ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 8, Issue – 4, August – 2025, Page No. : 168 - 183

To Compare The Post Treatment Effects of Fixed Palatal Crib and Bonded Lingual Spur in Reduction of Open Bite and Overjet Following Cessation of Digit Sucking Habit Among 8 To 11 - Year Old Children Attending A Tertiary Health Care Centre in Thiruvananthapuram

[1]Dr. Bukya Bharathi, Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram

[2]Dr. Rita Zarina, Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram

[3]Dr. Sabitha CP, Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram

[4]Dr. Reshmi J, Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram

Corresponding Author: Dr. Bukya Bharathi, Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram

Citation of this Article: Dr. Bukya Bharathi, Dr. Rita Zarina, Dr. Sabitha CP, Dr. Reshmi J, "To Compare The Post Treatment Effects of Fixed Palatal Crib and Bonded Lingual Spur in Reduction of Open Bite and Overjet Following Cessation of Digit Sucking Habit Among 8 To 11 - Year Old Children Attending A Tertiary Health Care Centre in Thiruvananthapuram", IJDSIR- August – 2025, Volume – 8, Issue – 4, P. No. 168 – 183.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim*:* To compare the post treatment effects of Fixed palatal crib and Bonded lingual spur among 8 to 11 year old children with digit sucking habit attending a tertiary health care centre in Thiruvananthapuram.

Methodology*:* A total of 60 subjects (41 girls and 19 boys) of age group 8 to 11 years children were consecutively selected and randomly assigned into two groups: Group - A (n=30) was treated with Bonded lingual spur (BLS) and Group - B (n=30) was treated with Fixed palatal crib (FPC). Data obtained from digit sucking diary (at intervals of every 10 days during the 1st month, every 2 weeks during the next three months and every 1 month during the following months), pre and post study models were assessed for the cessation of digit sucking habit and reduction of overjet & open bite.

Statistical Analysis*:* The statistical analysis was performed by using a statistical software package SPSS version 20.0. Categorical and quantitative variables were expressed as frequency (percentage) and mean ± SD respectively. Independent t test was used to compare quantitative parameters between the categories. Wilcoxon Signed-rank test was carried out to compare ordinal parameters between two intervals of time and Mann-Whitney U test & Kruskal Wallis test was used to compare the ordinal parameters between two groups. Chi-square test was used to find the association between the categorical variables.

Results: Socio demographic variables were equally distributed among the two groups ($p > 0.05$)**.** Both FPC and BLS were effective in cessation of digit sucking habit and reduction of overjet and open bite ($p < 0.001$), but BLS was more effective in reduction of open bite (in 94.4 % of study subjects, $p < 0.001$) as compared to FPC (in 69.7 % of study subjects). However FPC was more effective in reduction of overjet (in 66.7 % of study subjects, $p < 0.001$) as compared to BLS (in 17.9 % of study subjects). The time taken for cessation of digit sucking habit was less with BLS than FPC ($p < 0.001$).

Conclusion: Both FPC and BLS were effective in open bite and overjet reduction associated with digit sucking in children during mixed dentition period, with BLS being more advantageous than FPC in terms of the variables studied.

Keywords: Digit sucking habit, Overjet & Open bite, Fixed palatal crib (FPC), Bonded lingual spur (BLS), Cessation of digit sucking habit

Introduction

Non-nutritive sucking habit (NNSHs) can be considered as the first step towards the development of a child's self-regulation and the ability to control his/her emotions. Digit sucking habit or non-nutritive sucking, is considered to be the most prevalent of oral habit, with a reported incidence ranging from 13% to almost 100% at some time during infancy. Non-nutritive sucking in the form of digit sucking begins as early as the 29th week of gestation and continues through infancy and peaks at 18 to 21 months of age. Digit sucking habit considered to be normal during the first 2 or 3 years of life, may cause permanent damage if it continues beyond this age. The older the child and longer the duration of the habit, greater the likelihood that malocclusion will develop. [(1)]

Fixed palatal crib is more effective and most commonly used interceptive appliance in the cessation of thumb sucking habit during mixed dentition as it works as an obstacle in continuing the non-nutritive sucking habit and maintains the tongue in a more retruded position thereby preventing its interposition between the incisors but it requires longer laboratory procedures for fabrication and is associated with low patient compliance, decalcification of teeth, food lodgement, calculus formation and gingivitis.[(2)]

Bonded lingual spurs have been found to be effective in the cessation of thumb sucking and tongue thrusting habit. Smaller size of about 3 mm, low cost, better esthetics, lack of need for laboratory procedures, easy installation with reduced clinical time for bonding (about 2 minutes per spur) and less technique sensitive procedures are the advantages of the Bonded lingual spurs over Fixed palatal crib appliances. The absence of an anchorage unit on the molars eliminates the possibility of the mesial movement of those tooth due to the abnormal thrusting force of the tongue and is another notable advantage of the Bonded lingual spurs.[(3)] The simple design and smaller components of Bonded lingual spurs makes the maintenance of oral hygiene easier, especially in young children. Thus Bonded lingual spur is considered to be a better option as it eliminates the deleterious oral habit like digit sucking, tongue thrusting and associated abnormal tongue posture which allows the normal development of the dentoalveolar structures.[(4)]

The main aim of our study was to observe if self-correction of malocclusion occurs with the early interruption of digit sucking habit during mixed dentition period by allowing the normal physiologic eruption of incisors. Very few studies could be found in the literature that compares the effectiveness of Bonded lingual spur (BLS) and Fixed palatal crib (FPC) in cessation of digit sucking habit and the correction of associated malocclusion during the mixed dentition period. The

present study was done to compare the effectiveness of Bonded lingual spur and the Fixed palatal crib in terms of the post-treatment effects of a reduction in open bite and overjet following the cessation of digit sucking habit.

Aim

To compare the post-treatment effects of the Fixed palatal crib and Bonded lingual spur among 8 to 11-year-old children with digit sucking habit attending a tertiary health care centre in Thiruvananthapuram.

Objectives

Primary objectives

To compare the post-treatment outcome of Bonded lingual spur over the Fixed palatal crib as assessed by the measurement of the reduction in open bite and overjet with Peer assessment rating (PAR) index ruler in millimetre by using pre and post-operative study models

Secondary objectives

To compare the reduction in digit sucking habit by the two deterrent methods as measured by the frequency of sucking episodes.

Methodology

Study Design

Analytical Observational Study

Study Setting

Department of Paediatric and Preventive dentistry (Government Dental College, Thiruvananthapuram)

Participants

Children who had digit sucking habit with anterior open bite, who reported to Department of Pediatric and Preventive Dentistry at Government Dental College, Thiruvananthapuram, were selected for the study based on the inclusion and exclusion criteria.

Inclusion criteria

- Parents who were willing to give consent and children from whom assent could be obtained
- Children having digit sucking with open bite, between 8 to 11 years of age, who could be reviewed for a period of 1, 3, 6 and 10 months interval, till the cessation of digit sucking.
- Definitely positive and positive children with digit sucking habit during waking hours or sleep.
- Angle's class 1 malocclusion cases with overjet more than 4 mm and open bite more than 1 mm.
- Children who had already undergone some form of home remedies to stop the habit, but need further professional assistance.
- Fully erupted first permanent molars and incisors.

Exclusion criteria

- Physically and medically compromised children
- Children with a previous history of professional intervention for habit cessation
- Clinically missing anterior teeth
- Patients having normal occlusion despite having digit sucking habit.
- Known neurodevelopmental disabilities.

Sampling

Sample size

Sample size was calculated using the formula

$$n = \left\lfloor \frac{2 x \sigma^2}{\Delta^2} \right\rfloor \lfloor Z\alpha + Z\beta \rfloor^2$$

Where

n = Sample size

Zα = False positive error (5%)

Zβ = False negative error (20%)

Δ = 1 mm (clinically meaningful difference)

σ = 1.25 (standard deviation of open bite)(5)

n = 25

Minimum sample size for the study derived from the above formula is 25 in each group. For satisfying the power of efficiency, 20 % extra patients were added to

the above number. Hence size of the sample was upsized to 30 patients.

Sampling Procedure

Children who had digit sucking habit with anterior open bite, who reported to Department of Pediatric and Preventive Dentistry at Government Dental College, Thiruvananthapuram, were selected for the study based on the inclusion and exclusion criteria. Children were consecutively selected and randomly assigned into two groups by the treating clinician till the sample size was achieved.

Outcome Measurement

Evaluation of the treatment outcomes were based on pre-operative and post-operative measurements of overjet and open bite with PAR index ruler in millimetre by using study models.

Outcome variables

- Overjet and Open bite
- Cessation of digit sucking habit

Ethical Consideration

- IEC clearance obtained from Government Dental College Institutional Ethics Committee IEC (IEC/E/23/2019/GDCT/dtd/12/11/2019)
- Assent from children and verbal-informed consent from parents and care givers of the child were obtained.

Methods of Data Collection

Study participants were divided randomly into two groups based on the type of the appliance worn for correction of digit sucking habit.

Group A: Subjects treated with Bonded lingual spur (BLS)

Group B: Subjects treated with Fixed palatal crib (FPC)

Armamentarium

- Gloves and mask
- Impression trays
- Alginate impression material
- Dental stone
- Plaster of Paris
- Pre and Post-operative study models
- PAR index ruler

The study subjects undergoing treatment in the Department were observed and recorded by the principal investigator and pre-operative study models were taken from the study participants just prior to the start of the treatment and post-operatively after cessation of the digit sucking habit. Both pre & post-operative overjet and open bite were measured from study models with the Peer assessment index ruler (PAR) in millimeter. Overjet and Open bite scoring was given according to PAR index ruler.

Overjet and Open bite Score according to PAR ruler

Scores	Overjet in millimeter	Open bite in millimeter
1	0 to 3	No open bite
2	1 to 5	Less than or equal to 1
3	5.1 to 7	1.1 to 2
4	7.1 to 9	2.1 to 4
5	> 9	> 4

The cessation of digit sucking habit was measured by the reduction in number of digit sucking episodes from the digit sucking diary, as recorded by follow-up calls made every 10 days during the 1st month, every 2 weeks during the next three months, every 1 month during the following months.

Plan of Analysis

- Statistical analysis was done using Statistical Package of Social Sciences (SPSS) software version 20.0.
- Categorical and quantitative variables were expressed as frequency (percentage) and mean ± SD respectively.
- Independent t-test was used to compare quantitative parameters between the categories.
- Wilcoxon signed-rank test was carried out to compare ordinal parameters between two intervals of time.
- Mann-Whitney U test & Kruskal Wallis test were used to compare ordinal parameters between the groups
- Chi-square test was used to find an association between the categorical variables.

Representative cases

Case 1:

Figure 1.1: Preoperative image of an 8-year-old female child with anterior Open bite and increased Overjet

Figure 1.2: Intraoral image showing Fixed palatal crib appliance

Figure 1.3: 12 weeks follow-up image showing improvement in anterior Open bite

Figure 1.4: Post-operative image showing improvement in anterior Open bite following cessation of digit sucking habit

Case 2

Figure 1.5: Preoperative image of a 9 and half-year-old female child showing anterior Open bite and increased Overjet

Figure 1.6: Intraoral image showing Bonded lingual spurs/palatal spurs appliance

Figure 1.7: 8 weeks follow-up image showing improvement in anterior Open bite

Figure 1.8: Post-operative image showing achievement in normal over bite following cessation of digit sucking habit

Results

The present study was conducted to compare the post-treatment outcome of Bonded lingual spur and Fixed palatal crib in reduction of open bite and overjet following cessation of digit sucking habit. The study was done among 60 children in the age group of 8 to 11 years who reported to the outpatient Department of Pediatric and Preventive Dentistry, Government Dental College, Thiruvananthapuram and satisfied both the inclusion and exclusion criteria. This study evaluated effects on digit sucking episodes by two deterrent methods as measured by the change in frequency, duration and associated malocclusion.

Out of the total 60 study participants, 8.3% of the study subjects, three subjects in the Fixed palatal crib group and two subjects in the Bonded lingual spur group were lost to follow up due to the unprecedented Covid-19 scenario. Hence post-treatment statistical analysis was done for the available 55 cases, though only 25 were required in each group as per the calculated sample size.

The data collected were statistically analysed and the results are presented under the following categories:

Post-treatment outcome of Bonded lingual spur (BLS) and Fixed palatal crib (FPC)

- Treatment effects of the Bonded lingual spur in reduction of Overjet
- Treatment effects of the Bonded lingual spur in reduction of Open bite
- Treatment effects of the Fixed palatal crib in reduction of Overjet
- Treatment effects of the Fixed palatal crib in reduction of Open bite
- Comparison of treatment outcome of Bonded lingual spur and Fixed palatal crib in reduction of Overjet
- Comparison of treatment outcome of Bonded lingual spur and Fixed palatal crib in reduction of Open bite

Comparison of the cessation of digit sucking habit by the bonded lingual spur (BLS) and Fixed palatal crib (FPC)

- Comparison of reduction in the frequency of digit sucking episodes by the two appliances
- Comparison of the duration taken in weeks for cessation of digit sucking habit by the two appliances.

Post-Treatment Outcome of Bonded Lingual Spur (BLS) and Fixed Palatal Crib (FPC)

- Treatment effects of the Bonded lingual spur in reduction of Overjet

Among the study participants, the mean difference in the pre and post-treatment overjet reduction was 4.71 mm in the Bonded lingual spur group and it was statistically significant ($p < 0.001$).

Table 1:

Distribution of Overjet in the study subjects during the pre and post-treatment period						
Overjet (in mm)	Pre treatment		Post treatment		Z score ($)	*p value*
	N	%	N	%		
0 to 3	0	0.0	5	17.9	4.71	< 0.001
3.1 to 5	0	0.0	19	67.9		
5.1 to 7	13	43.3	4	14.3		
7.1 to 9	13	43.3	0	0.0		
> 9	4	13.3	0	0.0		
Mean ± SD	6.6 ± 1.4		4.3 ± 0.8			
Median	6.5		4.3			

$ - Wilcoxon signed-rank test

- Treatment effects of Bonded lingual spur in reduction of overjet

Treatment effects of the Bonded lingual spur in reduction of Open bite

Among the study participants, the mean difference in the pre and post-treatment open bite reduction was 4.76 mm in the Bonded lingual spur group and it was statistically significant ($p < 0.001$).

Table 2:

Distribution of Open bite in the study subjects during the pre and post-treatment period						
Open bite (-) (in mm)	Pre treatment		Post treatment		Z score($)	*p value*
	N	%	N	%		
No open bite	0	0.0	20	71.4	4.76	< 0.001
≤ 1	0	0.0	7	25.0		
1.1 to 2	0	0.0	1	3.6		
2.1 to 4	11	36.7	0	0.0		
> 4	19	63.3	0	0.0		
Mean ± SD	- 4.7 ± 1.1		1.5 ± 0.7			
Median	- 4.5		2.0			

$ - Wilcoxon signed-rank test

- Treatment effects of Bonded lingual spur in reduction of open bite

Treatment effects of the Fixed palatal crib in reduction of Overjet

Among the study participants, the mean difference in the pre and post treatment overjet reduction was 4.63 mm in the Fixed palatal crib group and it was statistically significant ($p < 0.001$).

Table 3:

Distribution of Overjet in the study subjects during the pre and post-treatment period						
Overjet (in mm)	Pre treatment		Post treatment		Z score ($)	*p value*
	N	%	N	%		
0 to 3	0	0.0	18	66.7	4.63	< 0.001
3.1 to 5	1	3.3	8	29.6		
5.1 to 7	10	33.3	1	3.7		
7.1 to 9	15	50.0	0	0.0		
> 9	4	13.3	0	0.0		
Mean ± SD	7.3 ± 1.4		1.7 ± 0.5			
Median	7.3		2.0			

$ - Wilcoxon signed-rank test

- Treatment effects of Fixed palatal crib in reduction of overjet

Treatment effects of the Fixed palatal crib in reduction of Open bite

Among the study participants, the mean difference in the pre and post-operative open bite reduction was 4.61 mm in the Fixed palatal crib group and was statistically significant ($p < 0.001$).

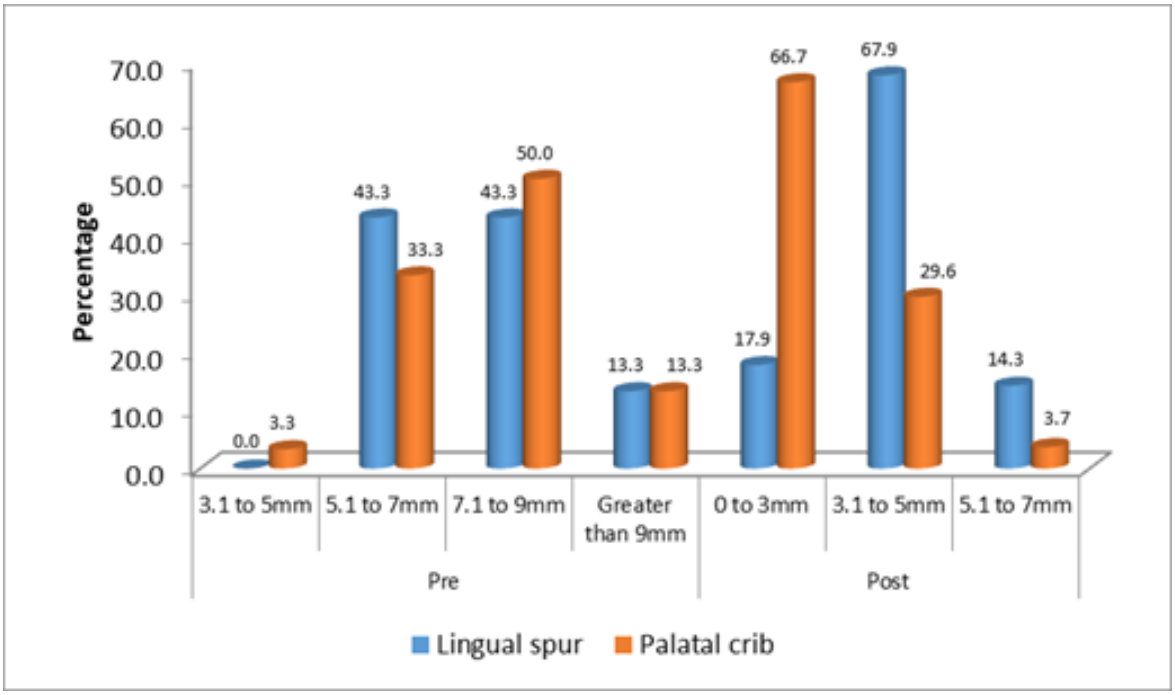
Table 4:

Distribution of Open bite in the study subjects during the pre and post-treatment period						
Open bite (-) (in mm)	Pre treatment		Post treatment		Z score($)	p value
	N	%	N	%		
No open bite	0	0.0	3	11.1	4.61	< 0.001
≤ 1	0	0.0	17	63.0		
1.1 to 2	0	0.0	6	22.2		
2.1 to 4	7	23.3	1	3.7		
> 4	23	76.7	0	0.0		
Mean ± SD	- 4.4 ± 0.9		- 0.7 ± 1.4			
Median	- 4.5		-1.0			

$ - Wilcoxon signed-rank test

- Treatment effects of Fixed palatal crib in reduction of open bite

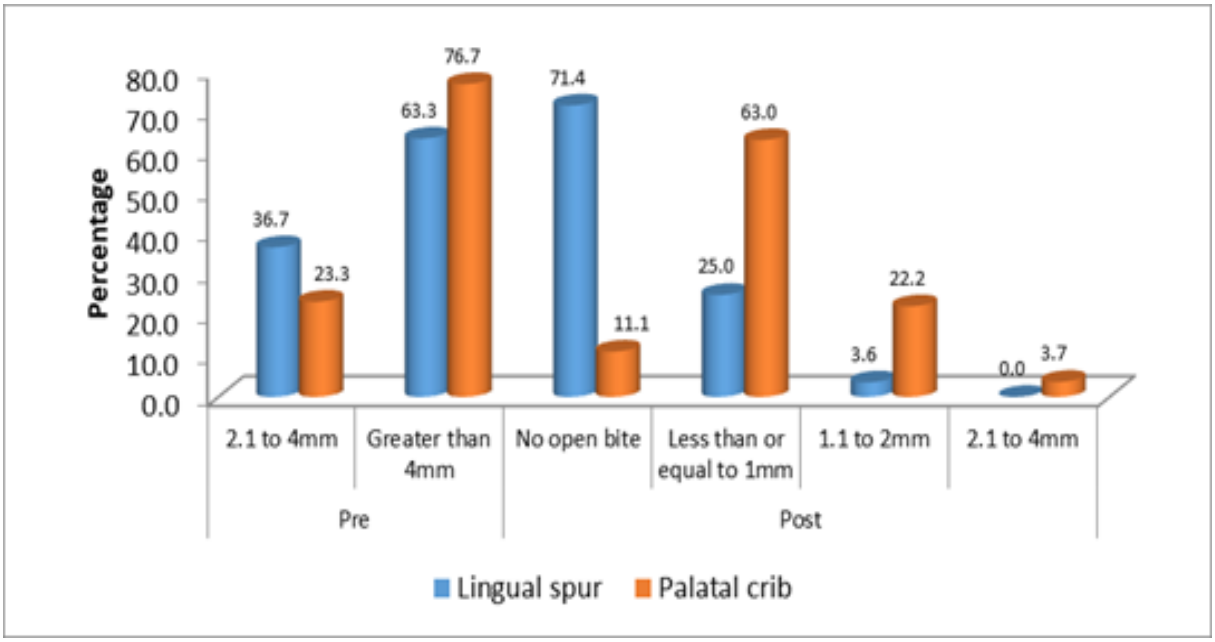
Comparison of treatment effects of Bonded lingual spur and Fixed palatal crib in reduction of overjet



Graph 1: Percentage distribution of overjet reduction with Bonded lingual spur and Fixed Palatal crib

Among the study participants, the percentage of subjects who achieved a normal overjet of 0 - 3 mm in the Fixed palatal crib group was 18 (66.7%) whereas only 5 (17.9%) in the Bonded lingual spur group achieved the same

Comparison of treatment effects of Bonded lingual spur and Fixed palatal crib in reduction of open bite



Graph 2: Percentage distribution of open bite reduction with Bonded lingual spur and Fixed palatal crib

- Among the study participants, the percentage distribution of the subjects who achieved normal overbite in the Bonded lingual spur group was 71.4% (20) whereas in the FPC it was only 11.1% (3).
- Seventeen subjects (63.0%) in the Fixed palatal crib group and 7 subjects (25%) in the Bonded lingual spur group achieved a reduction in open bite of ≤ 1 mm.

Comparison of The Cessation of Digit Sucking Habit by The Bonded Lingual Spur and Fixed Palatal Crib

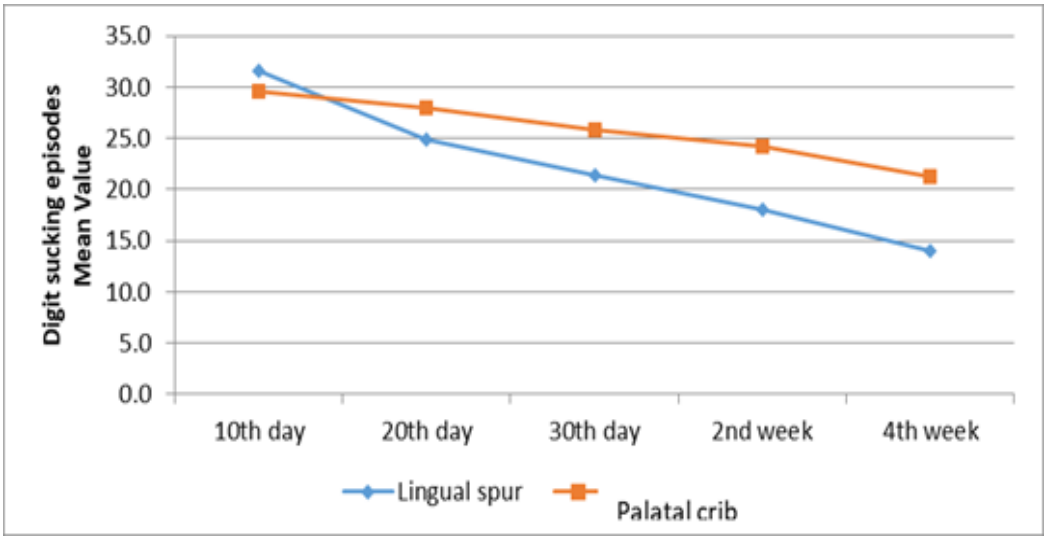
Comparison of reduction in the frequency of digit sucking episodes by the two appliances

A statistically significant reduction in the frequency of digit sucking episodes between the two groups were observed on the 30th day, 2nd week of 2nd month and the 4th week of 2nd month of follow-up.

Digit sucking episodes	Lingual spur			Palatal crib			t - value	*p value*
	Mean	SD	N	Mean	SD	N		
10th day	31.6	10.9	30	29.5	8.9	30	0.82	0.418
20th day	24.8	7.3	30	28.0	9.1	30	1.49	0.142
30th day	21.4	6.2	30	25.8	9.1	30	2.19*	0.032
2nd week of 2nd month	18.1	5.9	29	24.2	8.9	30	3.11**	0.003
4th week of 2nd month	14.0	7.6	29	21.3	8.2	29	3.51	< 0.001

**Significant at 0.01 level, *Significant at 0.05 level

Table 5: Comparison of reduction in the frequency of digit sucking episodes by the two appliances



Graph 3: Frequency distribution of digit sucking episodes by the two appliances

Comparison of the duration taken in weeks for cessation of digit sucking habit by the two appliances

In the Bonded lingual spur group, the mean duration taken to stop digit sucking habit was 13.2 ± 3.6 weeks whereas in the Fixed palatal crib group it was 22.5 ± 6.8 weeks and this difference in duration was found to be statistically significant (*p* < 0.001).

Groups	Minimum weeks	Maximum weeks	Mean	SD	N	t - value	*p value*
Lingual spur	4	24	13.2	3.6	28	6.36	< 0.001
Palatal crib	8	36	22.5	6.8	27		

Table 6: Comparison of the duration taken in weeks for cessation of digit sucking habit by the two appliances

Discussion

In children over 3 years of age with prolonged non-nutritive sucking habit, the American Academy of Pediatric Dentistry (AAPD) Council on Clinical Affairs, recommends a professional evaluation with the possibility of early intervention to break these habits. Once established, the treatment options that usually include age-appropriate explanations to the child, positive reinforcement, digital reminders, and fixed/removable intraoral habit-breaking appliances. These appliances work on the principle of preventing the sealing of the digit against the palate thus eliminating the pleasure associated with the habit.[6]

Graber [7] reported 92% success with the fixed appliance therapy than the removable appliance. The Fixed palatal crib is a fixed habit-breaking appliance that has been used effectively to break the digit sucking habit. However the disadvantages include negative emotional reactions, effects on speech & eating, irritation and trauma to the oral soft tissues and difficulty in maintaining proper oral hygiene.[8]

Lingual spur is a newer fixed habit-breaking appliance effective in cessation of the digit sucking habit. There are two types of lingual spurs, banded and bonded, in which Bonded lingual spur is a recently introduced variant of lingual spur. Huang et al.[3] demonstrated that anterior open bite caused by digit sucking and tongue thrusting habit can be corrected by spurs and have long term post retention stability. These spurs act by cessation of a digit sucking habit, encouraging mature tongue rest posture and allowing the incisors to erupt and decrease the anterior open bite. It also corrects the tongue posture and thereby a new neuromuscular pattern is established through reflexes (nociceptive or proprioceptive) initiated when the tongue touches the spurs. Simple design, cost-effectiveness, easy installation and absence of need for laboratory work are the other added advantages.

There are limited studies comparing the effectiveness of Bonded lingual spurs and Fixed palatal cribs. This in vivo analytical prospective study was conducted among 60 children in the age group of 8 to 11 years to compare the post-treatment effects of Fixed palatal crib and Bonded lingual spur appliances in terms of reduction in open bite and overjet following the cessation of digit sucking habit.

Post treatment effects of Bonded lingual spur (BLS) and Fixed palatal crib (FPC)

A significant reduction of overjet was found in the Bonded lingual spur group following the cessation of digit sucking habit with a mean overjet reduction of 4.71 mm ($p < 0.001$). Few other studies showing similar results were done by Canuto et al.[3] and Meyer Marcotty et al.[9] These studies showed a mean overjet reduction of 2.41 mm and 1.39 mm respectively ($p < 0.05$). Similarly, Leite et al.[5] and Mc Rae.[10] found that there was a clinical improvement in the overjet (2.63 mm and 0.01 mm respectively) following cessation of the digit sucking habit but was statistically insignificant ($p > 0.05$).

Distinctly significant reduction of open bite was observed in children who had used Bonded lingual spur in this study, mean value being 4.76 mm ($p < 0.001$). This observation is similar to the findings of Canuto et al.[3] & Insabralde et al.[11] who observed a mean reduction in open bite of 4.26 mm and 4.52 mm, respectively ($p < 0.01$). Cassis et al.[12] also found a clinical improvement by the reduction of open bite (2.23 mm) but it was statistically insignificant ($p < 0.01$).The findings of this study suggest that, Bonded lingual spur could help in the cessation of digit sucking and tongue thrusting habit (developed secondary to the open bite) and which allows bite deepening in the anterior region along with the elongation of maxillary and mandibular alveolar processes.

Children who used Fixed palatal crib (FPC) as the habit-breaking appliance showed a distinctly significant reduction in the overjet with a mean value of 4.63 mm ($p < 0.001$). This observation was consistent with the studies done by Leite et al.[5] & Harika et al.[13] A study done by Slaviero et al.[14] has found that there was no difference in the pre and post-operative overjet with the Fixed palatal crib (0.56 mm) following cessation of the habit and it was contrary to the findings of the present study.

In the present study subjects, there was a significant reduction in mean open bite (4.61 mm) in children who were treated with Fixed palatal crib (FPC) ($p < 0.001$). Similarly, Thiago et al.[14] & Rossato et al.[15] also found a reduction in mean open bite after cessation of digit sucking habit {(3.51 mm and 3.7 mm respectively ($p < 0.001$)}. But Giuntini et al.[16] and Ferreria et al.[17] observed that there was no significant reduction in open bite with the FPC. Insabralde et al.[11] concluded that Fixed palatal crib appliance were effective in correcting dental open bite in over 85% of the growing subjects with digit sucking habit and dentoskeletal open bites. Observation from this study may suggest that palatal cribs could work as a barricade in digit suckers and maintain the tongue in a more retruded position and thereby allowing the incisors to retract in the normal dentoalveolar position.

Comparative effectiveness of Bonded lingual spur (BLS) over the Fixed palatal crib (FPC) in reduction of open bite and overjet following cessation of digit sucking habit

Observation from this study may suggest that both Bonded lingual spur and Fixed palatal crib were effective in the cessation of digit sucking habit and spontaneous correction of open bite. This could be because both the appliances interrupt the digit sucking and tongue thrusting habit and allow the normal vertical dentoalveolar development at the anterior region by extrusion of the incisors. While there was a statistically significant reduction of open bite in 96.4% of the study subjects who used Bonded lingual spur (BLS), only 70.07% of the study subjects who used Fixed palatal crib (FPC) showed a reduction of open bite. Hence from this study, it may be concluded that BLS is more effective than FPC in reducing open bite following cessation of digit sucking habit and this finding was consistent with the observation made by Cassis et al.[12][BLS 86.7% & FPC 74%]. This observed difference in reduction of open bite could be probably because BLS mechanically blocks the digit sucking habit as well as alters the anterior tongue resting position to avoid its interposition between incisors, thereby enabling anterior teeth eruption and anterior open bite closure. However, Insabralde et al.[11] [FPC 97.5% & BLS 84.5%] and Leite et al.[5] [FPC 100% & BLS 53.8%] has concluded that FPC is more effective for the achievement of a normal overbite as compared to BLS.

According to Haryett et al.[18] a crib simply restrains, but won't retrain the tongue. Whereas the spurs discourage the tongue from resting against them, leading to the establishment of a new tongue posture, probably due to nociceptive or proprioceptive reflexes. While a crib, that is short in length allows the tongue to continue thrusting in an attempt to create a lip seal in open bite patients, as the spurs themselves appear to have a deterrent influence on the tongue thrust.

However, when reduction in overjet is considered, the findings of the present study shows that while Fixed palatal crib (FPC) demonstrated reduction of overjet in 66.7% of the study subjects, Bonded lingual spur (BLS) showed a reduction of only 17.9 %. Thus FPC could be considered to be more effective than BLS in reduction of

overjet following cessation of digit sucking habit and was in accordance with findings of Bourne et al.[19] [FPC 62.0 % & BLS 31.7%]. Not many studies comparing the effectiveness of FPC and BLS could be found in the available literature. But contrary to the findings of the present study, a similar study done by Slaviero et al.[14] found that there was no difference in pre and post-operative overjet reduction with FPC and BLS following cessation of the habit.

From the above observation, it may be suggested that both Bonded lingual spurs and Fixed palatal crib appear to interrupt digit sucking and tongue thrusting habit and promote better inclination of upper & lower incisors thereby improving overjet. However, further clinical studies with a larger sample size are needed to conclusively prove the effectiveness of one appliance over the other in overjet reduction.

Comparative effectiveness of both the appliances in reduction of frequency of digit sucking episodes and in the duration taken in weeks for the cessation of the digit sucking habit

The comparative effectiveness of Bonded lingual spurs and Fixed palatal cribs for the reduction in the frequency of digit sucking episodes and duration taken in weeks for cessation of the habit in a minimum time span were evaluated. it was observed that the mean reduction in sucking episodes was more in the Bonded lingual spur group (14 ± 7.6 sucking episodes) as compared to Fixed palatal crib (21.3 ± 8.2 sucking episodes).

This shows that the frequency of digit sucking episodes decreased faster in the Bonded lingual spur (minimum duration of 4 weeks) group as compared to the Fixed palatal crib (minimum of 8 weeks) group. A significant difference in the mean duration in weeks to stop the digit sucking habit was found between the two groups ($p < 0.001$). It was also observed that the mean duration was taken of 22.5 weeks for the study subjects in the Fixed palatal crib group and 13.2 weeks in the Bonded lingual spur group. Thus from this study, it was concluded that Bonded lingual spur appliance was more effective in the early cessation of digit sucking habit than the Fixed palatal crib appliance. This could be explained by the fact that the Bonded lingual spur with its sharp projections causes immediate pain reflex by the Somato-sensitive feedback mechanism, thereby leading to cessation of the habit.[20]

However, Haryett et al.[18] observed a contradictory finding that 81.0 % of the subjects in the Fixed palatal crib group and 66.7% in the Bonded lingual spur group showed cessation of digit sucking within 10 months of the duration. Mc Rae.[10] observed that 91.6 % of the study subjects successfully showed cessation of digit sucking within 6 months of period with Bonded lingual spur. Villa et al.[21] showed that 100% of the study subjects successfully stopped digit sucking with Fixed palatal crib within 6 months of period.

The findings of the present study can be summarized as follows,

1. Bonded lingual spur was more effective in reducing the frequency of digit sucking episodes as compared to the Fixed palatal crib.
2. The maximum duration taken to stop digit sucking habit in the Bonded lingual spur group was 24 weeks and in the Fixed palatal crib group was 36 weeks. Hence, BLS can be considered to be more effective in stopping the digit sucking habit than FPC.
3. In the mixed dentition, both Fixed palatal crib and Bonded lingual spur were effective in the reduction of open bite and overjet following cessation of the digit sucking habit
4. The average overjet reduction was 4.63 mm with a Fixed palatal crib and 4.71 mm with a Bonded

lingual spur. However, at the end of the treatment period, 18 subjects (66.7%) with FPC and only 5 subjects (17.9%) with BLS could achieve a normal overjet of 2 mm.

5. The average open bite reduction was 4.61 mm with a Fixed palatal crib and 4.76 mm with a Bonded lingual spur. At the end of the treatment period, 27 subjects (94.4%) with BLS and only 20 (69.7%) subjects with FPC could achieve a normal overbite of 2 mm.

Limitations of the study

1. The present analytical prospective study has a short follow-up period and the study participants were evaluated only till the cessation of the digit sucking habit.
2. Most of the study participants did not achieve the normal overjet and overbite following cessation of the digit sucking habit, probably due to the short follow-up period thereby failing to detect the end treatment results in terms of achieving normal overjet and overbite.

Strengths of the study

1. The findings of our study has confirmed that Bonded lingual spur helps in cessation of digit sucking within a shortest time span of 4 weeks in comparison with the Fixed palatal crib which took double the time. Hence management of digit sucking, which is a huge concern among parents of children with such habits can be easily addressed and their apprehension can be fully eradicated, ensuring harmony in their homes.

Recommendations of the study

1. We strongly recommended that more clinical studies should be conducted with a larger sample size and longer follow-up periods should be required to evaluate the stability of achieved correction of malocclusion and any relapse happening over time with both the appliances.
2. Use of orthodontic buttons instead of spurs could eliminate the initial pain and discomfort but its effectiveness in cessation of the habit based on nociceptive reflexes needs more evidence

Conclusion

Few prospective studies could be found in the literature comparing the effectiveness of Fixed palatal crib and Bonded lingual spur in reduction of malocclusion associated with the digit sucking habit. From the findings of the present study, it could be concluded that the correction of open bite and increased overjet following cessation of digit sucking habit happened primarily by the dentoalveolar changes. The correction of open bite and increased overjet in the digit suckers during the mixed dentition period is easily achieved because it is usually restricted to the dentoalveolar segment and the greater growth potential during this early stages can help in the self-correction of malocclusion once the habit is stopped.

Both the appliances studied induced favourable dentoalveolar changes resulting in the correction of the associated malocclusion. However Bonded lingual spur was found to be more effective in terms of correction of malocclusion and faster cessation of the habit. Other advantages of bonded lingual spurs like the simple design, low cost, absence of need for laboratory work and good patient compliance makes it a better option over Fixed palatal crib in children with digit sucking.

Acknowledgement

- First and foremost I bow my head to the Almighty for his amazing grace and endless love that has never ceased to help me throughout every ordeal in my life.
- With deep sense of gratitude I express my sincere thanks to my Professor, and Head of the Department,

Dr. Rita Zarina. A, for her valuable guidance, suggestions, being a constant source of inspiration. Also I thank her for providing me facilities to conduct this study.

- I am grateful to Dr.Oommen P Mathew and Dr.Muralidhar Nair who helped me with the statistical analysis.
- My deepest thanks to all the little ones without whom this study would not have been possible

References

2. Traisman AS, Traisman HS. Thumb-and finger-sucking: a study of 2,650 infants andchildren. The Journal of Pediatrics. 1958;52(5):566–72.
3. Borrie FR, Bearn DR, Innes NP, Iheozor-Ejiofor Z. Interventions for the cessation of non-nutritive sucking habits in children. Cochrane Database of Systematic Reviews. 2015;(3).
4. Canuto LFG, Janson G, de Lima NS, de Almeida RR, Cançado RH. Anterior open-bite treatment with bonded vs conventional lingual spurs: a comparative study. American Journal of Orthodontics and Dentofacial Orthopedics. 2016;149(6):847–55.
5. Dias FA, Assis Urnau FD, Pedron Oltramari PV, Lupion Poleti M, Rodrigues De Almeida M, Freire Fernandes TM. Stability of early treatment of anterior open bite: clinical performance of bonded lingual spurs. J Orthod. 2019 Mar;46(1):68–73.
6. Leite JS, Matiussi LB, Salem AC, Provenzano MG, Ramos AL. Effects of palatal crib and bonded spurs in early treatment of anterior open bite: a prospective randomized clinical study. The Angle Orthodontist. 2016;86(5):734–9.
7. subcommittee AA on PDCACPT. American Academy on Pediatric Dentistry Council on Clinical Affairs: Guideline on pulp therapy for primary and young permanent teeth. Pediatr Dent. 2008;30:170–4.
8. Graber TM. Thumb-and finger-sucking. American journal of orthodontics. 1959;45(4):258–64.
9. Mucedero M, Vitale M, Franchi L, Cozza P, Perillo L. Comparisons of two protocols for early treatment of anterior open bite. European Journal of Orthodontics. 2017;39(3):270–6.
10. Meyer-Marcotty P, Hartmann J, Stellzig-Eisenhauer A. Dentoalveolar Open Bite Treatment with Spur Appliances. J Orofac Orthop. 2007 Nov;68(6):510–21.
11. McRae EJ. Bondable lingual spur therapy to treat anterior open bite. Marquette University; 2010.
12. Insabralde NM, de Almeida RR, Henriques JFC, Fernandes TMF, Flores-Mir C, de Almeida MR. Dentoskeletal effects produced by removable palatal crib, bonded spurs, and chincup therapy in growing children with anterior open bite. The Angle Orthodontist. 2016;86(6):969–75.
13. Cassis MA, de Almeida RR, Janson G, de Almeida-Pedrin RR, de Almeida MR. Treatment effects of bonded spurs associated with high-pull chincup therapy in the treatment of patients with anterior open bite. American journal of orthodontics and dentofacial orthopedics. 2012;142(4):487–93.
14. Madiraju GS, Harika L. Effectiveness of appliance therapy in reducing overjet and open bite associated with thumb sucking habit. Minerva stomatologica. 2011;60(7–8):333–8.
15. Slaviero T, Fernandes TMF, Oltramari-Navarro PVP, de Castro AC, Conti F, Poleti ML, et al. Dimensional changes of dental arches produced by fixed and removable palatal cribs: A prospective, randomized, controlled study. The Angle Orthodontist. 2017;87(2):215–22.
16. Rossato PH, Fernandes TMF, Urnau FDA, de Castro AC, Conti F, de Almeida RR, et al. Dentoalveolar

effects produced by different appliances on early treatment of anterior open bite: A randomized clinical trial. The Angle Orthodontist. 2018;88(6):684–91.

17. Giuntini V, Franchi L, Baccetti T, Mucedero M, Cozza P. Dentoskeletal changes associated with fixed and removable appliances with a crib in open-bite patients in the mixed dentition. American journal of orthodontics and dentofacial orthopedics. 2008;133(1):77–80.
18. Ferreira FPC, Almeida RR de, Torres FC, Almeida-Pedrin RR de, Almeida MR de, Santana Filho R. Evaluation of the stability of open bite treatment using a removable appliance with palatal crib combined with high-pull chincup. Dental Press Journal of Orthodontics. 2012;17(6):52–60.
19. Haryett RD, Hansen FC, Davidson PO. Chronic thumb-sucking: a second report on treatment and its psychological effects. American journal of orthodontics. 1970;57(2):164–78.
20. Bourne CO. The comparative effectiveness of two digit-sucking deterrent methods. West Indian Med J. 2005;54(4):257–60.
21. Justus R. Correction of Anterior Open Bite with Spurs: Long-Term Stability. World Journal of Orthodontics. 2001;2(3).
22. Villa NL, Cisneros GJ. Changes in the dentition secondary to palatal crib therapy in digit-suckers: a preliminary study. Pediatric dentistry. 1997;19(5):323–6.