*Original Article*

Assessment arch dimensions in children with unilateral cleft lip and palate treated surgically by Furlow double-opposing Z-plasty protocol

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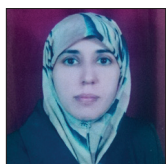
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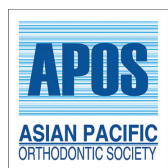
ABSTRACT

Objectives: The present study aimed to analyze the outcomes of Furlow double-opposing Z-plasty techniques and to know the effect of this technique on arch dimensions and also to compare these outcomes with the ordinary technique (pushback technique) and with the control group.

Materials and Methods: There are two treatment groups and one control group. Forty-two (20 males and 22 females) patients as a total number of the sample with unilateral cleft lip and palate (UCLP) children were included in this study, 1st group (10 males and 14 females) those treated with Furlow double-opposing Z-plasty performed at the age of 10 weeks repair of the lip, at 10 months closure of soft palate followed by construction of obturator done by an orthodontist, at 6 years of patient`s age a closure of hard palate, 2nd group (10 males and 8 females) treated with pushback technique. Criteria for selecting patients (two treatment groups), those without systemic diseases, cerebral disabilities, or any syndromes. The 3rd group consists of 20 healthy children (10 males and 10 females) those free from systemic diseases, aged 9–10 years old, free from oral habits and with limited or no crowding of teeth. Impressions of the upper arch of the patients were taken and the study model was poured at ages 9–10 years. Measurements include anterior arch width (ARW) or intercanine distance, posterior arch width (PAW) or intermolar distance, and arch depth (Adp). Statistical analysis; after collecting the data SPSS software program (version no. 21 Chicago, Illinois, USA) used for analysis, $P \leq 0.05$ will be considered as statistically significant. The data were analyzed for their normal distribution, and a comparison of dental arch dimensions between genders and between the two techniques of surgical repair was tested by independent *t*-test of samples.

Results: Significant larger mean values for arch measurements ARW and Adp for males and Adp for females than with the pushback technique. This is related to the growth pattern that occurred without surgical intervention.

Conclusion: An improvement in surgical outcomes, and the patients with UCLP treated with Z-plasty technique, revealed an increase in the mean values of arch measurements (anterior and PAW and Adp) for both genders when compared to the pushback technique, but less than that of healthy non-cleft children.

Keywords: Furlow double opposing, Z-plasty protocol, Pushback technique

INTRODUCTION

The growth defect in cleft palate patient is due primarily to the defect and the surgeries which interrupt the growth of various structures of the face in a patient with cleft deformity.[1,2] Two steps surgery is scheduled with optimizing the near-normal physiological development of speech and growth spurt of palatal and maxillary bones.[3] Cleft lip and palate is the highest occurring

congenital and developmental deformity occurring between 1:700 and 1:1000 among different population groups. The management of cleft lip and palate patients absolutely requires a multidisciplinary approach and orthodontists have proven to be the necessary member of the cleft palate team.[4] The majority of surgeons repair lip clefting around 10–12 weeks of age. A rule of tenth is still appropriate. It was suggested by Wilhelmsen and Musgrave that treatment of cleft lip should be taken place when the patients got the following cutoffs: Weight 10 lbs, hemoglobin 10 g/dL, and white blood cell count <10,000 mm³. It was Mallard who planned the commonly used "rule of order tenth" for the time of treatment stated as weight over 10 lbs, hemoglobin over 10 g, and age over 10 weeks.[5] Early surgical correction is correlated with proper speech development and aims for proper separation of oral and nasal compartments, in addition to the great negative effect on the growth of the midface due to the surgical stripping of the bone from soft tissue to close of the defect and fibrous tissues formation which in addition to the primary defect will deepen the three most important items of morbidity with cleft patients which are defective speech, cosmetic disability, and dental disharmony.[6] As early as 4 months of age of the patient, surgery may be performed with near-normal growth and development, keeping in mind the requirement of patients for orthognathic and orthodontic treatments with a high risk of velopharyngeal insufficiency and naso-oral fistula formation following early surgery, which require further surgeries and extra treatments.[7,8] Multiple treatment modalities had been studied to achieve the best results with cleft lip and palate patient treatment. Furlow procedure had been presented in 1978 and this procedure had been widely used for lengthening the soft palate with double-opposing Z-incisions and creating flaps for promoting the competence of velopharyngeal closure and hence better speech articulation. This may be associated with closure of hard palate directly at the time of surgery without lateral releasing incisions to avoid extensive soft-tissue reflection from bony structures.[9,10]

Two stages surgeries with the Furlow procedure in widely cleft patients had been proven to be challenging concerning naso-oral fistula formation in addition to the cost and the psychological effect on patients.[9,11]

Aims

The purpose of this research was to analyze the outcomes of Furlow double-opposing Z-plasty techniques, to know the effect of this technique on arch dimensions, and also to compare these outcomes with the ordinary technique (pushback technique) and with the control group.

Null hypothesis

There is no difference in the outcome and dental arch dimensions for patients treated with Furlow double-opposing Z-plasty than pushback techniques done for correction of unilateral cleft lip and palate (UCLP).

Alternate hypothesis

There is a difference in the outcome and dental arch dimensions for patients treated with Furlow double-opposing Z-plasty than the pushback techniques done for correction UCLP.

MATERIAL AND METHODS

The ethical approval (refer. No. uom. Dent/H.DM.14/20) was obtained from the research ethics committee at Mosul University.

Forty-two (20 males and 22 females) patients as a total number of samples with UCLP children. The inclusion criteria of the children depended on selecting the patients; were children of both genders, without systemic diseases, cerebral disabilities, any syndromes, or congenital abnormality rather than UCLP, were included in this research, which was done in the maxilla-facial department, in Al-Salam Teaching Hospital.

UCLP children were divided into two groups, the first group (10 males and 14 females) was those treated with Furlow double-opposing Z-plasty for two steps modality and the second group (10 males and eight females) treated with pushback technique. All the patients had been operated on by one surgeon.

The third group is the control which consists of 20 healthy children (10 males and 10 females) from the department of pedodontic, orthodontic, and preventive dentistry in the college of dentistry, Mosul University, those free from systemic diseases, their age 9–10 years old, free from oral habits, and with limited or no crowding of teeth and no premature loss of teeth were included in this study.

For pushback techniques, a surgical correction was done at 10 weeks of correction of the lip, and at 10 months closure of the hard and soft palate had been done. The time of first surgery for Z- plasty technique was performed at the age of 10 weeks repair of the lip only, at 10 months of age closure of the soft palate followed by the construction of an oral obturator done by the orthodontist to close the hard palate defect for assisting of patients' speech development and swallowing, with 6, 8, and 14 months interval for changing of obturators depending on growth requirement for the patient. Finally, at 6 years of patient age, a closure of hard palate was done.

Extra- and intra-oral photographs had been taken both pre-and postoperatively in a standardized method for the patients, in addition to the recording of arch relations both anteriorly and posteriorly. Follow-up of the patients for 4–5 years postoperatively with photographs and arch relation recording had been done.

Impression of the upper arch of the patients taken and study model was carried out at age 9–10 years, calibration of arch dimension done using Dimaxis software program. The measurements include; anterior arch width (ARW) or intercanine distance, the distance between the cusp tip of both canines (right and left), if the canine is not present, this distance was substituted by inter first primary molar width, which is the measurement between the mesiobuccal cusp of first primary molar (right and left). Posterior arch width (PAW) or intermolar distance; from the tip of the mesiobuccal cusp (right and left) first permanent molars.

Arch depth (Adp) from the central point at the midline of two central incisors or the central point at the mesial surface of one of the central incisors, (which is the aligned tooth with the line of the dental arch) in case of missing or malaligned other incisor, vertically to the line that connects the distal surface of first permanent molars [Figure 1]. Then, measurements were done on study models by computer. The casts were put over the glass stage of the scanner with a metal ruler. The taken figures will be stored in (a PC) laptop (Dell) for determining the dimensions required through the Dimaxis software program. Deformation that happened by the scanning procedure is corrected automatically with the Dimaxis program in the presence of a ruler.

Statistical analysis

Data were collected and entered into computer SPSS (statistical package version no. 21 Chicago, Illinois, USA) for a social science software program. $P \leq 0.05$ will be considered statistically significant. The data were analyzed for their normal distribution. Independent t-test used for comparison of dental arch dimensions between genders. Comparison among the three groups (two surgical techniques and control group) was tested by F-test and *post hoc* multiple comparison Duncan test.

RESULTS

In [Table 1] for comparison between males and females for the three groups, non-significant differences were found for all the variables that are larger in males than females.
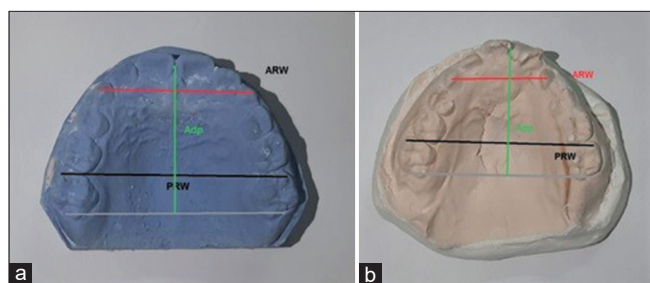

Figure 1: Arch measurements, (a) in normal patient`s group, (b) in patient with repaired unilateral cleft lip and palate.

A comparison among the three groups was done by ANOVA analysis followed by the Duncan test. For the ARW of the male group, there is a significant difference, with different letters for the three groups at $P \leq 0.05$ as shown in [Table 2]. The F-test value is 10.652, its significance is 0.001, the normal group had a larger mean value followed by Z-plasty, then the pushback technique.

PRW of the male group, there is a significant difference that is shown in [Table 2]. F-test value is 4.147, its significance is 0.039 seen between normal and pushback groups, a non-significant difference of Z-plasty with the others. For Adp [Table 2] reveal a significant difference in the variables with

Table 1: Comparison between males and females for the three groups.

Groups	ARW		PAW		Adp	
	M	F	M	F	M	F
Z-plasty						
Mean	28.450	27.051	46.648	46.100	35.677	34.645
SD	1.008	1.442	0.992	1.320	0.816	2.756
t-test	1.93		0.30		0.71	
P-value	0.08[NS]		0.76[NS]		0.49[NS]	
Pushback						
Mean	27.051	26.538	45.886	45.096	34.041	31.565
SD	1.337	1.412	1.058	1.217	1.965	2.579
t-test	0.64		0.73		1.87	
P-value	0.533[NS]		0.48[NS]		0.09[NS]	
Normal						
Mean	29.910	28.616	46.785	46.486	36.311	35.278
SD	1.270	0.963	1.491	0.928	0.674	3.00
t-test	1.98		0.33		0.82	
P-value	0.07[NS]		0.74[NS]		0.43[NS]	

ARW: Anterior arch width, PAW: Posterior arch width, Adp: Arch depth, NS: Non-significant

Table 2: Duncan test of the variables in three groups in males.

Groups	ARW		PAW		Adp	
	M	Dunc test	M	Dunc test	M	Dunc test
Z-plasty						
Mean	28.450	A	46.648	AB	35.677	B
SD	1.008		0.992		0.816	
Pushback						
Mean	27.051	B	45.886	A	34.041	A
SD	1.337		1.058		1.965	
Normal						
Mean	29.910	C	46.785	B	36.311	B
SD	1.270		1.491		0.674	
F-value	10.652		4.147		4.465	
Sig	0.001[S]		0.039[S]		0.033[S]	

ARW: Anterior arch width, PAW: Posterior arch width, Adp: Arch depth, S: Significant, Dunc: Duncan

different letters between normal and Pushback groups, the F-test value is 4.465, and its significance is 0.033.

For the females ARW, [Table 3] shows a significant difference, the F-test value is 5.663, and its significance is 0.015, that Z-plasty value in the middle between normal and pushback groups. Non-significant differences for PAW of Z-plasty group with the other two groups, F-test value is 2.766, it is significance is 0.097. A significant difference of ANOVA test for Adp shown in [Table 3] F-test value is 3.849, it is significance is 0.049, that pushback group had significant differences with both normal and Z-plasty, but non-significant differences between Z-plasty and normal group. [Figure 2] represents the outcome of Z- the plasty technique.

DISCUSSION

The knowledge about bone growth and remodeling, when it does, and exactly where it does, then planning, interpretation, and assessment of the relationship between growth and intervention of treatment become logically supported. The reduction of side effects from surgical procedures particularly on bone growth is the aim of this study which is achieved by avoiding further deepening of the negative impact of growth retardation on patients with cleft and aiding the patient normal speech and development to maximize life quality for the treated patients. No adverse effect on midfacial growth and minimal posterior and anterior crossbite with jaws

relations agreed with the finding of Kim et al., 2014, and Timbang et al., 2014.[12,13]

Furlow double-opposing Z-plasty is relatively simple, easy to do, and does not need a microscope, with good speech outcomes had been found in this research, this is also approved by Chorney et al., 2017, and Timbang et al., 2014.[6,13]

All the patients had been operated on by the same surgeon, for Z-plasty technique according to the two steps of surgery,

Table 3: Duncan test of the variables in three groups in females.

Groups	ARW		PAW		Adp	
	F	Dunc test	F	Dunc test	F	Dunc test
Z-plasty						
Mean	27.051	A	46.100	AB	34.645	B
SD	1.442		1.320		2.756	
Pushback						
Mean	26.538	A	45.096	A	31.565	A
SD	1.412		1.217		2.579	
Normal						
Mean	28.616	B	46.486	B	35.278	B
SD	0.963		0.928		3.00	
F-value	5.663		2.766		3.849	
Sig.	0.015[S]		0.097[NS]		0.049[S]	

S: Significant, NS: Non-significant, Dunc: Duncan, ARW: Anterior arch width, PAW: Posterior arch width, Adp: Arch depth

Figure 2: Outcome of Z-plasty technique, (a) unilateral cleft lip and palate child just before palate closure, (b) after closure of the palate, (c) extraoral profile view, (d) extraoral frontal view, (e) over view (12 o'clock photo), (f) intraoral frontal view.

with 2 patients (8.33%) having minor complications (bleeding, difficulty with breathing, swallowing, and speech disharmony) which require extra-treatment measures. The rest of the patients recover uneventfully, 91.6% of the patients showed near-normal growth patterns at the age of about 8–12 years with minor speech difficulties we expect a good facial harmony following orthodontic correction when those compared with the patients treated by pushback surgical technique. The patients who operated by Furlow surgery showed about 6% velopharyngeal deficiency that needs another treatment, the same finding by Stark *et al.*, 2017.[14]

The proposed objectives of occlusion, normal function, and balanced profile were achieved, and these results remained stable 4 years after the treatment.

From the tables obtained in the results, we found that all arch dimensions recorded for z-technique's patients were significantly larger mean values for arch measurements ARW and Adp for males, and Adp for females than with the pushback technique. This is related to the growth pattern that occurred without surgical intervention. The growth occurs by two main processes: Increase in size at the bony margins and change the shape by remodeling (resorption and deposition). In this technique (Z-plasty), the surgical intervention will be delayed compared to the pushback technique, away from the formation of fibrous tissue that followed surgery and that restrict bone remodeling. In addition, the early closure of the soft palate and lip will improve respiration and speech function, which positively affects the growth pattern according to the functional matrix theory of Moss. Hence, the author accepts the alternate hypothesis and refuses the null theory.

The mean values of all arch dimensions that were measured were still lower than the normal, orthodontic treatment needed to obtain an acceptable final appearance of the patient.

For the Duncan test, we found in Adp; non-significant differences of Z-plasty with normal group and a significant difference of the two groups with pushback group may due to faster growth process of Adp than transverse anterior or posterior variables; this stated by Cooper *et al.*, 1979.[15]

CONCLUSION

According to the outcome of the present study, the authors concluded that an improvement of surgical outcomes, and the patients with UCLP treated with Z-plasty technique, revealed an increase in the mean values of arch measurements (anterior and PAW and Adp) for both genders when compared to pushback technique, but less than that of healthy non-cleft children.

Conflicts of interest

There are no conflicts of interest.

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