

Evaluation of speech in children with class III malocclusion before and after orthodontic management

Adel Rashid¹, Salwa A. Abd Elhay², Shereen A. El Mahlawy³

Abstract:

Objectives:

This study aimed to identify speech sound disorders in children with class III malocclusion and evaluate the effect of orthodontic management and complementary speech therapy sessions on correction of these disorders.

Subjects and Methods:

A sample of eighteen patients with skeletal class III malocclusion and speech sound disorders. All patients were treated with maxillary protraction using facemask accompanied with rapid maxillary expansion using hyrax expander. Speech assessment for all children was performed at three times: T1 (before orthodontic management), T2 (6 months after orthodontic management), T3 (after giving complementary speech therapy sessions).

Results:

Results after three different times of speech evaluation showed that there was no significant difference between (T1) before and (T2) after orthodontic treatment for all types of speech impediments, with all cases being the same. While, there was a significant improvement in all types of speech impediments for all patients after speech therapy (T3).

Conclusion:

Complementary speech therapy sessions after orthodontic management showed a significant improvement in all types of speech impediments than orthodontic treatment alone for children with class III malocclusion accompanied with speech sounds disorders.

Keywords: Class III malocclusion, Speech Therapy, Speech sound disorders

Introduction:

Speech performance demands complex harmony of air flow opposed to articulating structures involving the teeth, cheeks, alveolus, and tongue⁽¹⁾. Pathologic speech takes place when the oral cavity or jaw relationship are malformed leading to probable compensatory distortions⁽²⁾. Jaws relationship evolution with a positively dental overjet has allowed for labiodental fricative consonants development⁽³⁾.

Patients with dentofacial deformations have severe malocclusions, 90 % of Class III and 80% of open-bite surgical patients suffer from speech disorders^(4,5). Class III malocclusion can be classified as skeletal, dentoalveolar or functional condition, the diagnosis and prognosis of treatment can be determined by its etiology⁽⁶⁾.

1. Assistant professor of orthodontics, Faculty of dentistry, Fayoum university, Egypt.

2. Lecturer of phoniatrics, Phoniatrics and Otorhinolaryngology Department, Faculty of Medicine, Benha University, Egypt.

3. Lecturer of orthodontics, Faculty of dentistry, Fayoum university, Egypt.

Early interception is mandatory for this malocclusion, preferably through the deciduous dentition stage, such that Class III attends to aggravate itself during growth, mainly throughout adolescence ⁽⁷⁾. The earlier treatment is begun, the more the orthopedic compensatory effects of the probable orthodontic discrepancy, which can frequently avoid need for orthognathic surgery at the termination of growth. Moreover, the early management of Class III conducts psychological profits, due to facial aesthetics improvement that enhances self-confidence ⁽⁸⁾.

For patients with skeletal Class III deficient maxilla, facemask is the most common treatment protocol, as it stimulates maxillary protraction and aids in controlling the development of mandible ⁽⁹⁾. Facemask therapy is usually accompanied with rapid maxillary expansion to increase the skeletal effect on the maxilla, where distraction causes a stimulating effect on the midfacial sutures with an improved response is expected on protraction ⁽¹⁰⁾. Although it was a controverse in the literature data regarding the benefit of such combination of treatment protocol ⁽¹¹⁾.

In addition to the skeletal discrepancy anteroposteriorly, other malocclusions could be associated with Class III due to maxillary hypoplasia, such as anterior open bite and posterior crossbite ⁽¹²⁾. For 2.5% of united states population, teeth and jaws discrepancies are accompanied with difficulties in breathing, speaking and masticating ⁽¹³⁾. Thus, the orthodontist's role exceeds straightening of teeth, but also includes handling problems related to jaw function and needs a knowledge

of the physiologic interaction of all craniofacial systems ⁽¹³⁾.

Class III underbites are identified by mandibular incisors being anteriorly positioned to their maxillary incisors, affecting the articulation of alveolar sibilant fricatives [z] and [s], such that the tongue normally interrelates with the maxillary alveolus, and labiodental fricatives [v] and [f], such that the lower lip interacts with the maxillary incisors. To compensate for an underbite, Class III patients produce compensatory articulation sounds, where the upper lip touching the mandibular incisors to produce fricatives [v] and [f], and the tongue touching the incisors instead of the alveolar ridge for sibilants [z] and [s] ⁽¹⁴⁾.

From the above mentioned, the objective of this study was to identify speech sound disorders in children with class III malocclusion and evaluate the effect of orthodontic management and complementary speech therapy sessions on correction of these disorders.

Subjects and Methods:

1-Sample size calculation:

A power analysis based on a previous study ⁽¹⁵⁾ results estimated a sample of eighteen patients which revealed a confidence level of 95% and power of 80% to yield a statistically significant level (alpha) 5%. G (*) Power version 3.1.9.4 was used.

2-subjects:

This prospective study compromised of eighteen children (ten males and eight females). All children were selected from the

outpatient clinic, Orthodontic Department, Faculty of dentistry, Fayoum University, Egypt.

All the included children in the current study fulfilled the following criteria:

- **Moderate to severe skeletal class III malocclusion (deficient or retruded maxilla) (ANB angle ≤ 0 , SNA angle ≤ 77)**
- **Anterior skeletal cross bite.**
- **Mixed dentition stage with a mean age of (7.56 \pm 1.10) years.**
- **Full language development, average mentality and intact hearing.**
- **Speech sounds defects.**

Children with delayed language development, sub normality or hearing loss or intact articulation were excluded from the study.

Methods:

This study was approved by the ethical committee of Fayoum University. Informed consents were obtained from parents of all individual participants.

A-Orthodontic Treatment protocol:

The treatment plan for all patients was maxillary protraction using facemask appliance attached through extra oral elastics to maxillary orthopedic expander (HYRAX). Figure (1)

The hyrax screw appliance was constructed for each patient as the following:

a -Molar bands (American Orthodontics, Roth, 0.022x0.028 tube size) were adapted on the maxillary first permanent molars.

b- Accurate alginate impression (CAVEX, ITALY) with the molar bands in place and dental casts were obtained using dental stone.

c -Hyrax screw was adapted on the palatal surface and soldered to the molar bands.

d- Wire of (0.045 inch) was soldered bilaterally to the hyrax and extended labially in the area between canine and the first deciduous molar area.

The parents were advised and instructed to activate the appliance one quarter turn twice daily (0.25 mm per turn) for 2 weeks or till the palatal cusps of the maxillary first molars occluding buccal to the buccal cusps of the lower first molar.

Maxillary protraction using the face mask appliance (MORELLI, Brazil) was started simultaneously with the first day of hyrax screw activation. The facemask was adjusted in order to apply an anteriorly and angulated force with a downward inclination of 20° to 30° to the occlusal plane.

A force of 400g was controlled clinically using a force gauge and applied on each side through extra oral elastics, the patients were instructed to wear face mask 12 hours a day.

The bite was raised bilaterally on the first molar using light cure composite until achieving one mm anterior open bite at the incisor area.

The treatment duration with both hyrax and face mask continued till correction of both posterior and anterior crossbite was achieved. In some cases, activation of hyrax was stopped and the patient continued with the facemask when the correction of the posterior crossbite achieved before the anterior one.



Fig (1): Facemask appliance attached through extra oral elastics to maxillary orthopedic expander (HYRAX)

B-Speech analysis:

- Assessment of speech sounds by The Arabic Ain Shams Articulation test ⁽¹⁶⁾ was applied to all children by phoniatrician at three time point evaluations; T1(before orthodontic management), T2 (6 months after orthodontic management), T3 (after giving complementary speech therapy sessions).

- The test covers all phonemes that appear in the colloquial dialect in different positions (initial, middle, final) of the words.

- Speech therapy sessions were given by speech pathologist after orthodontic treatment where we sit in front of mirror, teach the child the correct origin of articulation of the affected sounds, we correct sounds in different positions (initial, middle, final) of the words, then in short sentences, in long sentences, short story and finally in conversation.

Statistical analysis:

Numerical data were presented as mean and standard deviation (SD) values. Categorical data were presented as frequency and percentage values and were analyzed using Cochran's Q test, followed by pairwise comparisons using multiple McNemar's tests with Bonferroni's correction. The significance level was set at $p < 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.4.0 for Windows¹

Results:

1-The study was conducted on 18 cases (i.e., ten males and eight females) with a mean age of (7.56 ± 1.10) years. Demographic data are presented in Table (I).

¹R Core Team (2024). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

Table (I): Demographic data.

<i>Parameter</i>		<i>Value</i>
<i>Gender [n (%)]</i>	<i>Male</i>	10 (55.56%)
	<i>Female</i>	8 (44.44%)
<i>Age (Mean ±SD) (years)</i>		7.56±1.10

2- Speech analysis for children with class III malocclusion at T1 and T2 revealed that:

A- All cases (100%) had Interdental stigmatism (\ s\, \ s.\, \ z\ sounds uttered interdental), (33.33 %) of cases had Rhotacism (error of \R\ sound) and (33.33 %) of cases had Imprecision of /f/ sound. Figure (2) However, at T3 all cases (100%) with previous speech defects were free from any sound errors.



Fig (2) Intraoral photograph frontal view:

a) T1: before orthodontic management b) T2 :6 months after orthodontic management

B-Three time point evaluations showed that for all types of speech impediments, there was no significant difference between T1 and T2, with all cases being the same. while, they showed

that all the cases improved significantly after T3 and they were free from any impediment.

3-Associations between speech impairment, orthodontic, and speech therapy are presented in Table (II) and Figure (3).

Table (II): Effect of treatments on the Incidence of different speech impediments.

Parameter	Time	n (%)		Test statistic	p-value
		No	Yes		
Interdental sigmatism	T1	0 (0.00%) ^A	18 (100.00%) ^A	36.00	<0.001*
	T2	0 (0.00%) ^A	18 (100.00%) ^A		
	T3	18 (100.00%) ^B	0 (0.00%) ^B		
Rhotacism (imprecision of /R/ sounds)	T1	12 (66.67%) ^A	6 (33.33%) ^A	12.00	0.002*
	T2	12 (66.67%) ^A	6 (33.33%) ^A		
	T3	18 (100.00%) ^B	0 (0.00%) ^B		
Imprecision of /f/ sound	T1	12 (66.67%) ^A	6 (33.33%) ^A	12.00	0.002*
	T2	12 (66.67%) ^A	6 (33.33%) ^A		
	T3	18 (100.00%) ^B	0 (0.00%) ^B		

Values with **different superscripts** within the **same vertical column** are significantly different, * significant (p<0.05).

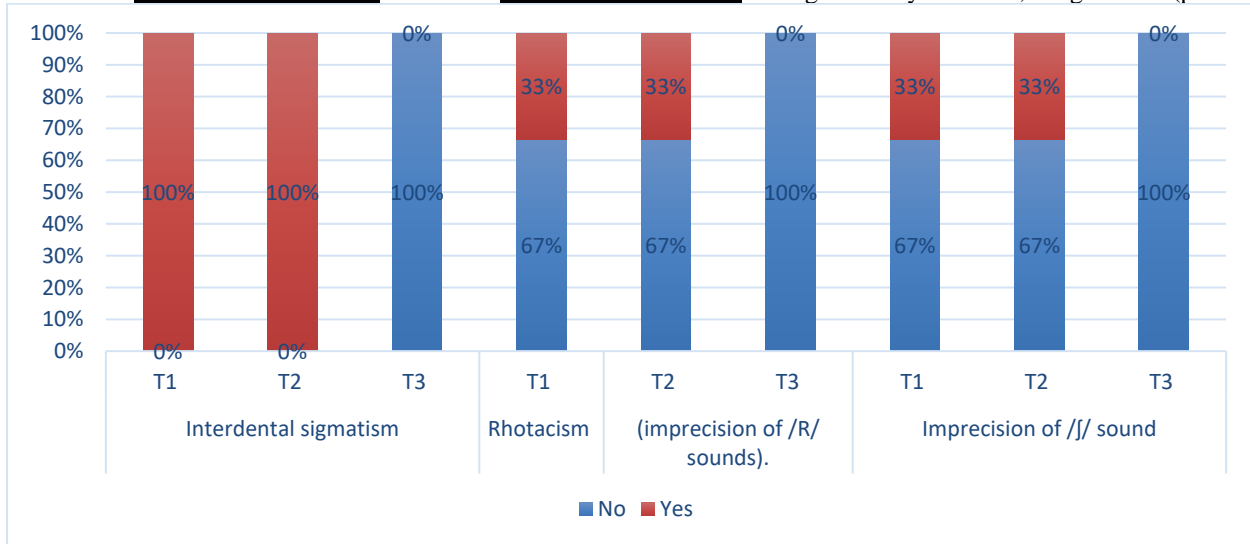


Figure (3): Stacked bar chart for the incidence of different speech impediments.

Discussion:

People with malocclusion may have difficulty articulating specific sounds which affects the uttering of certain speech sounds as (/s/, /z/, /t/, /d/, /l/, /r/, /f/, and /tʃ/) because of lip closure, tongue position, and airflow problems⁽¹⁷⁾.

Patients with class III malocclusion have a larger tongue which is mostly located at the inferior arch which is commonly wider and more profound than the superior one.⁽¹⁸⁾

When the upper and lower teeth are guided together, air may flow between them, give rise to the sounds like /f/ and /v/. Moreover, the teeth' position can impact the tongue and other articulators' position, influencing the produced sound by the mouth. The teeth play an important role in articulating affricate sounds (/tʃ/, /dʒ/) and fricative sounds (/s/, /z/, /f/, /v/, /θ/, /ʃ/)⁽¹⁹⁾.

The results of the current study revealed that class III malocclusion had harmful effects on pronunciation, particularly when producing specific speech sounds. Speech analysis at T1 (before orthodontic management) revealed that all cases (100%) had Interdental stigmatism (\ s\, \ s.\, \ z\ sounds uttered interdental), (33.33 %) of cases had Rhotacism (error of \R\ sound) and (33.33 %) of cases had Imprecision of /f/ sound. This was in agreement with several studies which had discovered that class III malocclusion could lead to speech difficulties which could affect pronunciation of specific sounds^(17,20).

Other previous studies had also indicated that malocclusions with variable levels and

types could induce difficulties at speaking and also could cause compensatory articulation defects such as tongue thrusting while producing certain sounds^(21,22).

At the current study, speech analysis at T2 (6 months after orthodontic treatment) showed that all cases (100%) still had Interdental stigmatism (\ s\, \ s.\, \ z\ sounds uttered interdental), (33.33 %) of cases had Rhotacism (error of \R\ sound) and also (33.33 %) of cases had Imprecision of /f/ sound. These results were in disagreement with previous studies^(23,24) which found that pronunciation can be improved in individuals with malocclusion by orthodontic treatment.

Also, other studies^(25,26) discovered that cases who received orthodontic treatment had improved speech intelligibility in comparison to cases who did not receive treatment. On the contrary, some studies^(27,28,29) found that orthodontic treatment may cause temporary pronunciation difficulties, specially at the initial stages of treatment.

At the present study speech analysis proved that at T3 (after speech therapy) all cases (100%) with previous speech defects were improved and free from any sound impediments. These results were in accordance with Lathrop M H; 2022⁽³⁰⁾ who suggested that speech therapy is a critical part in management class III dentofacial disharmonies patients after orthodontics or surgery.

Also, Marchesani I Q; 2000⁽¹⁸⁾ concluded that speech pathology treatment could not be isolated from orthodontic treatment in class III malocclusion cases and best results occur when the individuals were managed from childhood

with orthopedics of the maxillaries or interceptive orthodontics.

Finally, meeting with a speech-language pathologist and orthodontist can help people to recognize the primary cause of speech errors and outline a suitable treatment plan.

Conclusion:

Complementary speech therapy sessions after orthodontic management showed a significant improvement in all types of speech impediments than orthodontic treatment alone for children with class III malocclusion accompanied with speech sounds disorders.

Recommendation:

For children with class III malocclusion accompanied with speech sound disorders, complementary speech therapy after orthodontic management is the best treatment protocol.

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