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Effect of prematurely primary front teeth loss with anterior esthetic fixed appliance on fricative production in Arabic-speaking children

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Abstract

Background Primary teeth affect the life quality regarding chewing, speech production, esthetics, and psychological well-being. Young children usually lose their primary maxillary incisors due to trauma or care and that leads to fault production of alveolar and dental fricatives. Fixed esthetic appliance replacing the lost primary front teeth were inserted and fricative sounds /s/,/s̲/,/ʃ /,/z/and /z̲/ were tested before and after insertion of the fixed appliance through different time intervals.

Results Improvement of fricative sound production occurred after fixed appliance insertion the /s/ sound, followed by /s̲/ sound showed immediate improvement while the /ʃ / sound was the least to be improved even after 1 month duration. Both sounds /z̲/ and /z/ sound showed distortion immediately.

Conclusion Premature loss of primary incisors in young children has a significant impact on speech production.

Keywords Fricatives, Articulatory deficits, Speech problems, Anterior teeth loss

Background

Primary and permanent dentitions are of greatest benefit to human beings. Children benefit from their primary teeth in mastication phonation and aesthetically as a space keeper for permanent teeth erupting later [1–3].

Complications due to premature loss of primary teeth include the inability to properly chew and speak accompanied by pain and swelling [4, 5]. Premature loss of primary teeth occurs a year before its normal time range of exfoliation [6, 7].

Early loss of primary anterior teeth is usually caused by caries, pulp infection because of nursing bottles or early childhood caries [8, 9], and dental trauma which is considered a major medical, psychological, and esthetical problem for children and parents which usually occurs between the age of 1 to 3 years [10–12] because of fall accidents [13].

Speech problem occurs in children with premature loss of primary incisors [14–17]. During the evaluation of fricative sound articulation ([f], [v], [ð], [θ], [s], and [z]) it was found that children with intact incisors have better production of speech than those with lost ones [18].

Alveolar fricatives such as /s/ /z/ / s̲/ /ʃ/ and dental fricatives as /z̲/ are the sounds mostly affected by loss of anterior maxillary primary teeth as alveolar fricatives are produced by escaping of the air with friction through a

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narrow gap while the tongue is in contact with alveolar ridge [17].

Different esthetic treatment options are available to replace the primary incisors. The esthetic appliances can be fixed, semi-fixed, or removable but in children, the fixed space maintainer is preferred because removable ones can cause irritation and also due to poor cooperation of children.

The fixed space maintainer chosen to replace the premature extracted primary anterior tooth includes adapting stainless-steel bands on the second molars and soldering a wire to the two bands. The wire was modified to move near the palatal surfaces of all teeth anterior to the bands. The acrylic resin was poured over the wire that spans the edentulous space and holds the pontic [19, 20].

Fixed space maintainer replacing anterior primary teeth allows appropriate tongue alignment that is necessary for proper sound production [21, 22] as it allows proper tongue posture, which might get trapped between the arches, producing errors of speech.

Aim of the work

The aim of this study is to detect fricative production errors in children with prematurely lost anterior teeth before and after fixed functional space maintainer by detecting the most affected sound and earliest to be corrected.

Methods

Study design and settings

This was a quasi-experimental pre-post study that was carried out in the outpatient clinic of the Pediatric Dentistry Department, Faculty of Dentistry, Tanta University, Egypt. Speech evaluation and assessment was done at the Phoniatric Unit, ENT Department, Faculty of Medicine, Tanta University, Egypt.

Patient selection

Twenty-five children aged from 3 to 6 years old with their maxillary primary incisors already extracted or required to be extracted were selected from patients attending the outpatient clinic of the Pediatric Dentistry Department, Faculty of Dentistry, Tanta University, Egypt. In 6-month duration,

Inclusion criteria

1. Loss of at least two maxillary primary incisors or need to be extracted.
2. Arabic is the mother tongue of all children.

Exclusion criteria

1. Recent hospitalization.
2. Accompanying health problems such as (seizure disorder, mental retardation, immunocompromised patients, and hearing impairment).
3. Previous speech therapy due to delayed language or previous speech errors prior to teeth loss.
4. Very poor oral hygiene or inability to follow up.
5. Inappropriate feeding habits.
6. Significant deep bite, excess overjet, or anterior crossbite.

Methods

Full medical and dental history were recorded at the beginning of the study, clinical examination was done and periapical/panoramic X-rays were taken, when needed, to ensure proper case selection and confirm the inclusion criteria.

Clinical examination and extraction of anterior teeth if required, in case of trauma no remaining root and no traumatic injuries for soft tissue was just ensured. Prosthetic rehabilitation was done by a fixed functional space maintainer after (4–6 weeks) of extraction for primary maxillary incisors to ensure complete healing of the soft tissues.

Steps of anterior esthetic fixed functional appliance fabrication

Initially, preformed stainless steel bands for bilateral maxillary second primary molars were selected properly according to the size of the molars, and contoured to be closely adapted to the abutment teeth. The bands were seated approximately one millimeter below the mesial and distal marginal ridges. If the selected molars were in need of pulp therapy treatment and stainless-steel crowns, were done first and then the bands were tried and adjusted on stainless-steel crowns.

Alginate impression was made with the bands placed on both maxillary second primary molars. Then the bands were removed from the mouth with band remover, placed and stabilized in the impression in the correct position and the cast was prepared from dental stone with the bands in place (Fig. 1a, b).

Speech and language evaluation

Speech evaluation was done by two phoniatricians using the protocol of speech assessment done in the Phoniatric Unit, ENT Department, Faculty of Medicine, Tanta University, Egypt.

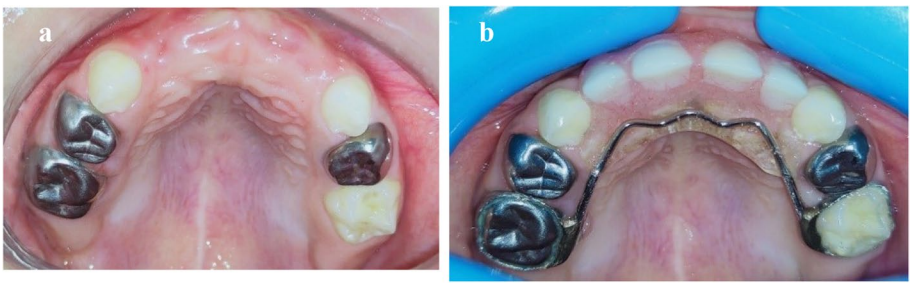

Fig. 1 **a** Prematurely lost four primary maxillary incisors. **b** Inserted anterior esthetic fixed appliance

Elementary diagnostic procedures

A. History taking

Personal data: complete history taking, including patient's age, sex, address, date of birth, and special habits in the articulation.

B. General examination and examination of articulation
C. Auditory precipitation assessment (APA) of articulation

By careful listening to the child's manner of articulation to detect articulation errors.

Clinical diagnostic aids

A. Assessment of IQ using Stanford-Binet (5th edition)
B. Articulation test [23]

Five fricatives were chosen to be studied /s/, /s̲/, /z/, /z̲/, /∫/ and were tested in the initial, medial, and final word positions according to the following errors:

Phonological errors

1. Omission: absence of a required speech sound in a word.
2. Substitution: replacing a speech sound with another speech sound.
3. Addition: adding an extra speech sound next to the articulated speech sound.

Articulation errors

1. Distortion: inaccurate production of a speech sound.
2. Interdental sigmatism: occurs in s/ and /z/ sounds where the tongue tip is between the teeth.

III. Speech intelligibility test [24]

The general intelligibility score was calculated using Speech intelligibility in context: 5-point scale:

Grade 1: Speech is completely unintelligible.
Grade 2: Speech is very difficult to be understood; only isolated words or phrases are intelligible.
Grade 3: The listener can understand with difficulty about half the content of the message.
Grade 4: Speech is intelligible with the exception of a few words or phrases.
Grade 5: Speech is completely intelligible.

Additional instrumental measures

A. Spectrographic analysis

Using the computerized speech lab (CSL 4300 B), the child was seated in an upright position and allowed to talk freely and repeated syllables were said to him/her. The microphone was fixed about twenty cm away from the child's mouth.

Each child was evaluated at five sittings:

- Initial sample: before appliance delivery.
- Second sample: immediately after appliance insertion.
- Third sample: 7 days after appliance insertion.
- Fourth sample: 14 days after appliance insertion.
- Fifth sample: 1 month after appliance insertion.

The speech samples

Five Arabic consonants placed with the vowel in vowel-consonant- vowel (V-C-V) syllabic form, e.g., / æ s æ /, / æ ∫ æ /, / æ z æ /, / æ s̲ æ /, / æ z̲ æ /. Thereafter, a spectrographic analysis was made. The following parameters were obtained after that.

Table 1 Sample distribution according to gender, age, and number of missing teeth

Gender	Boys	11 (44%)
	Girls	14 (56%)
Age	Range	3–6 years
	Mean	4.44
	Median	5
Number of missing teeth	Two teeth	5 (20%)
	Three teeth	7 (28%)
	Four teeth	13 (52%)

1) Shimmer in dB (shdB): in decibels (dB).
2) Absolute jitter (Jita): in mseconds (ms).
3) Noise to harmonic ratio (NHR).

Statistical analysis

The data were wrangled, tabulated, and analyzed using MedCalc version 18.2.1. Categorical variables were expressed as number and %. Chi-square test was used to estimate the difference between the categorical variables. Statistical significance was considered when $p < 0.05$.

For the quantitative values jitter, shimmer, and noise to harmonic ratios (NHR), the data was wrangled, coded,

Table 2 Change in articulation test among the studied children

	Appliance device								
	Before	**Immediate**	**Improvement from baseline**	**7 days after**	**Improvement from baseline**	**14 days after**	**Improvement from baseline**	**One month after**	**Improvement from baseline**
/s/ sound speech errors			8.0%		28.0%		56.0%		76.0%
Normal	4 (16.0)	6 (24.0)		11 (44.0)		18 (72.0)		23 (92.0)	
Interdental lisping/substitution	21 (84.0)	19 (76.0%)		14 (56.0)		7 (28.0)		2 (8.0)	
/s̲/ sound speech errors			8.0%		28.0%		56.0%		68.0%
Normal	5 (20.0)	7 (28.0)		12 (48.0)		19 (76.0)		22 (88.0)	
Interdental lisping/substitution	20 (80.0)	18 (72.0)		13 (52.0)		6 (24.0)		3 (12.0)	
/z/ sound speech errors			0.0%		−8.0%		24.0%		36.0%
Normal	15 (60.0)	15 (60.0)		13 (52.0)		21 (84.0)		24 (96.0)	
Interdental lisping/substitution	10 (40.0)	10 (40.0)		12 (48.0)		4 (16.0)		1 (4.0)	
/z̲/ sound speech errors			0.0%		12.0%		20.0%		28.0%
Normal	15 (60.0)	15 (60.0)		18 (72.0)		20 (80.0)		22 (88.0)	
Interdental lisping/substitution	10 (40.0)	10 (40.0)		7 (28.0)		5 (20.0)		3 (12.0)	
/ʃ / sound speech errors			−12.0%		0.0%		4.0%		4.0%
Normal	23 (92.0)	20 (80.0)		23 (92.0)		24 (96.0)		24 (96.0)	
Substitution/distortion	2 (8.0)	5 (20.0)		2 (8.0)		1 (4.0)		1 (4.0)	
P value	< 0.001*	< 0.001*		0.002*		0.227		0.704	

* Significant at $p \leq 0.05$

and analyzed using the SPSS software (Armonk, NY: IBM Corp. version 25.0). Quantitative variables were expressed using median (minimum and maximum). Kruskal–Wallis and Friedman tests determine the statistically significant differences between the studied groups. Statistical significance was considered when $p < 0.05$.

Results

This study was carried out on 25 children 14 girls and 11 boys ranging in age from 3 to 6 years with a mean age of 4.44. The distribution of the sample according to gender, age, and number of missing teeth is shown in Table 1.

Tested children had a significant difference between the five tested sounds before, immediately, and 7 days after the appliance device ($p < 0.001, < 0.001$, and 0.002. respectively). While after 14 days and after 1 month most of the children had normal sound production. However, the improvement from baseline was better in /s/ sound, followed by /s̲/ sound and the least improvement from baseline was in /∫/ sound. Both sounds /z̲/ and /z/ sound showed distortion immediately (− 12.0%) and after 7 days (− 8.0%), respectively (Table 2, Figs. 2 and 3).

Articulation test results showed interdental stigmatism in both /s/, /s̲ /, /z/, /z̲/,

Substitution in /z/, /z̲/, /∫/ and distortion in the /∫/ sound, as mentioned in Table 2.

Regarding speech intelligibility results showed that before appliance insertion 5 children (20%) had grade 3 intelligibility and 20 children (80%) had grade 4.

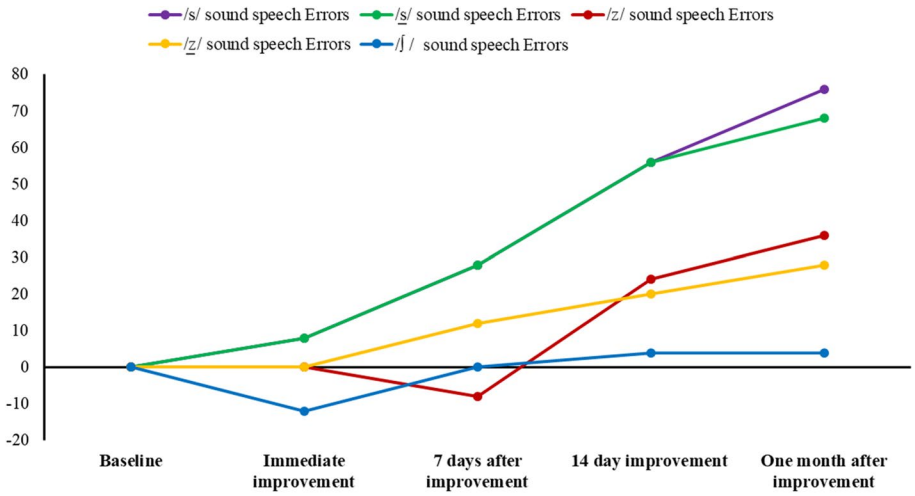

Fig. 2 Improvement of sounds from the baseline

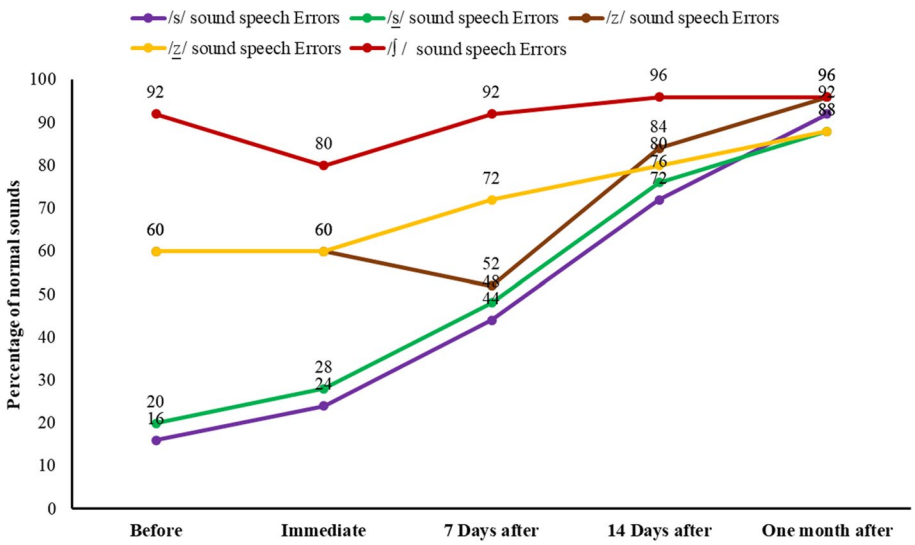

Fig. 3 Percentage of children producing normal sounds

Immediately after insertion of the fixed appliance 3 children (12%) had Grade 3 and 22 children (88%) had grade 4 while, at 7 days after appliance insertion 18 children (72%) had grade 4, and 7 children (28%) had grade 5.

While at 14 days after appliance insertion 6 children (24%) had grade 4 and 19 children (76%) had grade 5, at the last follow-up after 1 month of insertion 2 children (8%) had grade 4 and 23 children (92%) had grade 5. The difference was statistically significant between different follow-up periods (p value ≤ 0.05) as shown in Table 3.

Figure 4 shows that all five studied sounds showed significant differences in shimmer readings over the studied follow-up periods ($p < 0.001$ in all five sounds). In the change (%) results, immediate change (%) varied from 2.4 in sound /s/, 7.13 in sound /s̲/, 34.55 in sound /z/, 21.65 in sound /z/ and 52.99 in sound /ʃ/ with significant difference, $p < 0.001$, 7 days change (%) was 49.64 in sound /s/, 19.31 in sound /s̲/, 8.83 in sound /z/, 3.53 in sound /z̲/ and 26.49 in sound /ʃ/, $p < 0.001$, day 14 change (%) was 22.78 in sound /s/, − 5.75 in sound /s̲/, − 4.94 in sound /z/, − 22.59 in sound /z/ and 11.17 in sound /ʃ/, $p < 0.001$, (Table 4 and Fig. 5).

All five studied sounds showed significant differences in jitter readings over the studied follow-up periods ($p < 0.001$ in all five sounds), (Fig. 6). In immediate change (%) significant difference was detected: sound /s/ (30.09), sound /s̲/ (− 0.3), sound /z/ (23.65), sound /z̲/ (− 2.93), and sound /ʃ/ (− 0.26), $p = 0.002$. Seven days change (%) was also significant: sound /s/ (35.47), sound /s̲/ (− 2.81), sound /z/ (− 14.95), sound /z̲/ (− 23.30), and sound /ʃ/ (− 33.85), $p < 0.001$. Day 14 change (%) was 12.66 in sound /s/, − 24.82 in sound /s̲/, − 24.95 in sound /z/, − 45.64 in sound /z̲/, and − 38.69 in sound /ʃ/, $p < 0.001$ and 1-month change (%) was − 12.89 in sound /s/, − 29.84 in sound /s̲/, − 29.73 in sound /z/, − 47.44 in sound /z̲/, and − 43.89 in sound /ʃ/, $p = 0.005$ (Table 5 Fig. 7).

Table 3 Intelligibility test of children at different follow-up periods

Follow-up grade	Before appliance delivery		Immediately after appliance insertion		7 days after appliance insertion		14 days after appliance insertion		One month after appliance insertion	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
Grade 1	0	0	0	0	0	0	0	0	0	0
Grade 2	0	0	0	0	0	0	0	0	0	0
Grade 3	5	20	3	12	0	0	0	0	0	0
Grade 4	20	80	22	88	18	72	6	24	2	8
Grade 5	0	0	0	0	7	28	19	76	23	92
χ2	83.829									
P value	0.001*									

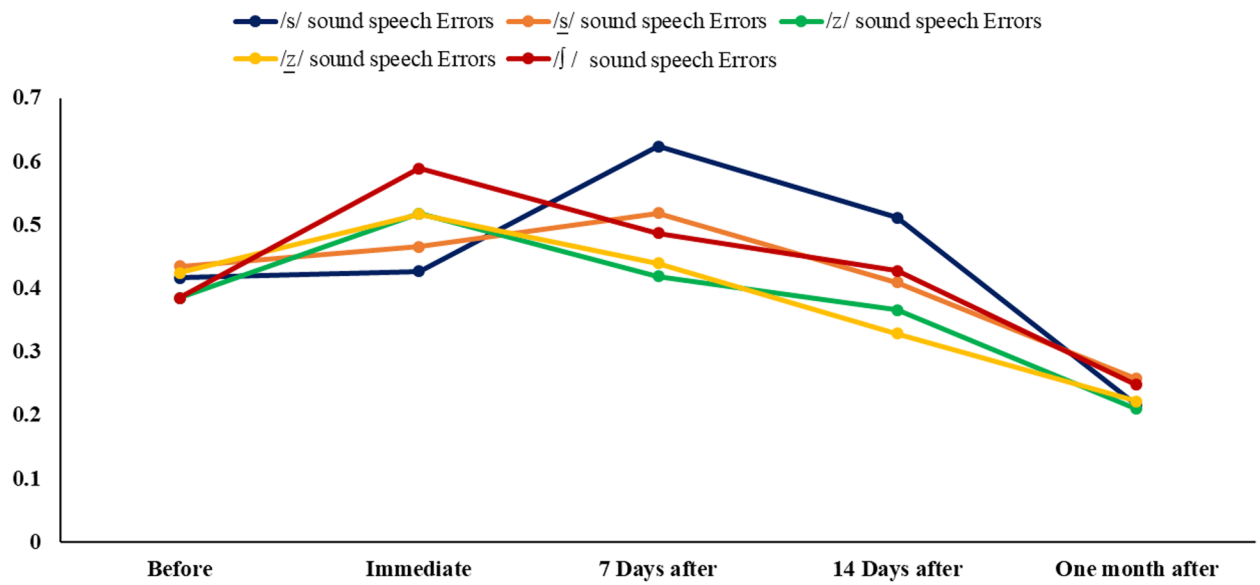

Fig. 4 Shimmer readings of the studied sounds

Table 4 Shimmer reading test for the studied sounds

	Shimmer								
	Before	**Immediate**	**7 days after**	**14 days after**	**One month after**	***P* value**	**Immediate change (%)**	**7 days change (%)**	**14 days change (%)**	**One month change (%)**
/s/ sound speech errors						**< 0.001***	2.4	49.64	22.78	−48.0
Median	0.417	0.427	0.624	0.512	0.216					
Min.–max	0.244–0.914	0.317–0.839	0.516–0.849	0.318–1.061	0.176–0.432					
/s̲/ sound speech errors						**< 0.001***	7.13 a	19.31 a	−5.75 a	−40.69
Median	0.435	0.466	0.519	0.410	0.258					
Min.–max	0.366–1.051	0.346–0.70	0.439–0.959	0.338–1.06	0.18–0.502					
/z/ sound speech errors						**< 0.001***	34.55 b	8.83 a	−4.94 a	−45.45
Median	0.385	0.518	0.419	0.366	0.210					
Min.–max	0.242–0.821	0.421–0.703	0.312–0.610	0.311–0.485	0.176–0.363					
/z̲/ sound speech errors						**< 0.001***	21.65 b	3.53 a	22.59 a	−47.76
Median	0.425	0.517	0.440	0.329	0.222					
Min.–max	0.218–0.894	0.273–0.770	0.287–0.780	0.230–0.744	0.184–0.539					
/ʃ / sound speech errors						**< 0.001***	52.99 a, b, d	26.49 a, c, d	11.17 b, d	−35.58
Median	0.385	0.589	0.487	0.428	0.248					
Min.–max	0.283–0.800	0.520–1.369	0.270–1.127	0.317–0.851	0.176–0.562					
***P* value**							**< 0.001***	**< 0.001***	**< 0.001***	0.2

[a] Significant difference with sound /s/

[b] Significant difference with sound /s̲/

[c] Significant difference with sound /z/

[d] Significant difference with sound /z̲/

*(significant *P* value)

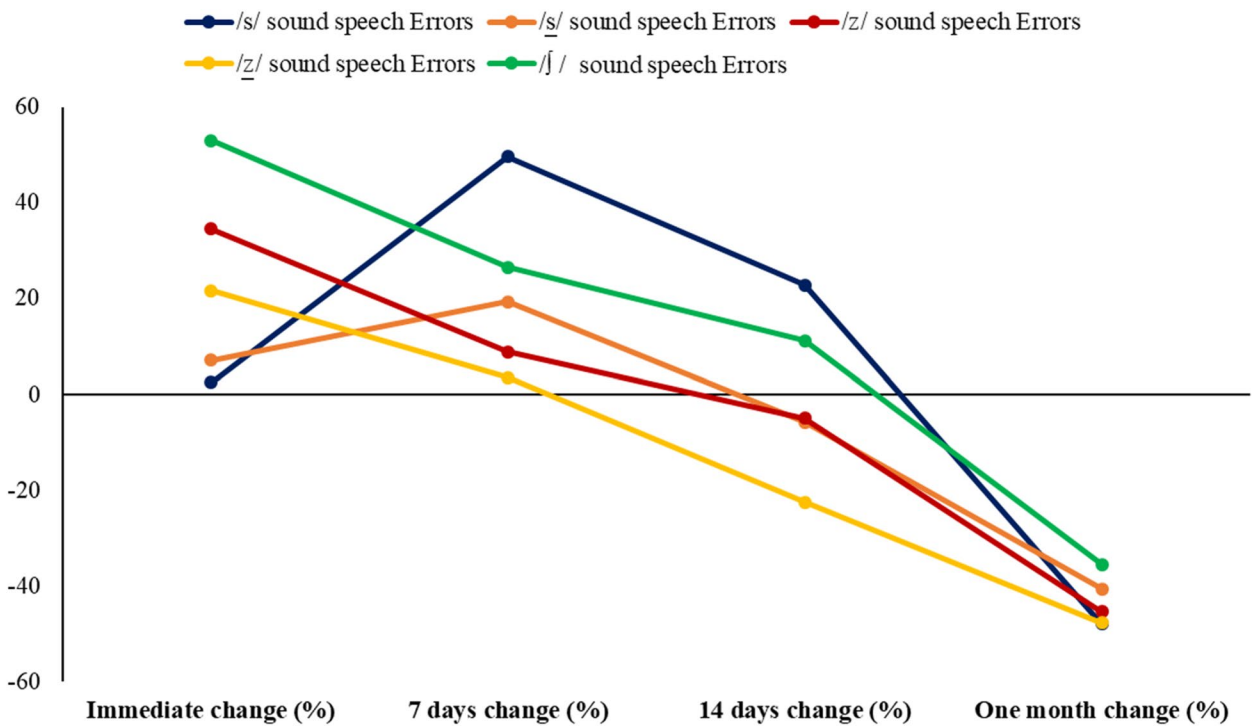

Fig. 5 Shimmer readings changes of the studied sounds

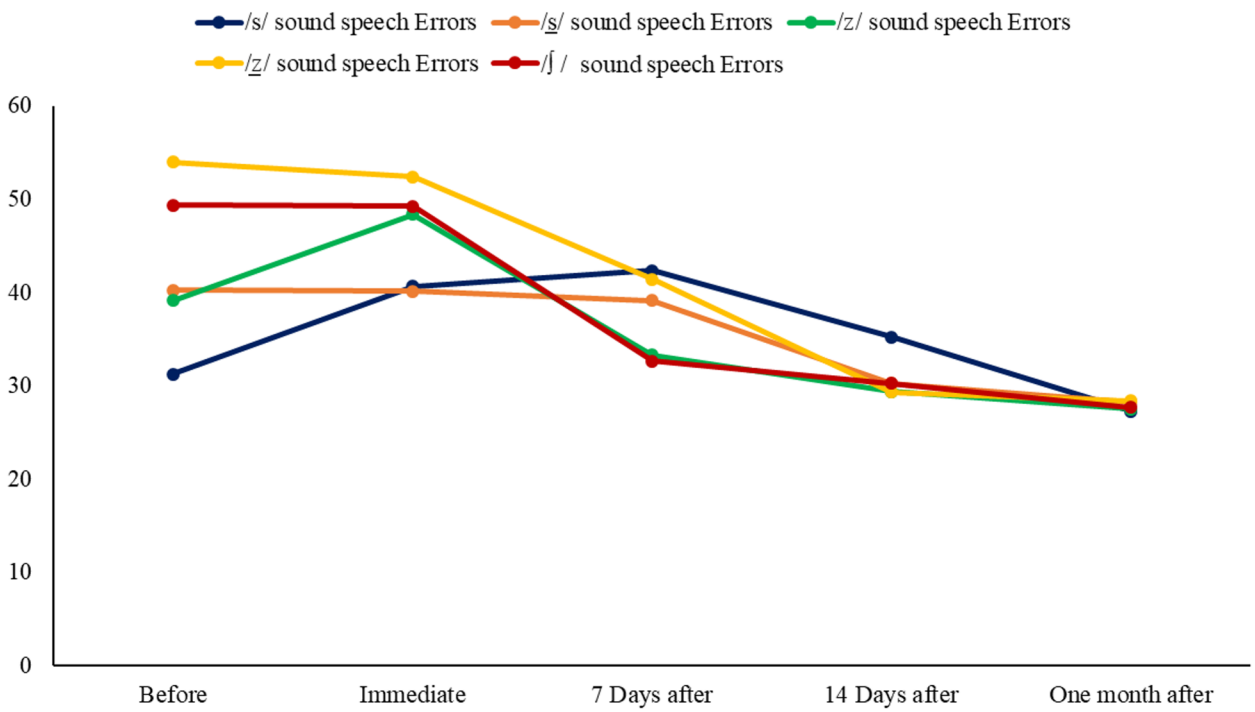

Fig. 6 Jitter readings of the studied sounds

Table 5 Jitter reading test for the studied sounds

	Jitter									
	Before	**Immediate**	**7 days after**	**14 days after**	**One month after**	***P* value**	**Immediate change (%)**	**7 days change (%)**	**14 days change (%)**	**One month change (%)**
/s/ sound speech errors						**< 0.001***	30.09	35.47	12.66	− 12.89
Median	31.27	40.68	42.36	35.23	27.24					
Min.–max	27.16–127.75	25.11–108.76	25.33–153.03	21.6–155.03	22.36–89.27					
/s̲/ sound speech errors						**< 0.001***	− 0.3 a	− 2.81 a	− 24.82 a	− 29.84
Median	40.25	40.13	39.12	30.26	28.24					
Min.–max	28.67–138.66	27.05–105.87	26.04–118.72	26.12–72.24	26.2–42.24					
/z/ sound speech errors						**< 0.001***	23.65 b	− 14.95 a	− 24.95 a	− 29.73
Median	39.12	48.37	33.27	29.36	27.49					
Min.–max	20.5–122.21	17.98–108.93	26.13–126.27	25.21–65.24	23.09–44.22					
/z̲/ sound speech errors						**< 0.001***	− 2.93 a, c	− 23.30 a	− 45.64 a, b	− 47.44 a, c
Median	53.96	52.38	41.39	29.33	28.36					
Min.–max	17.93–163.96	19.02–106.7	25.25–98.24	25.14–61.33	26.33–46.24					
/ʃ / sound speech errors						**< 0.001***	− 0.26 a, c	− 33.85 a, b, c	− 38.69 a	− 43.89 a
Median	49.37	49.24	32.66	30.27	27.70					
Min.–max	21.52–140.39	31.24–165.95	26.55–128.72	26.58–87.39	26.23–45.29					
P value							**0.002***	**< 0.001***	**< 0.001***	**0.005***

[a] Significant difference with sound /s/

[b] Significant difference with sound /s̲/

[c] Significant difference with sound /z/

[d] Significant difference with sound /z̲/

*(significant *P* value)

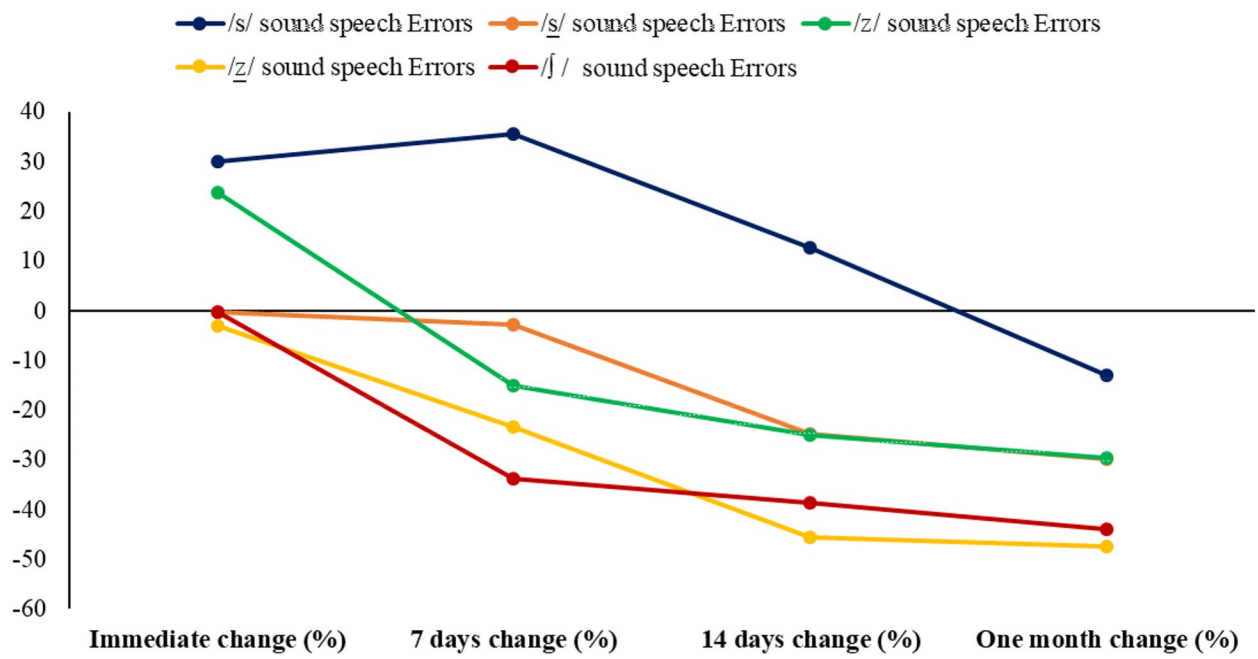

Fig. 7 Jitter readings changes of the studied sounds

NHR readings in Table 6 showed significant differences over the studied follow-up periods ($p < 0.001$ in all five sounds), (Fig. 8). The change (%) was significant among the studied sounds in immediate and day 7 change (%): sound /s/ (4.11, 2.74), sound /s̲/ (−8.28, −3.44), sound /z/ (6.57, −6.57), sound /z̲/ (−2.99, −10.45), sound /ʃ/ (−4.35, −13.04), $p = 0.007$, 0.002, respectively (Fig. 9).

Discussion

The studied age group was from 3 to 6 years old as it is the most common age of prematurely lost upper incisors due to trauma or dental caries and the appropriate age for replacing premature lost primary incisors by fixed aesthetic appliance before permanent eruption of permanent incisors at 7–9 years old also the chosen age allowed speech and language evaluation.

The children in the current study were estimated longitudinally to assist their self-control as this could eliminate individual variation and results interpretation**.** The large inter-individual and standard deviations produce many variables that are insignificant when comparing treatment and control group means. While, when comparing these variables to their typical values before receiving any appliances, significant differences can be noticed [21]. This was not like with Elbardissy et al. [25] who used a control group in their study.

Speech was evaluated by articulation test as Turgut et al. [15] and Kalia et al. [21] also by intelligibility test and spectrographic analysis using the computerized speech lab (CSL 4300 B) as Elbardissy et al. [25] which is considered more accurate because of its objective results.

Speech intelligibility improved through the follow-up periods from grade 3 to grade 5 which is completely intelligible, and speech errors markedly diminished after 1 month. This is due to tongue adaptability as it has a direct role in the generation of most speech sounds [17, 25].

As regards the articulation test of /s/ sound 4 (16%) children had normal /s/ sound before appliance delivery. During the follow-up schedule, the number of children who had interdental lisping of /s/ sound decreased along follow-up at 7 days were 14(56%) children, at 14 days were 7 (35%), and at 1 month were 5 (9%) after appliance insertion. To reach 23 (92%) children after 1 month. This is in agreement with Turgut et al. [15], Kalia et al. [12], and Elbardissy et al. [25].

When comparing the mean shimmer in dB, the mean absolute jitter and the mean noise to the harmonic ratio for /s/ sound diminishing of the previous values score was found after adaptation of the appliance with a high significant difference after 1 month of appliance insertion. The adaptation of the /s/ sound production returns to its nature as a (linguoalveolar sound), where a groove is commonly developed along the midline of the tongue to channel the air stream, and the sides of the tongue touch the sides of the teeth to achieve this. That is why it required time and showed no significant difference at the first follow-up [17, 25].

Table 6 NHR reading test for the studied sounds

	NHR									
	Before	**Immediate**	**7 days after**	**14 days after**	**One month after**		***P* value**	**Immediate change (%)**	**7 days change (%)**	**14 days change (%)**	**One month change (%)**
/s/ sound speech errors							**< 0.001***	4.11	2.74	− 11.64	− 19.86
Median	0.146	0.152	0.150	0.129	0.117						
Min.–max	0.13–0.219	0.123–0.213	0.133–0.220	0.118–0.205	0.110–0.157						
/s̲/ sound speech errors							**< 0.001***	− 8.28 a	− 3.44	− 1.31	− 19.31
Median	0.145	0.133	0.140	0.126	0.117						
Min.–max	0.103–0.217	0.101–0.151	0.127–0.216	0.114–0.158	0.112–0.137						
/z/ sound speech errors							**< 0.001***	6.57 b, d	− 6.57	− 9.49	− 14.60
Median	0.137	0.146	0.128	0.124	0.117						
Min.–max	0.106–0.155	0.114–0.199	0.115–0.191	0.103–0.199	0.112–0.133						
/z̲/ sound speech errors							**< 0.001***	− 2.99 c	− 10.45 a, b, c	− 11.19	− 15.67
Median	0.134	0.130	0.120	0.119	0.113						
Min.–max	0.106–0.183	0.113–0.186	0.107–0.211	0.108–0.162	0.110–0.280						
/ʃ / sound speech errors							**< 0.001***	− 4.35 c	− 13.04 a, b	− 13.77	− 16.67
Median	0.138	0.132	0.120	0.119	0.115						
Min.–max	0.122–0.201	0.121–0.190	0.109–0.185	0.112–0.177		0.110–0.161					
P value								**0.007***	**0.001***	0.369	0.097

[a] Significant difference with sound /s/

[b] Significant difference with sound /s̲/

[c] Significant difference with sound /z/

[d] Significant difference with sound /z̲/

*(significant *P* value)

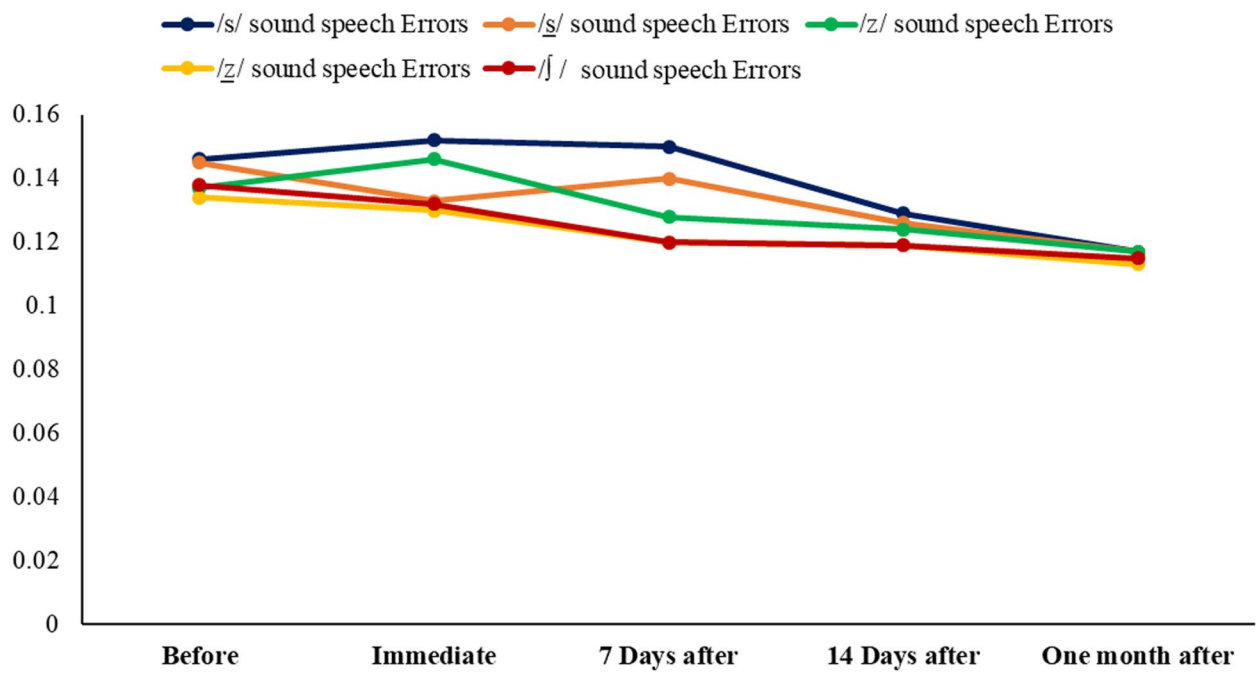

Fig. 8 NHR readings of the studied sounds

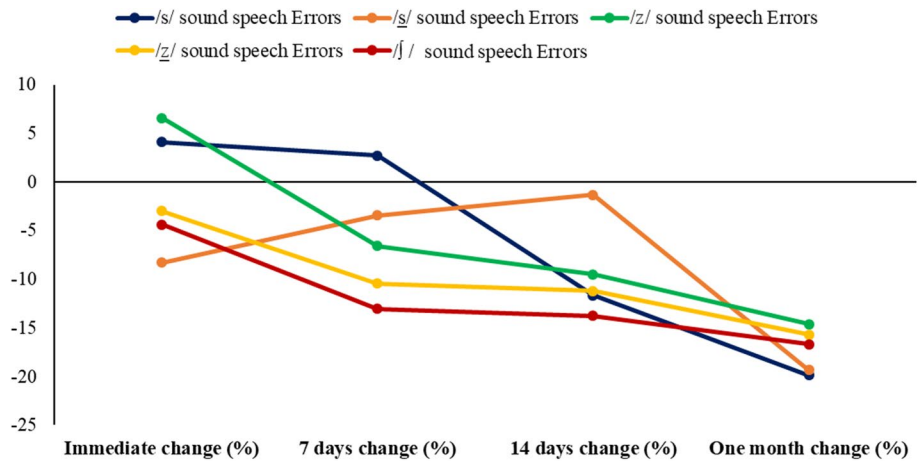

Fig. 9 NHR readings changes of the studied sounds

For the /s̲/ sound articulation, the number of children having normal /s̲/sound increased during follow-up from 5 (20%) children before appliance insertion to [22]. (88%) children after 1 month from appliance insertion regarding the interdental lisping of /s̲/sound it decreased among children during follow-up periods to reach only 3 (12%) children at the end of follow-up.

While the values of the mean shimmer in dB, the mean Absolute Jitter and the mean noise to harmonic Ratio for /s̲/ sound were reduced by the time similar to/s/ sound with a high significant difference in the follow-up after 1 month from the appliance insertion and all the following follow up settings. This is explained similarly to /s/ sound that /s̲/ sound is (alveolar sound) produced through a narrow gap from the oral cavity created by the tongue contacting the alveolar ridge of upper incisors [17] and requires adaptation as well.

Regarding the /z/ and /z̲/ sounds that are in accordance with Turgut et al. [15], Kalia et al. [21], and Elbardissy et al. [25]. The number of children that had normal production of both sounds increased during follow-up periods with a decreased number of children who had speech

errors like interdental lisping and substitution. But for /z̲/ sound no statistically significant difference between different follow-up periods.

They also showed a reduction of the mean shimmer in dB, the mean Absolute Jitter and the mean noise-to harmonic Ratio for /Z/ and /Z̲/ sounds along the different follow-up periods. There was a highly significant difference between the follow-up after 1 month of appliance insertion and all different follow-up settings except the follow-up done immediately after appliance insertion which showed no difference. This is due to the adaptation of the prosthesis and the nature of /z/and /z̲/ sounds as /z/ is (Alveolar fricatives) sound similar to /s/ and /s̲/ sound and /z̲/ is (dental sound) that needed the tongue contact with lower and upper teeth also /z̲/ sound is an emphatic sound that needs more power to produce. Additionally, the /z/ and /z̲/ sounds are voiced sounds that require vocal fold vibration to be produced [25].

The articulation test and spectrographic parameters for/ ∫/ sound were the same as other sounds But, without statistically significant difference between different follow-up periods in the articulation test as /∫/ is a palatal sound that requires appropriate air spreading through the teeth, highly precise tongue movement, and regulated jaw position in order to be produced [25] and that agrees with Turgut et al. [15], Kalia et al. [21] and Elbardissy et al. [25].

Conclusion

Loss of front primary incisors at an early age has a significant impact on speech production especially fricatives however early intervention with fixed prosthetic appliances allows proper speech development.

Recommendations

1. Additional studies should be conducted to compare sound production in children already lost their upper primary incisors for a long period with those who recently lost their incisors.
2. Further studies can be done on the impact of anterior aesthetic fixed appliances in the production of other consonant sounds as (Dental—plosives) ex: /d/ and /t/ sounds on large samples and long follow-ups.

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Study design
This study was conducted as a quasi-experimental pre-post study in a 6-month duration, the clinical part of the study was carried out at the outpatient clinic of Pediatric Dentistry while Speech evaluation and assessment were done in the Phoniatric Unit, ENT Department. In both the Faculty of Medicine and Dentistry, Tanta University.

Authors' contributions
RS contributed to the speech evaluation before and after the prosthesis application and scientific writing of the article. RM had contributed to the clinical evaluation of children, applying the dental prosthesis, and had contributed to the scientific writing of the article. A El. had contributed to the clinical evaluation of children and applying the dental prostheses. S El. contributed to the speech evaluation before and after the prosthesis application. All authors read and approved the final manuscript.

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Availability of data and materials
All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Declarations

Ethics approval and consent to participate
This study was approved by the ethics committee of the Faculty of Medicine, Tanta University with approval code: 36264PR139/3/23. The guardians of participants provided written informed consent. Research Ethics Committee–Federal Wide Assurance (FWA) FWA00022834, IRB0010038.

Consent for publication
Written informed consent for the publication was obtained from the guardians of participants.

Competing interests
The authors declare that they have no competing interests.

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References

1. Tyagi R (2008) The prevalence of nursing caries in Davangere preschool children and its relationship with feeding practices and socioeconomic status of the family. J Ind Soc Pedod Prev Dent 26(4):153–157
2. Casamassimo PS (2003) Dental disease prevalence, preventon, and health promotion: the implications on pediatric oral health of a more diverse population. Pediatr Dent 25(1):16–18
3. Hulland SA, Lucas JO, Wake MA, Hesketh KD (2000) Eruption of the primary dentition in human infants: a prospective descriptive study. Pediatr Dent 22(5):415–421
4. Mouradian WE, Wehr E, Crall JJ (2000) Disparities in children's oral health and access to dental care. JAMA. 284(20):2625–2631
5. Pierce KM, Rozier RG, Vann WF (2002) Accuracy of pediatric primary care providers' screening and referral for early childhood caries. Pediatrics 109(5):82–88
6. Facal-García M, Nova-García DE, Suárez-Quintanilla D (2001) The diastemas in deciduous dentition: the relationship to the tooth size and the dental arches dimensions. J Clin Pediatr Dent 26(1):65–69
7. Santos AG, Machado CD, Telles PD, Rocha MC (2013) Early loss of deciduous molars in children assisted by the School of Dentistry of the University of Bahia. Odontol Clín-Cient 12(3):189–193
8. Citron CI (1995) Esthetics in pediatric dentistry. NY State Dent J 61(2):30–33
9. Yiu CK, Wei SH (1992) Management of rampant caries in children. Quintessence Int 23(3):159–168
10. Rocha MJ, Cardoso M (2007) Survival analysis of endodontically treated traumatized primary teeth. Dent Traumatol 23(6):340–347
11. Borum MK, Andreasen JO. Sequelae of trauma to primary maxillary incisors. I. Complications in the primary dentition. Endod Dent Traumatol. 1998;14(1):31–44.
12. Odersjö ML, Koch G (2001) Developmental disturbances in permanent successors after intrusion injuries to maxillary primary incisors. Eur J Paediatr Dent 2(4):165–172

13. Bastone EB, Freer TJ, McNamara JR (2000) Epidemiology of dental trauma: a review of the literature. Aust Dent J 45(1):2–9
14. Overby M, Carrell T, Bernthal J (2007) Teachers' perceptions of students with speech sound disorders: a quantitative and qualitative analysis. Lang Speech Hear Serv Sch 38(4):327–341
15. Turgut MD, Genç GA, Başar F, Tekçiçek MU (2012) The effect of early loss of anterior primary tooth on speech production in preschool children. Turk J Med Sci 42(5):867–875
16. Giovannetti M, Casucci A, Casucci D, Mazzitelli C, Borracchini A (2011) Phonetic analysis and maxillary anterior tooth position: a pilot study on preliminary outcomes. Int Dent SA 5(11):32–39
17. Shariq M (2015) Arabic and English consonants: a phonetic and phonological investigation. Adv Lang Lit Stu 6(6):146–152
18. Snow K. Articulation proficiency in relation to certain dental abnormalities. J Speech Hear Disord. 1961; 26(3): 209–212.
19. Rajab LD (2002) Clinical performance and survival of space maintainers: evaluation over a period of 5 years. ASDC J Dent Child 69(2):156–160
20. Goenka P, Sarawgi A, Marwah N, Gumber P, Dutta S (2014) Simple fixed functional space maintainer. Int J Clin Pediatr Dent 7(3):225–228
21. Kalia G, Tandon S, Bhupali NR, Rathore A, Mathur R, Rathore K (2018) Speech evaluation in children with missing anterior teeth and after prosthetic rehabilitation with fixed functional space maintainer. J Ind Soc Pedod Prev Dent 36(4):391–395
22. Inagaki LT, Prado DGdA, Iwamoto AS, Pereira JS, Gavião MBD, Puppin-Rontani RM, et al. Interdisciplinary approach between dentistry and speech-language pathology in treatment of children with early childhood caries. Revista CEFAC. 2015;17(2):595–603.
23. Kotby MN, Elzomor M, Mohsen N. pilot study for standardization of an articulation test. Proc 10th Annu Ain-Shams Med Congr, Cairo, 1985.
24. Bassiouny SE, Hegazi MA, Nassar JF, Ibrahim MA, Saber AS, Hamid AA (2013) Development of an Arabic speech intelligibility test for children. Egy J Otolaryn 29(3):202–206
25. Elbardissy AAA, Mahmoud SA, Hamid AA. The influence of anterior esthetic fixed appliance of prematurel y lost primary incisors on sound production in a group of Egyptian children.(A case Control study). Egy Dent J. 2018;64 (4):3057–3068.

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