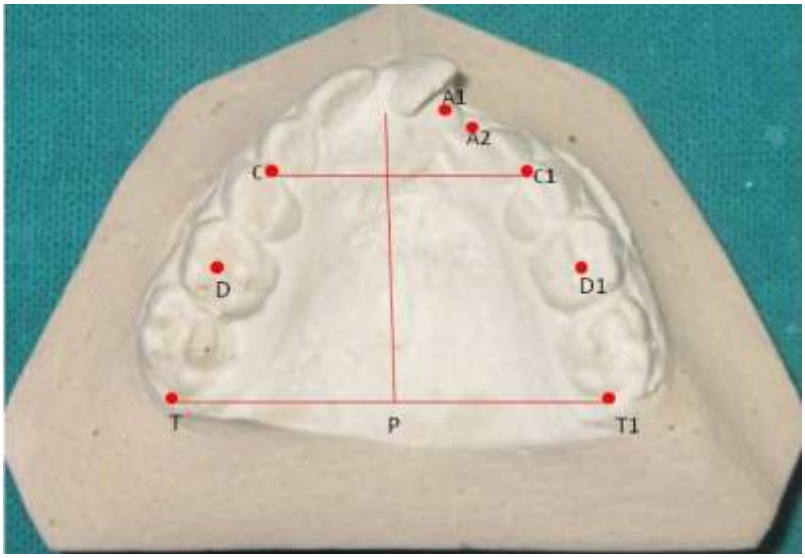


Figure 7- evaluation of Non-PNAM treated patients cast

A1 to A2	Alveolar cleft width evaluation
C to C1	Anterior arch width evaluation
T to T1	Posterior arch width evaluation
I to P	Antero-posterior arch length Evaluation
D to D1	Palatal depth evaluation

A) Comparison Of Mean Scores Of All Measurements Of Maxillary Arch Between Pnam And Non- Pnam Group((Table 1)- T Test

	Group	N	Mean	Std.Deviation	P Value
Alveolar cleft width	PNAM	10	0.6900	0.19120	0.02 (significant)
	NON PNAM	10	1.0100	0.38427	
Anterior arch width	PNAM	10	2.72	0.3011	0.60 (non significant)
	NON PNAM	10	2.65	0.2877	
Posterior arch width	PNAM	10	3.96	0.0843	0.01 (significant)
	NON PNAM	10	3.67	0.3199	
Ant-post arch length	PNAM	10	2.59	0.3247	0.63 (non significant)
	NON PNAM	10	2.50	0.4967	
Palatal depth	PNAM	10	.7500	.20548	0.05 (significant)
	NON PNAM	10	.4250	.25522	

B) Comparison Of Mean Scores Of All Parameters By Listener 1 Between Non-Pnam&Pnam Group(Table 2)- Independent Sample T-Test

	Treatment	N	Mean	Std. Deviation	P value
Hypernasality	non-PNAM	10	1.6000	.69921	P=0.02 significant
	PNAM	10	.6000	.51640	
Nasal air emission	non-PNAM	10	.6000	.51640	P=0.01 significant
	PNAM	10	.1000	.31623	
Consonant production	non-PNAM	10	.8000	.42164	P=0.17 Non significant
	PNAM	10	.5000	.52705	
Voice disorder	non-PNAM	10	.4000	.51640	P=0.39 Non significant
	PNAM	10	.6000	.51640	
Speech understandability	non-PNAM	10	0.6000	.69921	P=0.00 significant
	PNAM	10	1.4000	.51640	
Speech acceptability	non-PNAM	10	0.6000	.69921	P=0.01 significant
	PNAM	10	1.3000.	.48305	

C) Comparison Of Mean Scores Of All Parameters By Listener 2 Between Non-Pnam&Pnam Group(Table 3)- Independent Sample T-Test

	treatment	N	Mean	Std. Deviation	P Value
Hypernasality	non-PNAM	10	1.8000	0.63246	P=0.00 (significant)
	PNAM	10	0.6000	.51640	
Nasal air emission	non-PNAM	10	.1000	.31623	P=0.28 (Non significant)
	PNAM	10	.3000	.48305	
Consonant production error	non-PNAM	10	.2000	.42164	P=0.75 (Non significant)
	PNAM	10	.5000	.52705	
Voice disorder	non-PNAM	10	.6000	.51640	P=0.35 (Non significant)
	PNAM	10	.8000	.42164	
Speech understandability	non-PNAM	10	.6000	.69921	P=0.00 (significant)
	PNAM	10	1.5000	.52705	
Speech acceptability	non-PNAM	10	.6000	.69921	P=0.00 (significant)
	PNAM	10	1.5000	.52705	

D) Interexaminer Reliability Between Both The Listeners In Non PnamAnd Pnam Group Table 4-Inter Reliability Analysis

Parameters	Non PNAM	PNAM		Inter Examiner Agreement
	Correlation	Correlation	Reliability	
Hypernasality	0.37	0.29	0.8	Good Agreement
Audible nasal air emission	0.32	0.28	0.4	Moderate Agreement
Consonant production error	0.45	0.49	0.4	Moderate Agreement
Voice disorder	0.42	0.44	0.2	Mild Agreement
Speech Understandability	0.36	0.40	0.4	Moderate Agreement
Speech Acceptability	0.39	0.43	0.4	Moderate Agreement

V. Discussion

Controversy has existed within researchers regarding the use of PNAM.Due to various types of surgical procedures, timing of surgery for cleft lip and palate repair, which present their own controversies, comparing results becomes difficult.

Although lot of research work has been carried out and is still ongoing on speech therapy in cleft lip and cleft palate patients, there is minimum literature available which have evaluated the efficiency of speech in patients treated with and without presurgical infant orthopaedics.

The purpose of this study was thus, to evaluate the speech outcome in cases treated with and without PNAM based on their palatal dimensions.

Speech evaluation was done under the following headings

i. Hypernasality, ii)Audible nasal air emission, iii)Consonant production errors, iv)Voice disorder, v)Speech Understandibility, vi)Speech Acceptability

i) Hypernasality-In our study, when hypernasality was evaluated, it was found to be reduced in cases treated with PNAM as compared to cases treated without PNAM by both the listeners. Also when the hypernasality was compared using an interlistener reliability analysis, both the listeners agreed that the hypernasality was found to be reduced in cases treated with PNAM as compared to Non PNAM. One of the reason behind it may be the reduction in the alveolar cleft width by alveolar moulding which causes reduction in air passage from oral cavity to nasal cavity during early stages of speech development. Also the patients who underwent presurgicalorthopedics had early palate repair within 12-14 months of age which lead to early and better closure of the defect and helped in better speech development at an early age[5].

ii) Audible nasal air emission –In our study, when the audible nasal air emission was evaluated,it was found to be reduced in patients treated with PNAM as compared to cases treated without PNAM. Also when the audible nasal air emission was compared using an interlistener reliability analysis, both the listeners agreed that the audible nasal air emission was found to be reduced in cases treated with PNAM as compared to cases treated without PNAM. This may be due to the closure of oronasal fistula at an early age i.e early palatoplasty which causes reduction in the air escape from the nose during early speech development. In Non PNAM cases, some cleft cases may undergo palate repair at a later age which can produce oral escape of air through nose leading to audible nasal air emission during speech[6].

iii) Consonant production Error –In our study, when the consonant production error was compared, it was same and not much improved in cases treated with PNAM as compared to cases treated without PNAM. Also when the consonant production error was compared using the interlistener reliability analysis, both the listeners agreed that the consonant production error was same and not much improved in cases treated with PNAM as compared to cases treated without PNAM. The reason could be the lack of speech training to children because of lack of awareness of parents towards speech therapy during time of early speech development which causes the child to acquire improper speech or substitution of errors in place of proper words.

iv) Voice Disorder- In the current study when the voice disorder was compared , it was same and not much improved in cases treated with PNAM as compared to cases treated without PNAM. Also when the voice disorder was compared using the interlistener reliability analysis, both the listeners agreed that the voice disorder was same and not much improved in cases treated with PNAM as compared to cases treated without PNAM. The reason could be due to lack of awareness of parents and failure to approach a speech therapist during time of early speech development leading to disrupted speech[7].Thus, we can conclude that, the parental training for speech therapy shows promising effect on speech for children with a history of cleft palate and velopharyngeal dysfunction along with surgery and prosthetic methods[8].

iv) Speech Understandibility and Speech Acceptability-Speech intelligibility is the degree to which the acoustic signal is understood by the listener and speech understandability is the listener's understanding of an utterance in a communicative context.In our study, when the speech was compared for speech understandability and speech acceptability, it was found to be much understandable and acceptable speech in cases treated with PNAM as compared to cases treated without PNAM. Also the interlistener reliability analysis showed that speech understanding and speech acceptability was better in PNAM treated cases as compared to Non PNAM. The reason may be the reduction in cleft width, early palate repair leading to reduction in oronasal air escape and better tongue adaptation to the palate leading to better speech production[9].The speech understandability and speech acceptability in children's treated with the palatal obturators and speech bulbs were evaluated and showed a significant improvement in speech intelligibility due to the length of the soft palate during speech production which was achieved by the speech bulb prosthesis[10].

VI. Conclusion

With this study we can conclude that, the speech was better for all the cases treated with PNAM as compared to cases treated without PNAM. According to results of our study, the main reason for a better speech in children treated with presurgicalorthopaedics was early palate repair at appropriate time by using same surgical technique.For all the cases included in our study, cases treated with PNAM were operated for palate repair at an early age i.e between 12-14 months of age by 2-Step palatoplasty and V-Y palatoplastysurgical technique that is also one of the reason which lead to a better speech in these children. From the above findings it can be concluded that PNAM was significantly effective in improving speech in children treated with the appliance.However, the present study is a short term study with limited sample, so evaluation of studies with large sample size who have undergone PNAM therapy is necessary to determine its effects on speech and the growth of the naso-maxillary complex.

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