

**Research Article**

Comparative Evaluation of Modified Furlow Palatoplasty and Intravelar Veloplasty in Cleft Palate Repair

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Abstract:

Introduction: The purpose of this study was to comparatively assess the two techniques of cleft palate repair i.e. Kriens intravelar veloplasty (IVV) and modified Furlow Palatoplasty (MFP) for post-operative fistula formation, wound dehiscence at suture line, nasal regurgitation, velopharyngeal insufficiency, soft palate lengthening and speech.

Method: This prospective study was conducted on 60 patients having primary cleft palate. They were assigned either to IVV group or MFP group randomly so that both the groups consisted of 30 patients each. The two groups were operated under general anesthesia. Measurements at the time of operation were made with the help of soft ruler and Castroviejo caliper. Follow up of patient's was done 1 week, 1 month, 3 month, 6 months and complication is present was noted. Five year post operatively speech was recorded and assessed by the speech language pathologist. Post-operative Nasoendoscopy was also performed to assess the velopharyngeal insufficiency.

Result: The MFP group showed more percentage elongation of the soft palate and less incidence of post-operative palatal fistula formation than IVV group. Total speech scores were superior in MFP patients but the differences were less robust. Velopharyngeal incompetence was present in both groups but was less severe in MFP group than the IVV group.

Conclusion: The MFP group showed comparatively superior results than the IVV group but required an increased surgical time. Therefore MFP can be used as an alternative technique for cleft palate repair.

Keywords: Modified Furlow palatoplasty; Intravelar veloplasty; velopharyngeal insufficiency

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Introduction

Intervelar veloplasty and Furlow's double opposing Z-plasty are time tested methods of repairing the cleft palate. Either technique has its own advantages and limitations. Although there is extensive published work by many distinguished surgeons related to the technical aspects, fistula, speech and growth studies related to these techniques, the inter technique evaluations are few and far between. Furlow's double-opposing Z-plasty technique was unofficially introduced in 1978 and first published in 1986. The technique was based on well-established principle of Z-plasty [1,2]. Intervelar veloplasty was proposed by Kriens in 1969. Kriens innovation was to restore the levator sling and palatal musculature in the midline where they normally meet. This is accomplished by dissecting the anteriorly malpositioned muscle bundle from the posterior edge of the hard palate and repositioning these in midline [3]. Since then, there have been many modifications in either technique such as addition of lateral releasing incisions, a 2 flap palatoplasty or von Langenbeck release in the hard palate area while carrying out IVV or MFP in soft palate region.

This prospective study is a comparison of the result of modified Furlow palatoplasty (MFP) with intravelar veloplasty (IVV) with reference to post-operative lengthening of soft palate, fistula formation, wound dehiscence at suture line, velopharyngeal insufficiency and speech.

Patients and Methods

This study was carried out on 60 patients who were randomly divided into two groups, each group consisting of thirty patients. Each of the individual technique was carried out by different operators especially trained in CLPS with more than 15 years of experience. The criteria for selection of patients to be included in the study were as follows:

1. Patients in good physical health and free of general and local diseases.
2. Clefts of: isolated soft palate, soft & hard palate, complete unilateral cleft of the palate including alveolus and lip, complete bilateral cleft of the palate including alveolus and lip.
3. Patients of the cleft lip and palate in whom only the lip had been repaired earlier.

Sample grouping

Group MFP included 30 patients out of which 20 were male and 10 were females in the age range of 2 to 13 years with the mean age of 7.7 years.

Group IVV: 30 patients comprised of 22 male patients and 8 female patients falling in the age range of 1 to 13 years with mean age of 5.5 years. The patients were informed with regard to the purpose of study and consent was obtained. Institutional Review Board approval was taken for the same. Diagnosis of the patients was made according to the Kernahan and Stark (1958) classification [4].

Group A- Incomplete cleft of the secondary palate

Group B- Complete cleft of the secondary palate

Group C- Incomplete cleft of primary and secondary palate

Group D- Unilateral complete cleft of primary and secondary palate

Group E- Bilateral complete cleft of primary and secondary palate

Intraoperatively measurements were made with the help of soft ruler, Castroviejo and Epker caliper Fig1, Fig 2. Cleft width was measured at split posterior nasal spine (PNS) identification by palpation. Width of the palatal shelves in the region of maxillary tuberosity on right (RPW) and left (LPW) sides was measured as the distance from alveolopalatal junction to the split posterior nasal spine on that side. The length of soft palate on right (RSPL) and left (LSPL) sides was measured as the distance between the split posterior nasal spines on that side, to the tip of hemi uvula (Fig 3). At the end of the operation, postoperative soft palate length (PoSPL) was measured

as the shortest distance between transverse lines joining the split posterior nasal spine to tip of uvula (Fig 4).

Mean palatal width (MPW) was calculated as the mean of RPW and LPW for each case. Based on these measurements, the clefts were identified as “wide” if width at PNS was more than or equal to MPW. The cleft was defined as being “unrepairable” if width at PNS was more than or equal to RPW+LPW.

Mean preoperative soft palate length (MSPL) was calculated from the average of RSPL and LSPL. Velar lengthening given in mm (VL mm.) was obtained by subtracting MSPL from PoSPL. Percentage velar lengthening (%VL) was calculated by the formula (POSPL-MSPL) divided by MSPL and multiplying by 100 (Table 1,2).

Statistical analysis

All the values of different parameters viz (MSPL, PoSPL etc.) are expressed in terms of mean \pm standard deviation. Further unpaired ‘t’ test was applied to test the significance difference in the palatal lengthening between two groups at 1% level of significance ($P < 0.01$).

All the calculations were done on SPSS package 17.0 version.

Technique of Intravelar Veloplasty

This procedure was performed by sharp separation of muscle fibers from the posterior edge of the hard palatal shelves followed by separation of these muscle fibers from the enveloping oral and nasal mucosa and retro positioning and plication of these muscle bundles across the mid line between oral and nasal velar mucosal repair under 2.5x loupe magnification. On the hard palate mucoperiosteal flap was elevated in case of group C, D, E type of cleft palate and repaired using two flap palatoplasty technique. In group A, B type of cleft lateral relaxing incisions were given to get a tension free closure. First nasal mucosal layer was sutured followed by muscle and oral layer.

Technique of modified Furlow’s palatoplasty

This procedure was performed using the method described by Furlow (1986) with certain modification and additional procedure.

1. Medial pressure is applied near the hook of hamulus, in the space of Ernst to sever the tensor tendon. The hook of hamulus is not fractured [5].
2. On the hard palate mucoperiosteal flap was elevated in case of group C,D,E type of cleft palate while in group A,B type of cleft palate only releasing incision is given.
3. Lateral releasing incision was given on the palatal aspect of gingival crevicular area of the teeth [6]. (Carstens, 1999)
4. Islanding the mucoperiosteal flap on greater palatine pedicle, together with furrow palatoplasty to get a tension free closure at hard and soft palate junction [7]. (Bindingavele et al, 2008, Gupta et al)
5. Bilateral islanding of the mucoperiosteal flap, together with buccal flaps for the oral and nasal layers, for velar lengthening in combination in some cases of wide cleft palates. (Gupta et al)

Follow up of patient's was done post operatively at 1 week, 1 month, 3 month, 6 months and complications if present, noted Fig. 5-10 (MFP group) fig.11-16 (IVV group). All the patients were referred to the ENT department & Speech therapist 1 month after the surgical procedure to assess middle ear functioning, hearing threshold and speech therapy. Five years postoperatively, Patients were referred to the speech language pathologist who is blinded about the procedure, where speech was recorded and assured. Nasoendoscopy was also done to look for velopharyngeal insufficiency.

The case records were analyzed for postoperative soft palate lengthening, wound dehiscence at suture line, fistula formation, nasal regurgitation, speech and velopharyngeal insufficiency. Speech was assessed for ten patients in IVV group and for sixteen patients in MFP group post operatively. Nasendoscopy was performed in

eight patients in IVV group and fourteen patients in MFP group post operatively. In all 60 cases included in the study, the follow-up was for a minimum period of 6 months and longest period of follow up was 5 years.

Results

Total no. of patients were broadly classified as wide, narrow and unrepairable clefts and randomly selected for either IVV or MFP repair. None of the cleft were found to be unrepairable. No specific criteria were kept in the mind while selecting the patient for surgery.

Soft palate elongation

In IVV group, mean percentage elongation of soft palate was 24.2% while in MFP group it was 82.6%. There was no significant difference between the values of MSPL (preop) between the both groups, but postop values showed a marked difference as depicted in the bar diagram. There was significant difference in the palatal lengthening between two groups (table 1,2).

Complication

A)Wound dehiscence

In IVV group four patients reported with wound dehiscence at PNS region while in MFP group two patients had wound dehiscence at PNS region.

B)Fistula formation

In IVV group four patients presented with palatal fistula post-operatively at PNS region while in MFP group two patient presented with palatal fistula after three and six month post-operatively at PNS region.

C)Nasal regurgitation

It was not found in both the groups.

Speech assessment

Speech assessment could not be done in all thirty patients, either due to non-patient compliance or young age of the patient. Ten patients in IVV group and sixteen patients in MFP group underwent a standardized speech evaluation by the team speech language pathologist [cleft audit protocol for speech augmented CAPS-A]. Each patient was rated for hypernasality, hyponasality, Nasal emission, Nasal turbulence, and Grimace in both group. Assessments were made by the speech pathologist, who was blinded as to the type of surgical procedure that had been performed.

In IVV group, 40% patients shows mild, 60% moderate abnormality in Hypernasality. 30% patients shows mild, 70% moderate abnormality in Hyponasality, 40% shows Nasal emission. 40% shows Turbulence. 40% patients shows Grimace.

In MFP group, 43.75% patients shows mild, 43.75% moderate and 12.5% severe abnormality in Hypernasality. 31.25% patients shows mild,62.5% moderate and 6.25% severe abnormality in Hyponasality. 30% patients shows Nasal emission. 40% patients shows Turbulence. 30% patients shows Grimace.

Velopharyngeal insufficiency

It was evaluated through nasoendoscopy which requires immense patient cooperation (table 9). Patients were asked to sound m, ng, aah. **IVV group**, it was done in 8 patients, which revealed that 37% patients shows consistent closure, 37% shows inconsistent closure of velopharynx while velopharynx of 25% of patients never closes.

In MFP group, it was done in 14 patients, which revealed that 57% of the patients shows consistent closure, 28% patients shows inconsistent closure while velopharynx of 14% of patients never closes.

While comparing the two studies we reached to a conclusion that the % elongation was found higher in MFP than IVV when measured above 100%. (Average % of elongation in MFP was 82.6% and in IVV it was 24.2%). Rate of wound dehiscence and fistula formation was higher in IVV. Nasal regurgitation was successfully terminated in both the treatment modalities. There was no significant difference in speech between the two groups.

Discussion

Since its description by Le monier (1760) [8] palatoplasty has undergone several modifications in the hand of distinguished surgeons in two major direction: to increase the length of the palate and to increase palatal muscle function by uniting these in midline or creating a functional sling. Optimum timing for palatoplasty is to strike a delicate balance between the development of speech and completion of midfacial growth. Thus speech and midfacial growth are the ultimate measures of any palatoplasty technique. A successful palatoplasty (meaning closure of the cleft without dehiscence or fistula) did not always result in intelligible speech. Fistula rates range from 0% to 43% [7, 9-24]. This study shows fistula rate of 13% and 6% in IVV and MFP techniques respectively. Furlow's palatoplasty is based on the well known plastic surgery principle of Z-plasty which can provide an active lengthening by up to 1.75 times in the area of Z-plasty [25]. Quantitative evaluation of the palatal elongation after Furlow's palatoplasty with previous publications are 69.05% and adequate [14,26] which compares favorably with our studies (MFP, IVV). The results of present study showed higher mean percentage of improvement with respect to percentage elongation of soft palate in patients treated by MFP (82.6%) compared to patients treated by IVV (24.2%).

Comparison of the speech in furrow and non furrow group or by furrow palatoplasty alone by different authors concluded that the speech outcome in furrow palatoplasty is superior to outstanding with regards to hypernasality, articulation and to a lesser extent, total speech score [27,28,29]. Assessment of speech is by itself multidimensional and production of speech is not only the functioning velopharyngeal structure but also require strong coordination of brain before the development of speech. In present study, there was no significant difference in speech between the two groups. This could also be due to the fact that average age at operation in either group was high compared to that considered optimum for producing good speech results. Although the literature documents the diminution of velopharyngeal insufficiency following palatoplasty but the evaluation and management of individual with velopharyngeal insufficiency remain a significant component of cleft palate repair because no technique of palatoplasty yields 100% normal velopharyngeal function [2,14,16,17]. In this study MFP group shows significant reduction in velopharyngeal insufficiency.

Conclusion

Although the optimal technique for cleft palate repair remains controversial, several small series have suggested that superior results can be obtained with the Furlow's double opposing Z-plasty. Speech quality remains the single most important standard by which palatoplasty can be judged. We analysed two different techniques of cleft palate repair, IVV and MFP. Superior results were achieved regarding postoperative palatal lengthening, fistula formation and velopharyngeal insufficiency in MFP technique as compared to IVV technique. The only disadvantage of MFP technique was that it is more time consuming intraoperatively as compared to IVV technique. Though we have not obtained any significant result regarding speech, further research is required to collaborate the results of this study. If any technique has demonstrable advantage over other after certain modification, it is worthwhile to consider using that technique.

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Table 1 INTERVELAR VELOPLASTY TECHNIQUE OF SOFT PALATE REPAIR

PT. NO.	Age/ Sex	Dia g	Push back	Von Langen Beck	Vomerin e Flap	Buccal Flap	Island Flap	Two Flap	RP W	LP W	MPW	PNS	MH P	BU	RSPL	LSP L	MSP L	PoSPL	SP- PPW	FISTUL A	% ELON G.	Wound Dehi.	Nasal Regurg
1	13/M	A	NO	YES	NO	NO	NO	NO	15	14	14.5	8	0	8	13	13	13	20	10	A	153	A	A
2	2/M	C	NO	NO	YES	NO	NO	YES	13	13	13	7	7	10	12	13	12.5	13	8	A	104	A	A
3	1/M	B	NO	YES	NO	NO	NO	NO	13	14	13.5	10	-	10	13	13	13	13	7	A	100	A	A
4	6/M	B	NO	B	NO	NO	NO	NO	14	13	13.5	10	-	10	13	13	13	13	9	3m-pns 6m-pns	100	5 th day pns	A
5	4/F	Dlt	NO	NO	YES	NO	NO	YES	15	14	14.5	12	12	14	14	13	13.5	15	12	3m-pns 6m-pns	111	4 th day pns	A
6	13m/M	B	NO	YES	NO	NO	NO	NO	11	11	11	-	-	6	12	12	12	19	10	A	158	A	A
7	2/M	A	NO	YES	NO	NO	NO	NO	12	11	11.5	8	-	9	13	14	13.5	15	9	A	111	A	A
8	9/M	B	NO	YES	NO	NO	NO	NO	15	15	15	9	-	10	14	14	14	14	6	A	100	A	A
9	5/F	B	NO	NO	YES	NO	NO	YES	14	13	13.5	8	-	6	13	13	13	15	10	A	115	A	A
10	12/M	Dlt	No	No	Yes	No	No	Yes	16	16	16	9	8	9	20	20	20	24	12	A	120	A	A
11	10m/m	Drt	NO	NO	Yes	No	No	Yes	12	12	12	6	6	6	17	17	17	21	11	A	123	A	A
12	12/m	A	NO	NO	NO	NO	NO	YES	12	11	11.5	10	-	11	13	13	13	15	9	A	115	A	A
13	3/m	Dlt	NO	No	Yes	No	NO	Yes	11	11	11	7	6	7	18	18	18	20	10	A	111	A	A
13	7/f	A	NO	NO	NO	NO	NO	YES	13	13	13	17	-	19	18	18	18	18	11	A	100	A	A

								S															
15	4/m	Drt	yes	No	YES	No	No	Yes	13	13	13	6	5	6	19	19	19	19	13	A	100	A	A
16	14/m	A	No	No	No	No	No	Yes	18	18	18	5	-	7	18	14	16	20	14	A	125	A	A
17	9/f	A	No	No	No	No	No	Yes	12	12	12	18	-	20	21	21	21	25	15	A	119	A	A
18	4/f	B	No	No	Yes	No	No	Yes	14	13	13.5	15	-	15	19	21	20	27	12	A	135	A	A
19	7/m	B	No	No	No	No	No	No	14	14	14	8	-	13	19	21	20	26	10	3m-pns 6m-pns	130	5 th day pns	A
20	14/m	A	No	Yes	No	No	No	No	11	11	11	6	-	6	33	34	33.5	34	15	A	101	A	A
21	3/m	B	No	No	No	No	No	Yes	13	13	13	13	12	12	20	20	20	25	14	A	125	A	A
22	5/f	D lt	No	No	Yes	No	No	Yes	13	13	13	15	14	15	20	20	20	24	14	3m-pns 6m-pns	120	3 rd day 1 m	A
23	3/m	A	No	Yes	No	No	No	No	13	13	13	8	-	8	18	17	17.5	22	14	A	126	A	A
24	1/m	B	No	Yes	No	No	No	No	14	14	14	-	-	5	17	19	18	21	17	A	117	A	A
25	7/f	A	No	No	No	No	No	No	13	14	13.5	8	-	9	16	14	15	20	14	A	133	A	A
26	2/m	C,E	No	Yes	No	No	No	No	13	13	13	6	5	4	19	19	19	25	13	A	132	A	A
27	11m/m	D rt	No	No	Yes	No	No	Yes	12	14	13	10	12	8	5	20	17.5	27	13	A	154	A	A
28	2/m	D lt	No	No	Yes	No	No	Yes	12	12	12	8	8	8	20	20	20	24	15	A	120	A	A
29	10/m	D lt	No	No	Yes	No	No	Yes	15	15	15	8	7	8	18	20	19	24	30	A	126	A	A
30	3/m	D lt	Yes	No	Yes	No	No	No	12	12	12	7	9	6	20	20	20	20	14	A	100	A	A
MEAN									13.3	13.2	13.2	9.36	7.93	9.5	16.83	17	17.3	20.6	12.37		124.2		
STDDE V									1.57	1.58	1.54	3.41	3.69	3.9	4.72	4.5	4.266	5.0963	4.255		13.154		
STDER R									0.29	0.29	0.28	0.62	0.67	0.7	0.862	0.8	0.779	0.931	0.777		3.396		

Table2 Modified furlow technique of soft palate repair

PT. NO.	Age/ sex	Dia g	Push back	Von Lange n beck	Vomerine Flap	Buccal Flap	Island Flap	Tw o flap	RP W	LP W	MP W	PN S	MH P	B U	RSP L	LSP L	MSP L	PoS PL	SP- PPW	FIST ULA	% ELON G.	Wou nd Dehi .	Nasa l regur g
1	13/M	E	NO	NO	YES	YES,B/L,RAN,L TO	YES, B/L	YE S	16	16	16	8	8	10	17	18	17.5	24	7	A	137	A	A
2	5/M	B	NO	YES	NO	NO	NO	NO	13	14	13.5	6	-	10	16	17	16.5	29	8	A	175	A	A
3	9/F	E	NO	NO	YES	YES,B/L,RAN,L TO	YES, B/L	YE S	18	17	17.5	12	11	15	16	17	16.5	30	9	A	181	A	A
4	10/M	B	NO	YES	NO	NO	NO	NO	15	15	15	8	-	12	16	16	16	24	6	A	150	A	A
5	14/M	Dlt	NO	YES	NO	NO	NO	YE S	17	18	17.8	8	8	10	17	16	16.5	26	8	A	157	A	A
6	7/M	B	NO	YES	NO	NO	NO	NO	16	16	16	13	-	16	17	17	17	29	5	A	170	A	A
7	6/F	B	NO	YES	NO	NO	NO	NO	14	14	14	9	-	13	16	15	15.6	22	12	A	141	A	A
8	12/M	E	NO	NO	YES	YES,B/L,RAN,L TO	YES	YE S	14	13	13.5	14	14	16	17	17	17	28	13	A	164	A	A
9	5/F	B	NO	YES	NO	NO	NO	NO	14	14	14	8	8	13	16	15	15.6	30	7	A	192	A	A
10	3/F	Drt	NON O	NO	NO	YES,RTO	YES,rt	NO	13	12	12.5	8	5	8	13	13	13	18	7	A	138	A	A
11	8/M	E	NO	NO	YES	YES,RAN	YES,B /L	YE S	17	17	17	9	8	12	15	15	15	28	7	A	186	A	A

12	4/F	B	NO	YES	NO	NO	NO	NO	15	15	15	13	-	13	18	18	18	28	6	A	155	A	A
13	14/M	B	NO	YES	NO	YES,B/LRAN,L TO	YES,lt	NO	15	16	15.5	9	-	14	16	16	16	27	11	A	168	A	A
14	4/M	Drt	NO	NO	YES	YES,B/L RAN,LTO		YES	16	16	16	11	11	11	19	19	19	30	11	A	157	A	A
15	5/m	Dlt	NO	NO	Yes	Yes,b/l,RAN,LT O	Yes, b/l	yes	15	14	14.5	10	9	10	18	18	18	28	9	A	155	A	A
16	3/m	D rt	No	No	yes		Yes, rt	Yes	14	14	14	11	11	12	17	17	17	27	12	A	159	A	A
17	4/m	D lt	No	No	Yes	Yes, b/l RAN, LTO	Yes, b/l	Yes	14	13	13.5	14	11	16	30	28	29	40	11	A	138	A	A
18	15/m	B	No	yes	No	Yes, b/l RAN, LTO	Yes, rt	no	13	13	13	19	17	15	19	21	20	51	30	0	255	A	A
19	16/f	D lt	No	No	Yes	NO	No	yes	14	14	14	11	13	10	11	13	12	24	17	A	200	A	A
20	7/m	B	No	No	No	Yes, LTO	Yes, b/l	Yes	12	12	12	10	-	11	8	11	9.5	32	18	A	337	A	A
21	5/f	B	No	yes	No	No	Yes, rt	No	14	14	14	8.5	8	8.5	20	21	20.25	27	14	A	135	A	A
22	15/m	D lt	No	No	Yes	No	No	Yes	18	17	17.5	6	6	8	12	16	14	30	17	A	214	A	A
23	7/m	E	No	No	Yes	Yes, rt Nasal	Yes, lt	Yes	15	15	15	11	11	9	17	17	17	26	15	A	153	A	A
24	8/m	E	No	No	No	Yes, RAN	Yes, b/l	Yes	12	12	12	16	14	14	26	24	25	32	15	A	128	A	A
25	16/f	B	No	yes	No	Yes, b/l RAN, LTO	Yes, b/l	No	14	13	13.5	19	-	18	26	23	24.5	47	32	A	192	A	A
26	16/m	B	No	Yes	No	No	Yes, b/l	No	14	14	14	14	-	15	27.5	28	27.75	42	20	A	151	A	A

27	5/f	D rt	No	No	Yes	Yes	Yes, lt nasal	Yes	13	14	13.5	17	16	18	18	18	18	35	14	A	183	A	A
28	2/f	D rt	No	No	No	Yes, RTO	Yes, rt	No	13	13	13	11.5	11	12	17	15	16	30.5	13	A	191	A	A
29	4/m	E	No	No	No	Yes, lt nasal	Yes, b/l	Yes	12	12	12	16	16	16	15	15	15	26	16	3m-p ns 6m-p ns	173	l m pns	A
30	3/m	D lt	No	No	Yes	No	Yes, b/l	Yes	14	12	13	9.5	9	5	21	20	20.5	27	20	A	132	A	A
MEAN									14.5	14.3	14.4	11.3	10.7	12	17.72	18	17.76	29.9 17	13		182.6		
STDDEV									1.63	1.7	1.65	3.55	3.32	3.2	4.675	3.9	4.249	7.00 99	6.51		55.448		
STDERR									0.3	0.31	0.3	0.65	0.61	0.1	0.853	0.7	0.776	1.28 1			14.31		

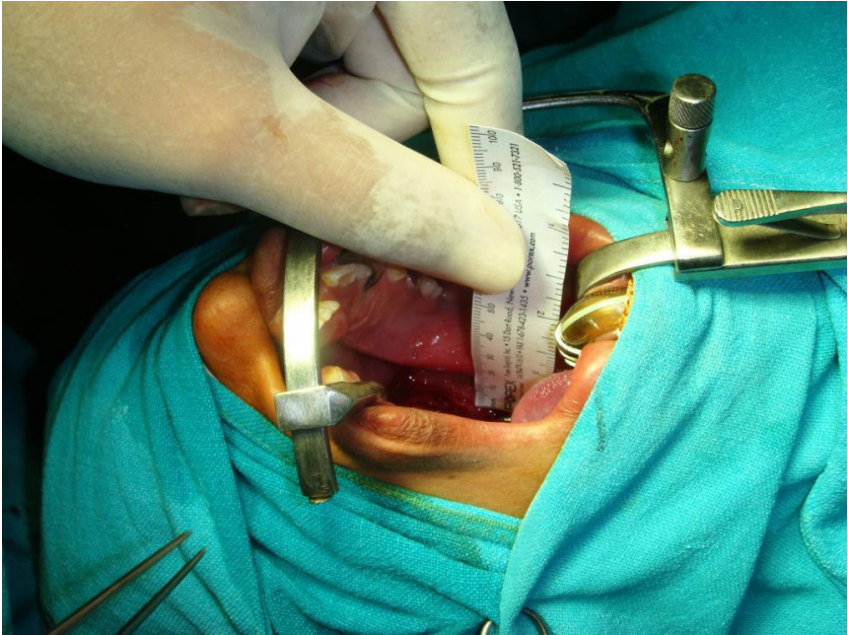


Figure 1 soft ruler

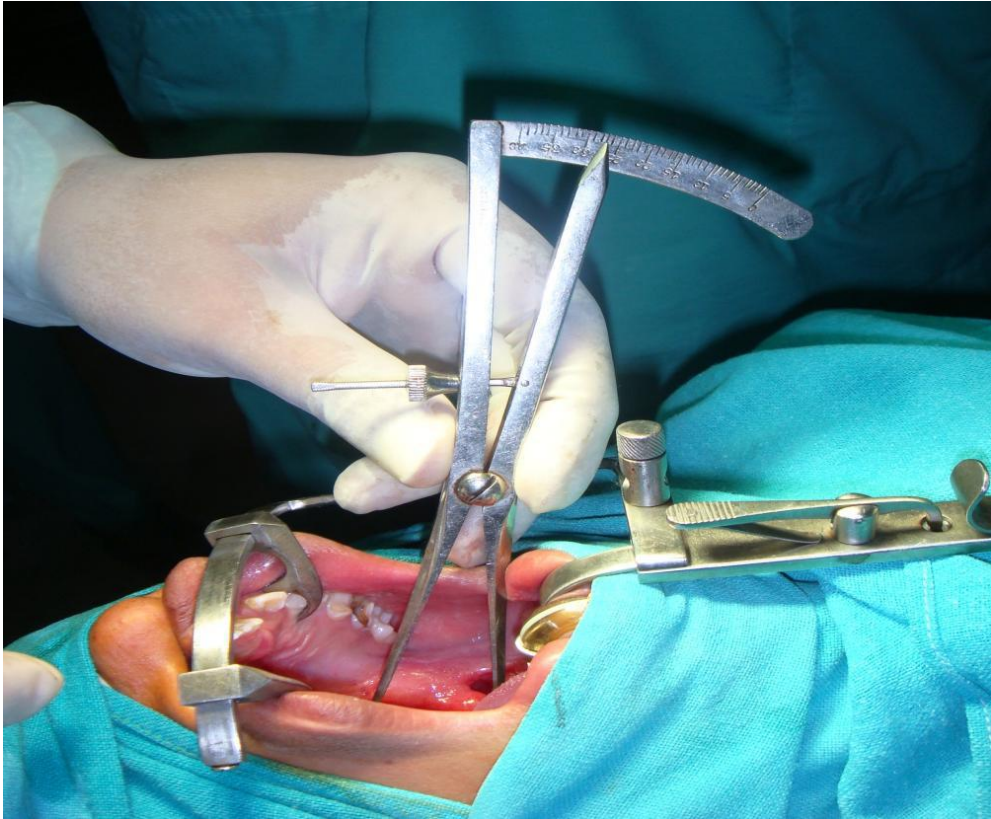


Figure 2 caliper

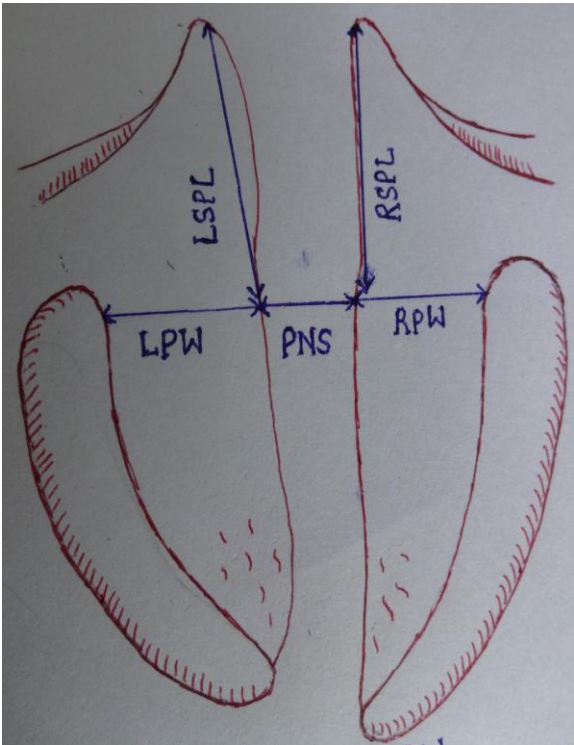


Figure 3 Intraoperative measurements

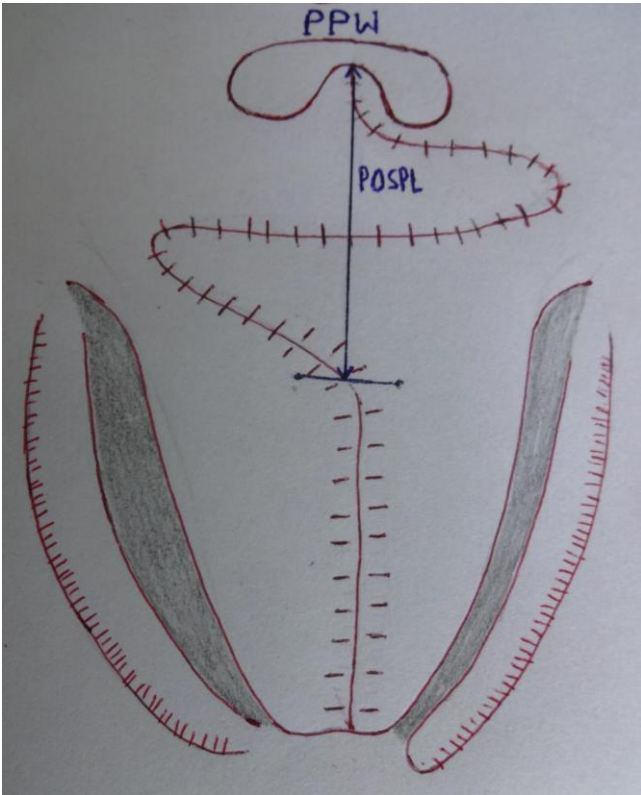


Figure 4 Post-operative soft palate lengthening

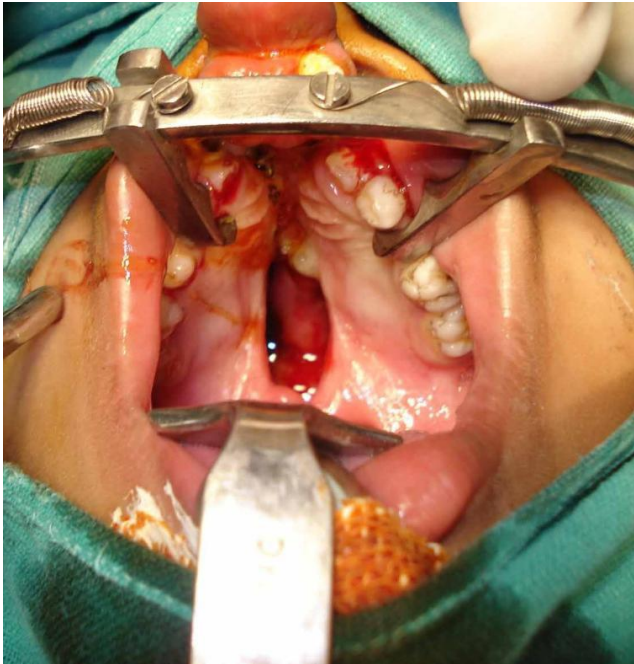


Figure 5 intra-operative

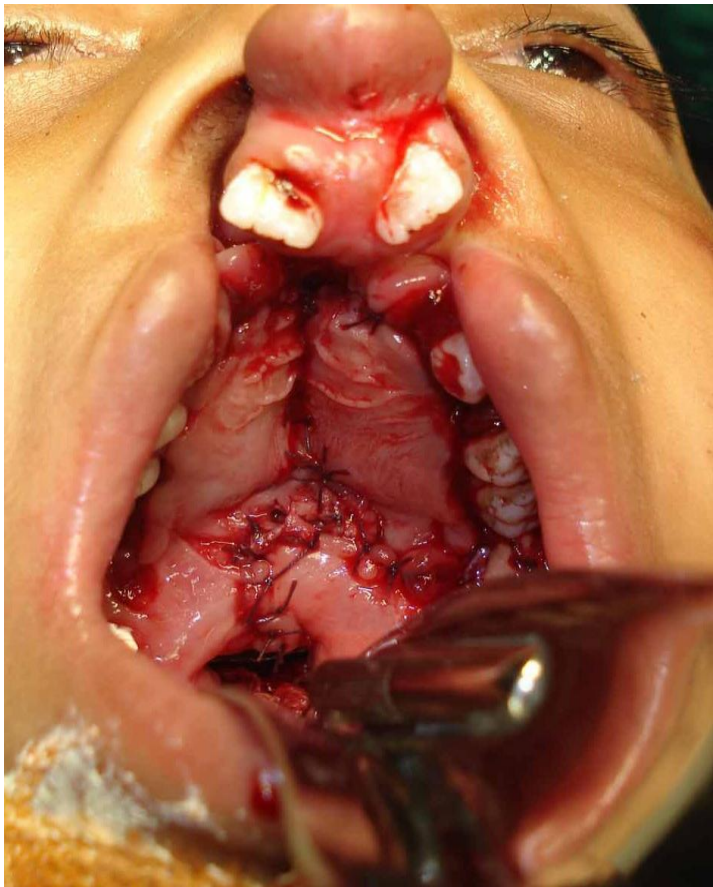


Figure 6 intra-operative



Figure 7 post-operative (1 week)

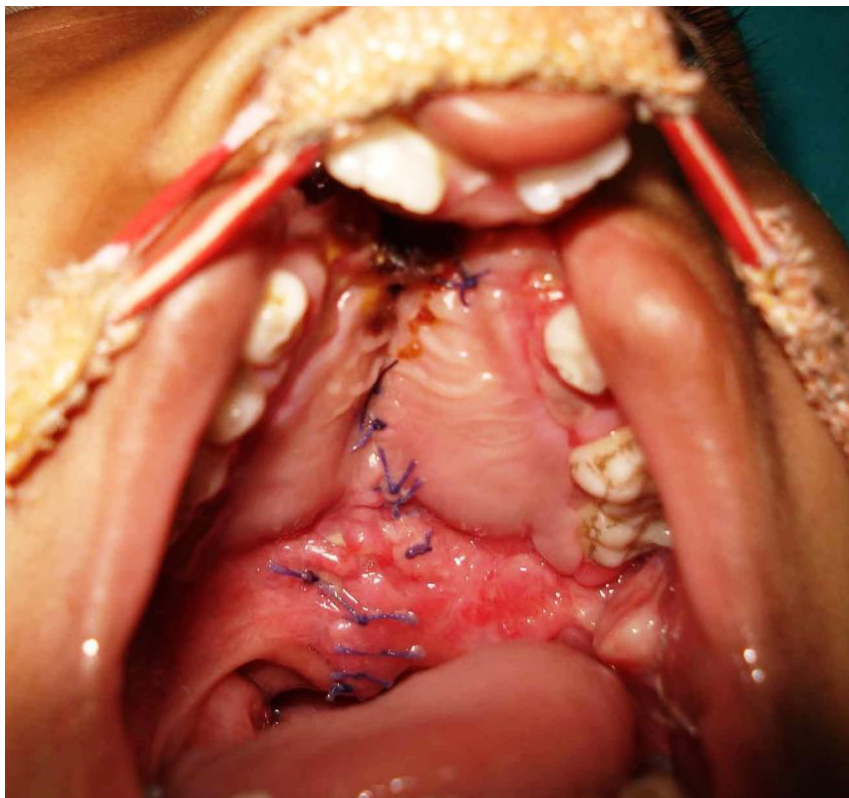


Figure 8 post-operative (1 month)



Figure 9 post-operative (3 months)

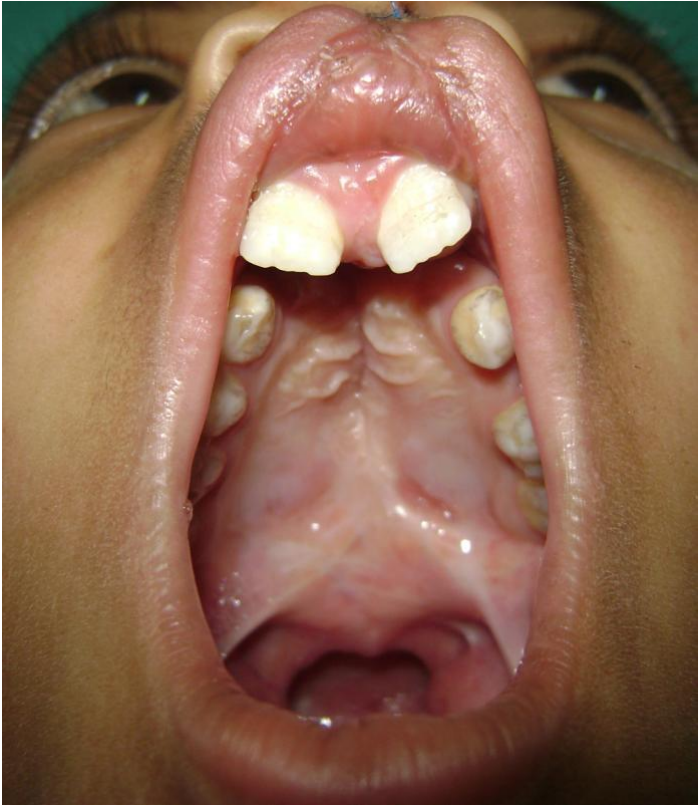


Figure 10 post-operative (6 months)

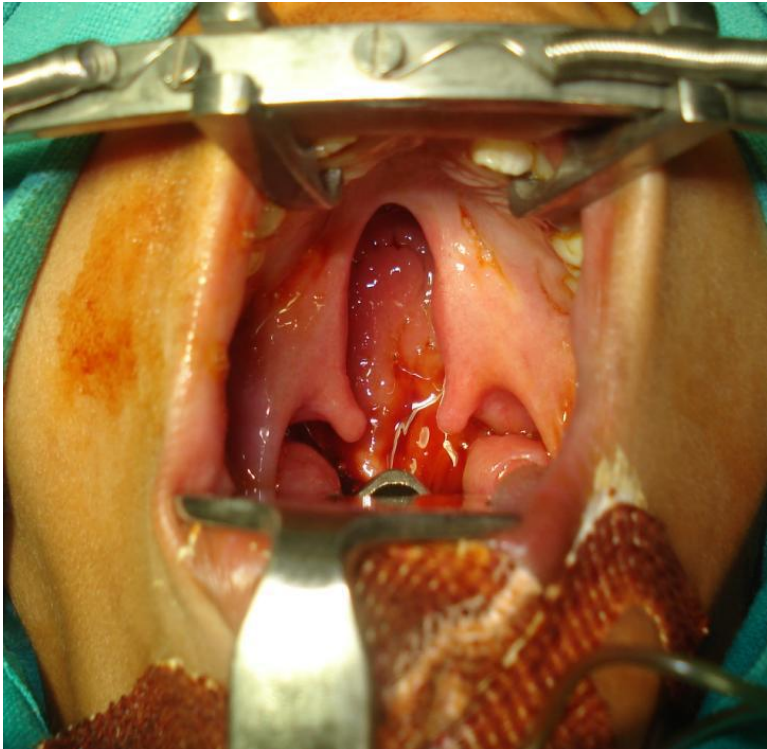


Figure 11 intra-operative

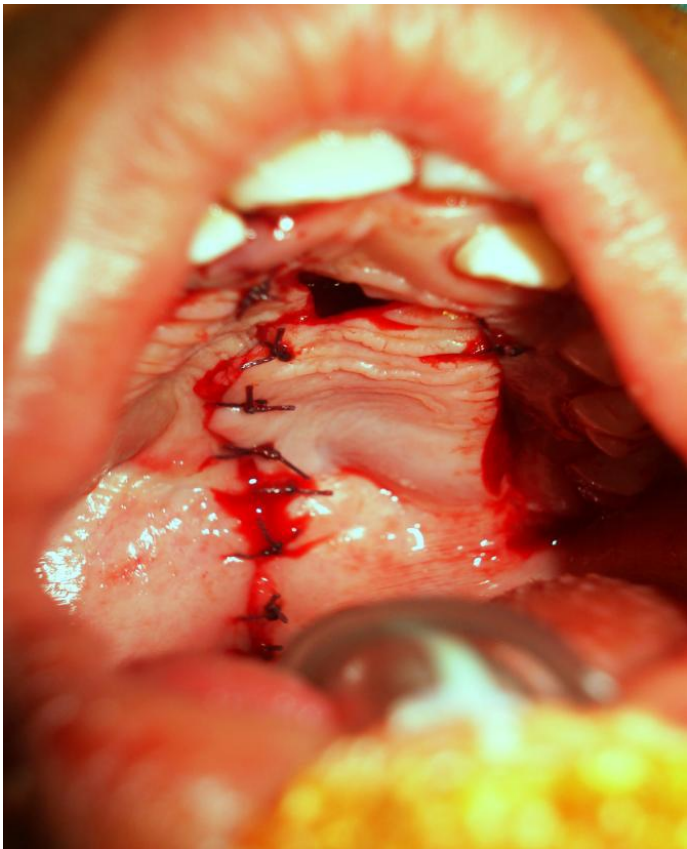


Figure 12 intra-operative



Figure 13 post-operative (1 week)

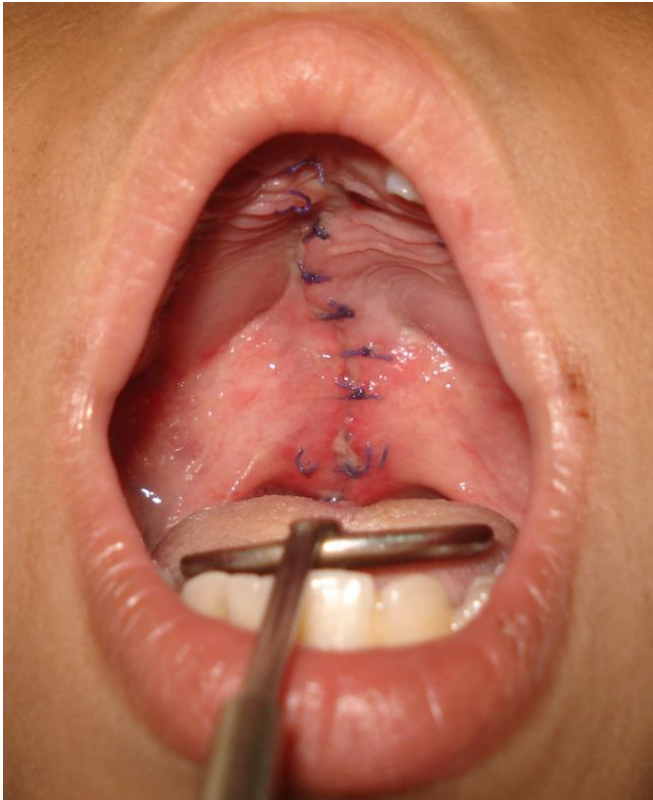


Figure 14 post-operative (1 month)



Figure 15 post-operative (3 months)



Figure 16 post-operative (6 months)