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Comparative Evaluation of Compliance and Speech Intelligibility among Complete Denture Wearers Based on Modifications in Anterior Palate

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Abstract:-

Introduction: Palatal rugae duplication in complete denture prosthesis acts as an effective aid helping patient to favourably position his tongue during denture adaptation. This aids the patient in learning to speak with dentures shortly, hence improving his denture satisfaction. Covering the palatal area by denture base acrylic resin results in proprioceptive changes hence rendering most of the complete denture wearers handicapped with respect to speech and pronunciation. Although, evident importance of palatal rugae in speech production has not been proven, it has been suggested that duplicating the palatine rugae in the complete denture base facilitates speech especially the linguo-palatal consonants.

Aim: The present in vivo study was done to compare compliance and speech intelligibility of complete denturewearers with conventional denture & denture with modified anterior palate.

Materials and Methods: The study included four phases (phase one without denture, phase two with conventional complete denture, phase three subject with complete denture having anatomic palate fabricated in PMMA and phase four with complete denture having anatomic palate fabricated in silicone). Sound samples were recorded in each phase. Fifty individuals in the age group of 55 to 70 years participated in the study. The sound samplesrecorded from each subject were assessed both quantitatively (by speech analysis software) and qualitatively (by team of speech specialist). The recorded data was analysed using a one-way ANOVA for repeated measurements and Mann-Whitney U test for Likert's scale rating.

Results: Quantitatively Pitch & intensity of phase IV as per statistical analysis showed significant difference from phase I and patients showed more compliance for phase IV dentures.

Conclusion: Within the extent of this in vivo study, it can be inferred that speech intelligibility as well as compliance after denture Insertion was more in phase IV followed by phase III and phase II.

I. INTRODUCTION

Linguistic association is elicited through speech which is a multidimensional signal.[1]Oral cavity is used as an instrument by stomatognathic system for production of speech. Static components of speech include teeth, alveolus, palate whereas dynamic components include tongue, lip and velum[2,3]. Any variation from normal will thereby affect adversely production of speech. With complete edentulism and atrophy of associated structures, this problem exacerbates many folds resulting in compromised phonation, aesthetics as well as functional handicap[4]. Complete denture being the most common dental treatment modality for the completely edentulous patients, alters the intraoral scenario i.e anatomy, physiology and even brain function activity [5]. During fabrication of complete dentures evaluation of speech is usually overlooked by clinicians while the elements like esthetics, function, and comfort of denture treatment are prioritized.[6-9]Unpleasant and embarrassing situation is encompassed by the patients due to improper speech while having complete dentures in place. As such, patients adapt to new dentures within few weeks [10-14], however for elderly patients it may take longer to adopt for changes in the oral milieu[13].

Patients with complete denturesusually bewail about the unacceptable pronunciation of certain words which is accredited to the rugae form and palatal contour[9]. The ridges present on sides of the mid palatine raphe anteriorly constitute the rugae palatine, commonly referred to rugae. For audible speech, accurate approximation of tongue with the palate is required. Thus, the replication of soft tissue contour favours the articulation of sibilants similar to normal dentate individual. Precise reproduction of rugae in the complete denture not only enhances phonetics but also helps in mastication, deglutition and better taste perception [15]. There is scarcity of methods in the literature that could be used to improvise the speech intelligibility in such patients. Few methods advocated include duplication of palatal rugae, palatographic recontouring of the palate, incorporation of roughness in the anterior palate[3].

Replicating anterior palate anatomically has proven to be beneficial, however fabricating it with a material that gives patient a feel of natural resilient mucosa may enhance the compliance as well as speech intelligibility. Contributing towards it, the present in vivo study was planned with the aim to compare the speech intelligibility and compliance of complete dentures wearers with conventional complete denture, complete denture having anatomic palate fabricated

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in PMMA and complete denture having anatomic palate fabricated with silicone.

II. MATERIALS AND METHODOLOGY

The present in vivo study was carried out in the department of prosthodontics, GDC srinagarover a period of 16 months. In this study, the quality of speech sounds (i.e., pitch and intensity) and compliance was tested in completely edentulous patients in four phases (phase one without denture, phase two with conventional complete denture, phase three with complete denture having anatomic Palate fabricated in PMMA and phase four with complete denture having anatomic palate fabricated in silicone. Fifty completely edentulous patients participated in the study and were selected inclusion and exclusion criteria.

A. *Inclusion Criteria:*

- Moderately educated patients from same area and ethenicity.
- Patients with healed well rounded ridges, with no history of tongue tie and other related treatments
- Patients with good hearing ability (thresholds more than 20 dB in their poorer ear).

B. *Exclusion Criteria*

- Uncooperative hysterical patients;
- Patients with congenital or acquired maxillofacial defects;
- Patients withintraoral or extraoral pathosis;
- Neuromuscularly debilitated patients.

After obtaining signed written informed consent from each patient and ethical clearance was obtained from the Institutional Ethical Committee. For all patients complete dentures (maxillary and mandibular) were constructed as per standardised protocol suggested by Boucher[4]. For sounds recordinglinguopalatal sounds (e.g., t, d, l, n in which the tongue made active contact with the palate) and other linguopalatal sounds (s, sh, ch, jh, which are formed by passive contact of tongue with the palate) were used. These speech sounds were recorded in local language (kashmiri) and consists of-Phrases, words loaded with phonemes. eg. drav, Salaam, sham, Tata, Dum, Daam, Naal.

III. RECORDING OF SPEECH SAMPLES

Recording was done in a sound proof room (semi-anechoic room) while making patients sit at a distance of 20 cms in front of microphone.

IV. MODIFICATIONS MADE IN COMPLETE DENTURE

- **Type I:** Conventional complete denture: constructed following the protocol suggested by Boucher[4].
- **Type II:**Complete denture with anatomic anterior Palate fabricated in PMMA(figure 1): preliminary impression was recorded using impression compound with a stock tray. This was followed by fabrication of primary cast using dental plaster (type II). Acrylic Custom tray made on primary cast was used to record secondary impression following border molding. Before pouring the impression intaglio surface in the region of rugae was replicated using self cure acrylic resin. This acrylic template so obtained is placed on the master cast (obtained after pouring secondary impression with type III dental stone) and incorporated into temporary denture base. The positive replica of anterior hard palate incorporated in temporary denture base will be hence duplicated in final dentureby following steps similar to that used for fabrication of conventional denture.
- **Type III**: Complete denture having anatomic palate fabricated in silicone (figure 2): Fabricated in a similar way as type I except for replicating anterior hard palate with silicone elastomer.

V. ASSESSMENT OF THE SOUND SAMPLES

Sound samples were recorded from patients first without dentures, then with conventional dentures and then with modified dentures. The sound samples recorded from each patient at different phases were analysed by using-objective method (quantitative analysis) and subjective method (qualitative analysis). In this study quality (pitch & intensity) ofspeech sounds was done using voice pitch analyser and sound meter resp. Each sample was displayed in the form of a spectrograph (sound waves) which provided the details of the mean frequencies (pitch of sound) and mean decibel (intensity/loudness of sound). These sound frequencies and sound decibels were tabulated/ analysed statistically in order to determine which phase signified best intelligibility of the sound. Qualitative analysis was completely subjective and was divided into two groups GROUP A and GROUP B such that each group was assessed but different set of experts including, ENT surgeon, speech therapist and prosthodontist. Each group was randomly allocated 25 patients. The 5 point Likert's scale was used for evaluating the clarity of the speech sounds at each phase. In order to avoid bias the samples were played randomly without informing the observers about the phase. Likert's scale used for speech assessment consists of 5 points –from 0 to 4.

- Clear Sounds: 4
- Normal sounds, slightly unclear: 3
- Requires effort to understand: 2
- Understoodif content is known: 1
- Indistinct Sounds: 0.

Compliance with different dentures was again subjective and was evaluated by patient acceptance.

VI. STATISTICAL ANALYSIS

The recorded data was compiled and entered in a spreadsheet (Microsoft excel) and then exported to data editor of SPSS version 20.0 (SPSS INC., Chicago, Illinois, USA). Continuous variables were expressed as Mean±SD. Analysis of variance (ANOVA), with post-hoc tests were applied for comparing pitch and intensity among various phases. A p-value of less than 0.05 was considered statistically significant. The qualitative analysis was done using Likert scale ratingusing Mann- Whitney U test.

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VII. RESULTS

On analysing the results of pitch (table 1& graph 1) in phases I- IV, insignificant difference was seen between phase I and phase II as well as phase I and phase III(p=0.3 and p=1.3 resp.). However, there was significant difference between phase I and phase IV as evident from p value being less than 0.05(p= 0.0002).Similarly, insignificant difference was seen with respect to intensity (table 2& graph 2) between phase I and phase II as well as Phase I and Phase III.Phase I and phase IV(p= 0.005) showed significant difference statist2qwically. Hence quantitatively both pitch & intensity seems to be increased in phase IV.

The qualitative analysis involved evaluation of speech soundsby Likert scale ratings (table 3), given by group of experts, using MannWhitney U test. The scores given by experts to sound samples of different phases however, differ significantly from each other but no significant difference was seen between the ratings by judges to the sound samples of group A and B in a particular phase (p>.05). On comparing the ratings for Group A and B, phase four ratings were highest for both groups (3.10, 3.12 respectively).

In terms of compliance patients showed more acceptance with conventional dentures followed by phase four dentures. Least acceptance was shown with phase three dentures.

VIII. DISCUSSION

Comprehensive dental treatment in completely edentulous patient requires a thorough knowledge of speech. Speech is actually combination of sounds, Vowels, Diphthongs, Consonants and Combinations[16,17]. Probing of linguistic research has revealed documentation on importance of tongue-palate contact for phonation. Eslamian and Leilazpour, analysed the importance of tongue-palate contact and revealed that contact between the tongue-palate was mostly at the anterior/ lateral parts of the palate with least contact at mid palatal area [18]. Fiona Gibbon FE et al., also compared tongue-palate contact patterns for alveolar sounds (/t,/d/) with the nasal stop/n/using Electropalatography (EPG) and concluded “t” “d” “n” was under anterior constriction EPG frames [19]. Various studies have concluded that an increase in the quality of speech production can be appreciated after habituation to prosthesis.[14,20-22]It is assumed that complete edentulism can cause a persistent speech disorder by altering dental articulation areas, hence severely reducing the quality of speech[23]. Several authors advocated that immediately post denture insertion problemsin speech sound production might arise probably because of missing proprioceptors[30], change in sensory stimulus and dimensions palatal vault and gradual hearing loss due to senility[25-29]. Taking this in consideration, authors emphasised upon the importance of modifying palatal vaults of maxillary complete dentures to improve speech. Some have recommended arbitrary changes in shape and thickness[31], incorporation of palatal rugae [3] change in material of palatal part of the denture and functionally modify [11] palatal surfaces of the maxillary denture. Palatal rugae play a key role in phonetics. The absence of rugae hampers the proper articulation. These can be however transferred to the palatal surface of the denture in various ways viz. by using plastic palate forms, corrugated metal palate and free hand wax carving of anatomic palate[33], use of inter dental floss for duplication of width and thickness of rugae[34].

In context to above discussion that enumerated benefits of transferring anatomic rugae into final denture if replicated with a material that gives patient a feel of natural resilient mucosa may enhance the compliance as well as speech intelligibility.

In the present study, an attempt was made to improve the quality of speech sounds produced immediately post denture insertion by modifying anterior hard palate using PMMA and silicone elastomer. The aim of this study was to compare the speech intelligibility and compliance of complete dentures wearers with conventional complete denture, complete denture having anatomic palate fabricated in PMMA and complete denture having anatomic palate fabricated with silicone. The pitch and intensity of sound samples were assessed for quantitative analysis.

After statistical analysis, on analysing the results of pitch in phases I- IV, insignificant difference was seen between phase I and phase II as well as phase I and phase III (p=0.3 and p=1.3 resp.). However, there was significant difference between phase I and phase IV as evident from p value being less than 0.05(p= 0.0002).Similarly, insignificant difference was seen with respect to intensity between phase I and phase II as well as Phase I and Phase III. Phase I and phase IV however showed significant difference (p=0.005). Hence quantitatively both pitch & intensity seems to be increased in phase IV whereas in phase III intensity shows significant difference than phase I.

On comparing sound samples, statistically insignificant difference was seen between phases I versus Phase II and III. This may be attributed to the fact that the tongue had to work against the faux surface. It was quite possible that speech produced might get more clear if the tongue was allowed to adjust with the changed introral milieu.

It was observed that in phase one the intensity and pitch of sound was least i.e., without denture. Hence the speech intelligibility (frequency and intensity) was observed to be significantly low when compared to other phases where dentures were inserted. When the phase two was analysed with phase three the speech intelligibility was less in the former hence made it evident that modification of anterior palate can improve the speech sound quality. These findings were in association with the previous studies conducted by Raghavendra Adaki , Suresh Meshram , Shridevi Adaki [32]. The data so obtained from this study showed that the speech intelligibility increased in phase four (both intensity and pitch). This observation is understandable because the modification of palatal surface of the denture offers a more physiologic contact of tongue during pronunciation of sounds as compared to the smooth, highly polished, arbitrarily contoured palatal surface of a conventional denture. But still speech produced phase in

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three was but slightly unclear compared to phase four. This can be inferred to the fact that the even though the anatomic rugae were incorporated in the dentures of phase III patients, tongue had to work against the artificial surface that is hard and slippery. In phase four where anterior palate was replicated anatomically using extraoral silicone provided a better tactile sensation to the tongue thus resulting in even better speech intelligibility immediately after denture insertion. This allowed contact of the tongue with the resilient material in anterior palate resulting in production of sounds with high frequency and intensity, thus making it very clear. Similar results were depicted by the Likert chart with highest marking of 4 by the experts. Conversely, in phase two and one the sound was not much clear and could be understood with effort and only if the content was known in certain cases. Compliance for the particular type of denture was evaluated subjectively by reporting the preferred denture by the patient. Greater compliance was shown for phase four dentures followed by phase two. Phase three showed least acceptance.

IX. SUMMARY & CONCLUSION

Speech is an essential function of oral cavity. It is usually ignored quite frequently while fabricating dentures. In this study modification of anterior palatal surface of denture was done and was assessed for its impact on phonetics.

The duplication of anatomic palatal rugae in complete dentures has been advocated, with different techniques. Since its addition can increase the thickness of palate, its duplication is discouraged by few authors. Most of these studies however focused on clinical outcomes rather than patient-reported outcomes.

Based on the findings of this clinical trial, the following conclusions were drawn:

- The duplication of anatomic palatal rugae showed to improve the speech intelligibility of patients than smooth polished anterior palatal region of conventional dentures.
- Anterior palate replicated in silicone showed greater speech intelligibility as well as compliance.
- Phase three dentures i.e. anterior palate modified anatomically using PMMA showed least acceptance.
- Denture cleansing however was more difficult in phase IV denture than phase III & II.

Within the limits of this study, routine addition of palatal rugae to conventional complete dentures is recommended. However, more research in this field is required.

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- **Figure 1**

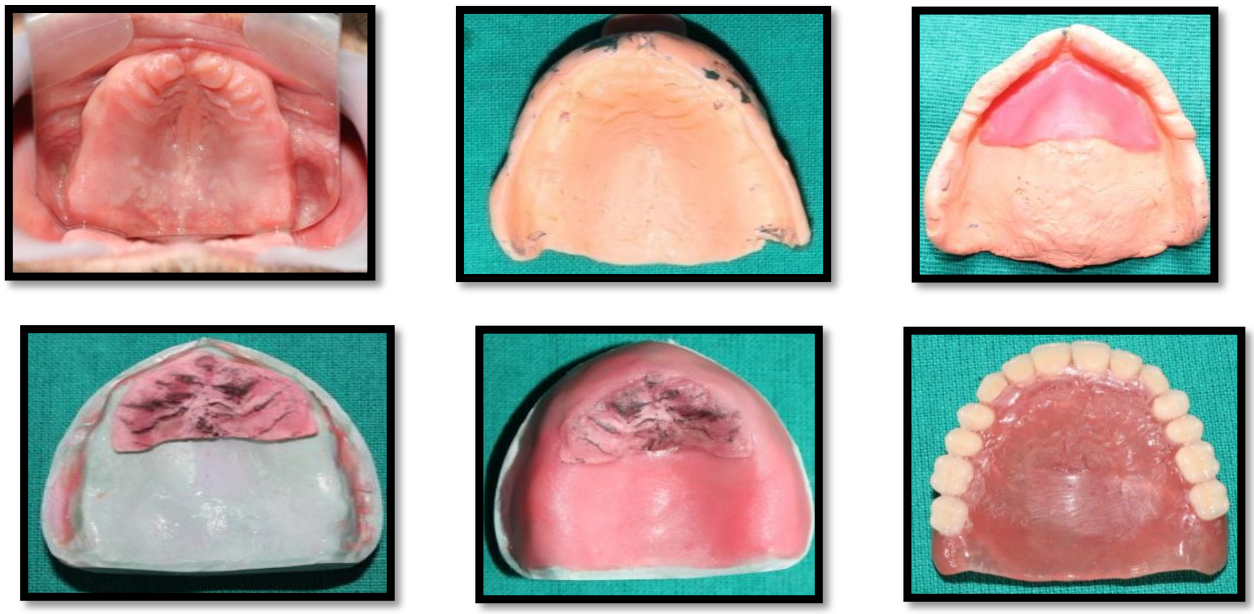

Fig. 1: (a) completely edentulous arch of patient. (b) secondary impression recorded after border moulding. (c) rugae in anterior palate recorded with selfcure acrylic resin. (d, e) incorporation of acrylic template into the temporary denture base. (f) final processed denture.

- **Figure 2**

Fig. 2: (a) anterior palate replicated in silicone (b) final processed denture

Table 1: Comparison based on pitch among various phases							
Pitch	Mean	SD	95% CI for Mean		Comparison	Mean Difference	P-value
Phase I	149.7	3.4	150.6	148.6	-	-	-
Phase II	150.8	3.45	151.7	149.8	II vs I	1.1	0.3
Phase III	155.2	3.3	156.2	154.3	III vs I	5.5	1.3
Phase IV	158.9	4.08	160.07	157.7	IV vs I	9.2	0.0002

Table 1: *Statistically Significant Difference (P-value<0.05) CI: Confidence Interval

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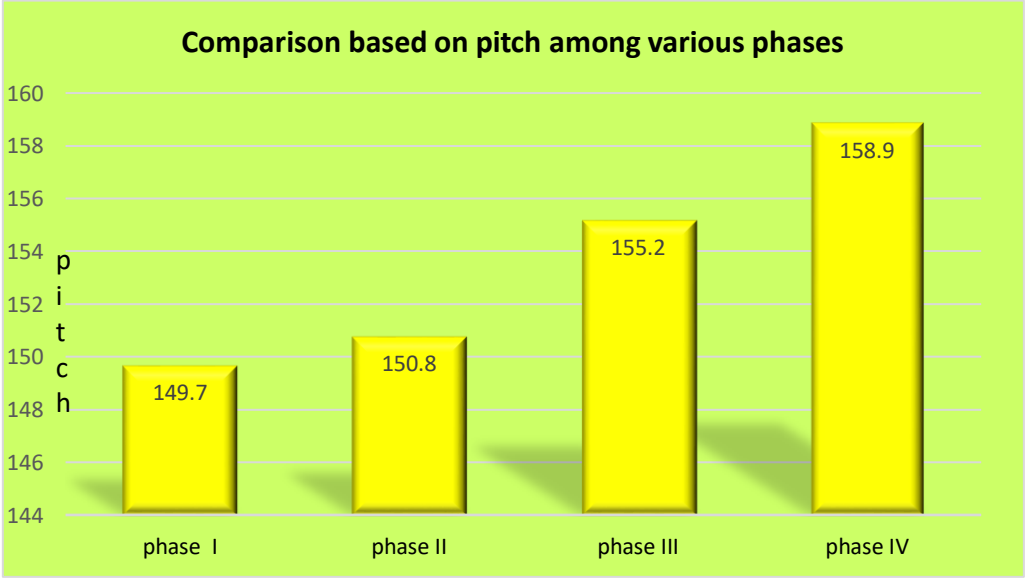
Table 2: Comparison based on intensity (dB) among various phases							
Intensity (dB)	Mean	SD	95% CI for Mean		Comparison	Mean Difference	P-value
Phase I	50.34	2.68	51.03	49.49	-	-	-
Phase II	52	2.668	52.7	51.1	II vs I	1.66	0.31
Phase III	55.26	2.666	56.02	54.4	III vs I	4.92	0.08
Phase IV	58.06	2.8	58.9	57.25	IV vs I	7.72	0.005

Table 2: *Statistically Significant Difference (P-value<0.05); CI: Confidence Interval

Mann-Whitney U comparisons of Likert scale rating by experts for Group A and B				
	Phase I	Phase II	Phase III	Phase IV
Group A	1.71± 0.45	2.14±0.33	2.40±0.4	3.10±0.67
Group B	1.69±0.46	2.15±0.33	2.53±0.4	3.12±0.74
P value	0.735	0.795	0.626	0.648

Table 3



Graph 1

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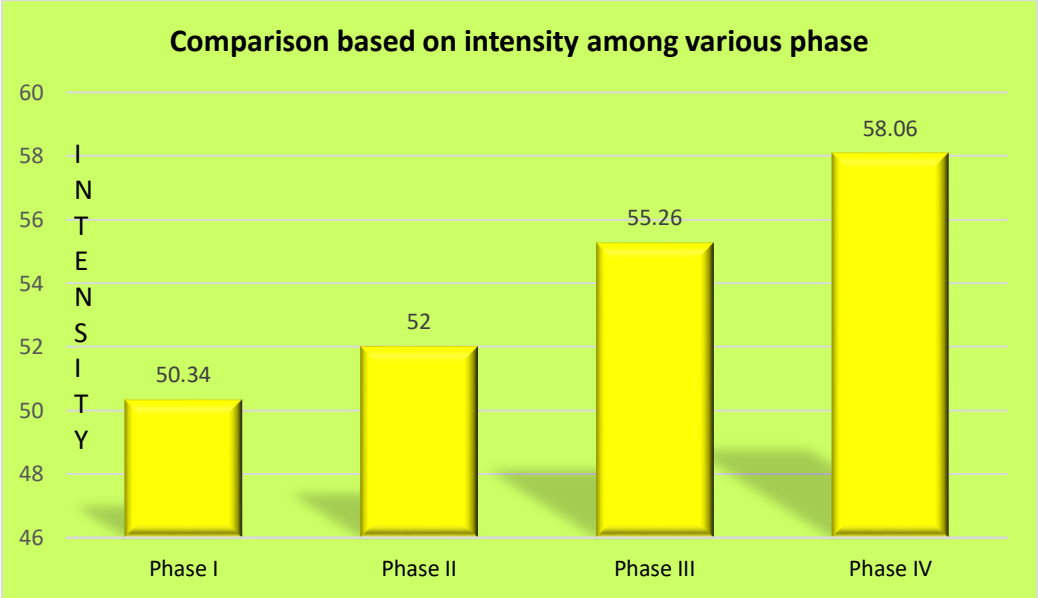
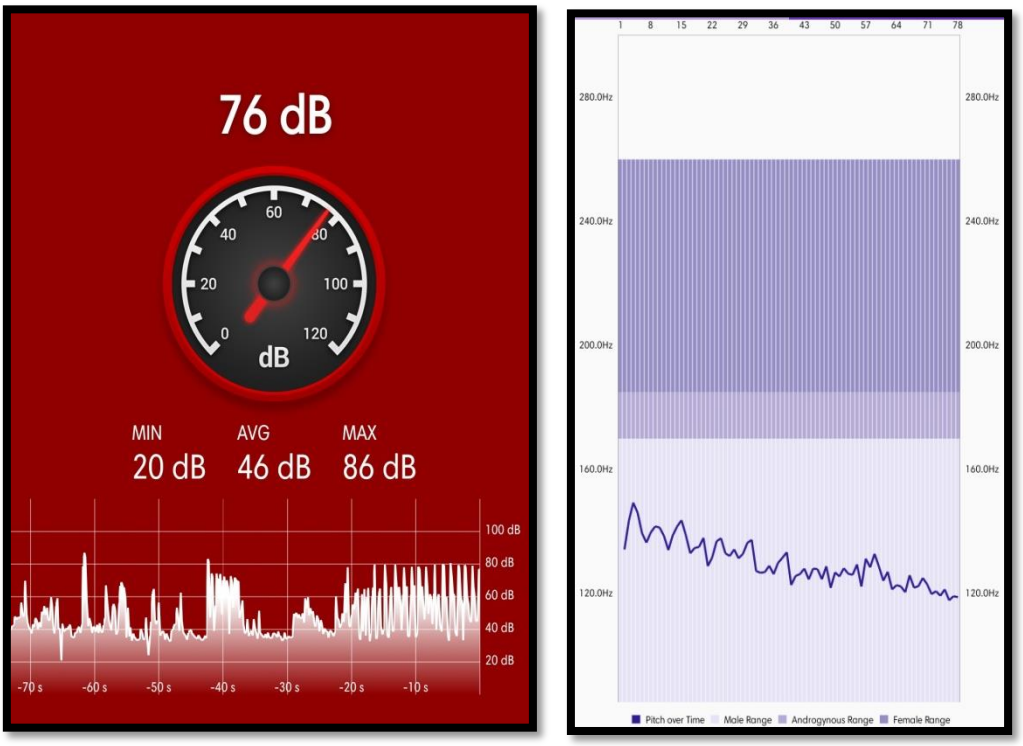


Graph 2



SPECTOGRAPHS OBTAINED FOR INTENSITY AND PITCH RESPECTIVELY