

## A Review of Speech Function and Maxillary Growth in Cleft Palate Patients

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### Abstract

There are variations in methodology of palate repair in many cleft centres in the world. The aim of this systematic review is to describe speech function and maxillary growth outcome from various methodology of palate repair in cleft palate patients.

Methods: Literature search was conducted in the electronic database Pubmed/Medline. The literature inclusion criteria were English written, and keywords were verified in MeSH. Boolean "AND" was used to specify the search. The keywords used in this study were speech, maxillary, growth, cleft, and palate.

Ninety two papers were filtered from Pubmed, only twenty six papers fit the inclusions criteria. Twelve papers discussed the speech function and maxillary growth, 7 papers only discussed the speech function and 7 papers only discussed the maxillary growth. There are variations in technique, stages, and timing of palate repair in many cleft centres. The results revealed that early closure of the soft palate is favorable for speech function, whereas early closure of the hard palate can interfere the maxillary growth.

Findings from this review conclude that in most cleft centres worldwide, a one-stage palate repair is preferable than the two-stage procedure. Further studies should be conducted to explore potential benefits of the two-stage palate repair in improving speech function and maxillary growth.

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### Introduction

Cleft lip and palate are the most common congenital birth defect of the craniofacial region. Cleft lip and palate are classified into two groups, isolated cleft palate and cleft lip with or without cleft palate. The prevalence of cleft lip and palate is 1 per 700 live births worldwide.<sup>1,2</sup> The management of cleft lip and palate patients is very complex and the treatment outcome assessment is essential to assess the efficacy of treatment and maintain quality assurance. There is a diversity of treatment protocols applied by different cleft centers worldwide. The Eurocleft study found 194 different treatment protocols amongst the 201 units assessed.<sup>1</sup> Cleft palate

affect growth of dentofacial structures and development of speech. The objective assessment of a cleft treatment protocol should include speech, dental arch relationship, and growth, as well as aesthetic and psychosocial factors. To date, maxillary growth and speech function have been considered as useful benchmarks to assess the efficacy of management of children with cleft lip and palate.

There are differences of opinion on the technique of cleft palate repair to obtain good speech and maxillary growth outcomes. Some surgeons prefer the classic two-flap palatoplasty according to Bardach's technique, on the other hand many other surgeons perform the cleft palate repair with different techniques.<sup>3,4</sup> In fact, there are surgeons using a surgical technique that involves just one mucoperiosteal flap raised from the noncleft side, and the results comparable to the 2-flap technique in terms of postoperative fistula development and hypernasal speech.<sup>4</sup> Cleft palate repair can be performed in a one stage surgery or in a two-

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stage surgery. Some surgeons still perform the old and classical one-stage cleft palate repair in infants. Advantages for the patient in one-stage cleft palate repair are only one period of hospitalisation, less scars in the palate region, no dissection in scarred tissue of the soft palate as seen in the second surgery when using the two-stage cleft palate repair and hopefully a better speech development. Nevertheless, disadvantages such as a larger wound site, risk of increased blood loss, and risk of airway obstruction have to be considered.

Success in cleft palate treatment cannot only be judged by assessing functional parameters such as speech development after palate repair, but also by assessing the maxillary growth. The surgical goals of primary cleft palate repair include closure of the anatomic defect of the hard and soft palate and achieving normal speech based on a complete velopharyngeal closure mechanism. However, wide undermining of mucoperiosteal flaps during palate repair had the potential for impairing maxillary growth. This lacking of soft tissue will cause scarring and thus will also have a higher risk to develop a velopharyngeal insufficiency beside maxillary growth disturbances. Cleft palate repair should ensure better morphology and functional outcomes when the patients are adults.<sup>5</sup>

It is generally conceded that early closure of cleft palate is associated with better speech function.<sup>6</sup> Early palate repair, however, may - accompanied by a higher incidence of maxillary growth disturbance. It has been noted that earlier cleft palate repair benefits the speech function as the speech process in some children begins at 1 year of age. On the contrary, the late cleft palate repair theoretically allows for a proper maxillary growth because the transverse facial growth is not complete until 5 years of age.<sup>7</sup> Recently, there is no best protocol that widely accepted in this cleft treatment field. The aim of our research was to scope the studies on different protocol of the palate repair in cleft palate patients.

### Materials and methods

As our aim was to scope the studies on different methodology of palate repair in cleft palate patients. We are seeking to generate a question and related key terms. The question "How does different palate repair methods effect speech function and maxillary growth?". MeSH

was used to obtain the correct terms for keywords. Further, key search terms were identified and a Boolean search string developed. Our final keywords were "speech AND maxillary AND growth AND cleft AND palate" guided the search strategy. An initial search of Google Scholar was carried out to determine the relevance of the key terms, but google scholar was not used as the search engine in this study due to the lack of replicability from this search engine.<sup>8</sup> To determine an appropriate time frame for the review, the Google Scholar search located Maxillary growth cleft palate speech prior to 1955 so this date was chosen as appropriate for this study. Databases searched included Pub Med. Inclusion and exclusion criteria, consistent with our review purpose, were developed and are outlined in Table 1.

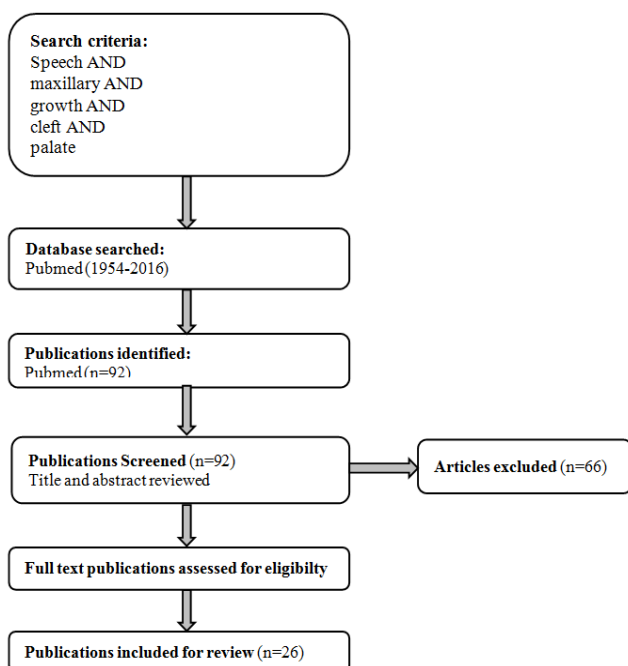
Criterion	Inclusion	Exclusion
Time Period	From 1955– February 2016	Any study outside the dates
Language	English	Non-English
Type of article	Original article	Any publication that was not original research
Study Focus	Speech function and maxillary growth and in cleft palate patients	- Genetics in cleft patients - Dental anomalies in cleft patients - Height of the palatal vault
Geographical area of interest	All international studies including those with specific cultural groups	Nil
Subjects	Cleft palate with or without cleft lip patients	Cleft lip patients

**Table 1.** Inclusion and Exclusion Criteria.

The full papers of the selected publications were obtained. Good or excellent treatment result in the studies refers to good speech function or good maxillary growth or both based on the author's conclusions. On the other hand, bad or poor treatment results also based on the author's conclusions. Table 2 describes the studies related to this review.

### Results

Our literature search identified 92 publications, and we screened these publications according to our inclusion and exclusion criteria (Figure 1). Accordingly, only 26 publications fit the inclusion criteria, 7 publications discussed the speech function, 7 publications discussed the maxillary growth, and 12 publications discussed both speech function and maxillary growth after palate repair. All publications were published between 1968 and 2016.



**Figure 1.** Flowchart of literature search and selection.

There are differences in cleft palate repair techniques, and also differences in timing of palate repair. Some authors reported good results both in speech function and also in maxillary growth. Dissaux et al. (2016) used Malek and Talmant technique to perform two-stage palate repair on 20 complete cleft lip and palate patients. The patients were evaluated at the mean age of 5 (range, 4-6), and the result was good speech development and less negative impact on maxillary growth.<sup>2</sup> Nadjmi et al. (2013) also conducted a two-stage palate repair using a modified Furlow technique. The mean age at the time of soft palate reconstruction was 10.2 months (SD = 1.2), and 23.9 months (SD = 6.7) at the time of hard palate closure. The speech outcome was good, based on the Bzoch test, nasometry and hypernasality. The short term follow-up of the maxillary growth was excellent.<sup>26</sup>

Pradel et al. (2009) compared the one-stage and two-stage cleft palate repair of 24 patients with non-syndromic unilateral or bilateral cleft lip and palate or complete cleft palate. The patients were evaluated at an age of 4 years and 6 years. The speech outcome showed less altered resonance and less nasal emission at 4 years of age compared to the children who had two-stage cleft palate repair procedure. At 6 years, the patients who had two-stage procedure had improved their speech skills, but they did not

equal the results of patients who had one-stage procedure. In the study models at 6 years of patients who had two-stage procedure, the transverse dimension (anterior and posterior width of the dental arch) was smaller than in the models of patients who had one-stage procedure.<sup>5</sup>

## Discussion

The timing of palate repair related to speech function has been discussed extensively. The relationship between early cleft palate repair and speech function has been reported by several authors. The publication from Koberg and Koblin (1973) revealed that beyond the third year of life, the functional speech result continuously worsened without exception with advancing age at the time of operation.<sup>10</sup> Other publication from Ysunza *et al.* (1998) concluded that if cleft palate closure is performed as early as possible, and normal velopharyngeal function occurs before the abnormal phonologic patterns are formed, speech outcome would be improved.<sup>12</sup>

Maxillary growth in relation to timing and stages of palate repair has also been a major topic in cleft palate surgery. There is still no consensus about the optimal timing and stages of palate repair. Koberg and Koblin (1973) concluded that the time for palate repair could best be chosen at the age 2-3 years without any major damage to maxillary development.<sup>10</sup> Dr. Pradel et al. (2009) published their study about one-stage palate repair and the result showed that one-stage repair of cleft palate at the age of 9-12 months seems to have more positive influence on early maxillary growth than the two-stage procedure.<sup>5</sup> On the contrary, the newest publication from Dissaux et al. (2016) revealed that the two-stage procedure, including a Sommerlad intravelar veloplasty seems to have less negative impact on maxillary growth.<sup>2</sup>

The two-stage cleft palate repair has been discussed intensively by many authors to minimize maxillary growth disturbances from early intervention to the hard palate. The basic concept over the timing of hard palate closure in the early two-stage procedure is to provide complete palatal closure before the development of integrated speech. Unfortunately, many publications have reported poor speech outcome after two-stage palate repair. Lohmander (1998) reported a different result in a study with 59

patients treated by the Goteborg regimen for treatment of children with cleft lip and palate. This regimen included early soft palate repair at 6-8 months of age and delayed closure of the hard palate at about 8 years of age. The results showed a low prevalence of hypernasality after hard palate closure and pharyngeal flap surgery in only five children (8%), indicating a primary velopharyngeal insufficiency in less than 10% of the children. Only three children with bilateral clefts had glottal articulation when at pre-school age. These results were interpreted as an indication of velopharyngeal competence (VPC) in most of the children.<sup>11</sup>

Yamanishi et al. (2011) also reported good results from two-stage procedure. Seventy-two nonsyndromic patients with complete unilateral cleft lip and palate were enrolled in the study. They were divided into 2 groups: 30 patients, who were treated with early 2-stage palate repair, in which soft palate closure was performed using a modified Furlow's procedure at 12 months of age and hard palate closure was performed at 18 months of age, and 42 patients, who underwent one-stage Wardill-Kilner push-back palate repair at 12 months of age. The results show that the early two-stage protocol is advantageous with regard to maxillary growth compared with one-stage push-back palate repair without compromising speech development as evaluated for all patients at 4 years of age.<sup>22</sup>

### Conclusions

Cleft palate is marked by controversies and multiple protocols concerning its treatment. So far, there are no protocol which considered the best protocol in cleft palate treatment. In most cleft centers worldwide, a one-stage procedure is still used for cleft palate repair. Nevertheless, there are tendency in some center to perform a two-stage procedure with early soft palate repair and delayed hard palate closure. Further studies should be conducted to explore potential benefits of the two-stage palate repair in improving speech function and maxillary growth.

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### Declaration of Interest

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No	Authors	Year	Title	Aim	Observations	N	Type of Study	Setting	Outcome and Conclusion
1.	Bernstein L. <sup>9</sup>	1968	The effect of Timing of cleft palate operations on subsequent growth of the maxilla	To evaluate the possible effects of surgical repair of cleft palate on the subsequent growth of the maxilla	Group of patients who had cleft palate repair, and a group of patients who had not any palate surgery	325 patients with repaired cleft palate, 49 patients without palatal surgery	Prospective	Cleft patients in a university hospital, USA	- Growth and development of the maxilla, are altered if the palate repair is performed before all of the deciduous molars are in proper occlusion (before the age of 24-30 months) - The optimal time for cleft palate repair is between 30 and 36 months of age
2.	Koberg W, Koblinski. <sup>10</sup>	1973	Speech Development & Maxillary Growth in Relation to Technique & Timing of Palatoplasty	To evaluate the dependability of speech development & maxillary growth on the technique & timing of palatoplasty	Groups of Langenbeck's technique, Axhausen, Veau's technique, Wassmund's technique, Pichler's technique, & Schwegendiek's technique	1033 patients	Retrospective study	Cleft patients in a university hospital	- Patients operated between the ages of 2-3 had the optimal speech functional result - The time for palatoplasty could best be chosen at the age of 2-3 years without any major damage to maxillary development
3.	Cosman B, Falk AS. <sup>5</sup>	1980	Delayed hard palate repair & speech deficiencies: a cautionary report	To review the outcome of complete cleft palate treatment with early repair of the soft palate (before 1 year of age) & delayed repair of the hard palate (after 5 or 6 years of age)	Patients with complete cleft palate	32 patients	Longitudinal study	Cleft patients in a university hospital, USA	A majority of patients failed to achieve acceptable spontaneous speech by age five
4.	Lohmander A, Agerskov A. <sup>11</sup>	1998	Speech Outcome after Cleft Palate Surgery with the Goteborg Regimen Including Delayed Hard Palate Closure	To describe the regimen for treatment of children with cleft lip and palate includes delayed closure of the hard palate	Group of unilateral cleft lip and palate and a group of bilateral cleft lip and palate	59 patients	Longitudinal	Cleft patients in a university hospital, Sweden	- A low prevalence of hypernasality and nasal escape after hard palate closure and only 8 % patients with a pharyngeal flap. - Maxillary length has improved significantly
5.	Ysunza A, et al. <sup>12</sup>	1998	Speech Outcome & Maxillary Growth in Patients with Unilateral Complete Cleft Lip/Palate Operated at 6 versus 12 Months of Age	To evaluate speech outcome and maxillary growth in unilateral cleft palate patients	One group of cleft palate patients were operated on at 12 months of age, and 35 patients were operated on at 6 months of age.	76 patients	Prospective study	Cleft patients in hospital in Mexico	- Cleft palate repair performed at 6 months of age significantly enhances speech outcome and prevents compensatory articulation disorder - The maxillary growth outcome was not significantly different in both groups of patients
6.	Oyama T, et al. <sup>13</sup>	2002	Articulation disorders associated with maxillary growth after attainment of normal articulation after primary palatoplasty for cleft palate	To determine the possible effect on articulation of growth changes in dental arch dimensions, a comparison was made of deciduous dentition & mixed dentition oral cavity measurements	11 patients who exhibited palatalized articulation (PA group) and 11 patients who retained normal articulation (NA group)	22 patients	Retrospective	Cleft palate patients in a university hospital, Japan	- There was an increased occurrence of palatalized articulation among patients who had previously attained normal articulation after primary palatoplasty - Early management of dental arch dimensions and periodic management of the articulations are important
7.	Piggott RW, et al. <sup>14</sup>	2002	A Comparison of Three Methods of Repairing the Hard Palate	To compare growth, speech, and nasal symmetry outcomes of three methods of hard palate repair	Group I (hard palate repair by Cuthbert Veau or CV), Group II (von Langenbeck or vL), & Group III (Medial Langenbeck or ML)	66 patients	Cross sectional	Cleft lip & palate patients in a hospital in UK	Reduced periosteal undermining & residual exposed palatal shelf from CV to vL to ML improved incisor relationships & articulation
8.	LaRossa D, et al. <sup>15</sup>	2004	The Children's Hospital of Philadelphia modification of the Furlow double opposing z-palatoplasty: long-term speech & growth results	To evaluate the long term speech and growth results of cleft palate patients	Patients who underwent modification of the Furlow double-opposing z-palatoplasty	261 patients	Longitudinal	Cleft patients in a children's hospital in USA	- Majority of patients (over 90%) had minimal or absent hypernasality, almost 86% had inconsistent or no nasal emission, & 95% had no articulation errors related to velar function. - The patients with a Pittsburgh score indicating an incompetent velopharyngeal mechanism comprised only about 6% of the group - 94% had a socially functional speech quality

9.	Schliephake H, Donnerstg F, Berlen JL, Longquist N. <sup>16</sup>	2006	Palate morphology after unilateral and bilateral cleft lip and palate closure	To compare the morphology of the hard palate of patients with uni & bilateral cleft lip and palate after palatoplasty using vomer & palatal pedicled flaps with the palatal morphology of noncleft individuals	40 patients with cleft lip & palate (30 unilateral, 10 bilateral) and 40 non-cleft patients with class I occlusion, who served as controls	80 patients	Retrospective study	Cleft patients in a university hospital	-Maxillary archwidth did not differ significantly between uni & bilateral cleft patients & was not significantly different from controls at the age of 10 - Deviation from symmetry was present in both types of cleft and significant in unilateral clefts when compared to bilateral clefts & non-cleft patients - Palatal Morphology did not differ significantly between uni & bilateral clefts until the age of 15, but was significantly different from control patients in the molar area at the age of 10 - Palatoplasty significantly alters hard palate morphology, particularly in the posterior area
10.	David DJ, Anderson PJ, Schnitt DE, Nugent MAC, Sells R. <sup>17</sup>	2006	From birth to maturity: a group of patients who have completed their protocol management: Part II Isolated cleft palate	To present the results of patients with isolated cleft palate who completed protocol management	Isolated cleft palate patients who had completed protocol management	32 patients	Retrospective	Cleft patients in a hospital, Australia	-Cephalometric analysis at skeletal maturity revealed a range of facial growth, & maxillary advancement surgery was deemed necessary in just 2 cases -The speech function of 18 from 32 patients were assessed as being within normal limits -Facial growth does not appear to be adversely affected by use of the pushback technique to reconstruct the palate
11.	Richard B, Russell J, McMahon S, Piggott R. <sup>18</sup>	2006	Results of randomized controlled trial of soft palate first versus hard palate first repair in unilateral complete cleft lip & palate	To compare the outcomes for primary repair of unilateral cleft lip and palate, operating on the soft palate first versus the hard palate first	Group 1 (soft palate repair, with hard palate and lip repair 3 months later) & Group 2 (lip and hard palate repair, followed by the soft palate repair 3 months later)	47 patients	Randomized controlled trial	Cleft patients in Regional Cleft Service of West Nepal	No demonstrable difference in facial growth between operating on the soft palate first or the hard palate first at 4 to 7 years after completion of the primary palate repair
12.	Holland S, Gabbay JS, Heller JB, O'Hara C, Hurwitz D, Ford MD, Sauder AS, Bradley JP. <sup>19</sup>	2007	Delayed Closure of the Hard Palate Leads to Speech Problems and Deleterious Maxillary Growth	To compare single-stage versus delayed hard palate closure for speech outcome and maxillary growth	Group 1 (delayed hard palate repair), Group 2 (single-stage repair)	82 patients	Retrospective	Cleft patients in a University Cleft Palate Craniofacial Center, USA	-Single-stage repair had better speech outcomes compared with delayed hard palate repair -Single-stage repair showed less maxillary growth disturbance -The delayed cleft palate repair led to worse speech outcomes -The delayed cleft palate repair led to deleterious maxillary growth
13.	Koh KS, Kang BS, Seo DW. <sup>20</sup>	2009	Speech evaluation after repair of unilateral complete cleft palate using modified 2-flap palatoplasty	To compare speech after classic and modified 2-flap palatoplasty for unilateral complete cleft palate	A group of classic 2-flap palatoplasty and a group of modified 2-flap palatoplasty	31 patients	Retrospective	Cleft patients in a university hospital, Korea	There was no difference between the classic & modified 2-flap palatoplasty in terms of postoperative palatal fistula rate, speech, and secondary surgery rate
14.	Pradel W, Senf D, Mai R, Ludicke G, Eckelt U, Lauer G. <sup>5</sup>	2009	One-stage palate repair improves speech outcome and early maxillary growth in patients with cleft lip and palate	To compare the speech outcome and early maxillary growth of children with cleft lip and palate deformity after a one-stage or after a two-stage palate repair	Group A (two stage procedure), Group B (one stage procedure)	12 patients in Group A, 12 patients in Group B	Longitudinal	Cleft patients in a university hospital, Germany	-The children of group B showed less altered resonance and less nasal emission at 4 years of age compared to the children of group A -At 6 years, the children of group A had improved their speech skills, but they didn't equal the results of group B -In the study models of group A at age 6 years, the transverse dimension (anterior and posterior width of the dental arch) was smaller than in the models of group B -The one-stage repair of cleft palate at the age of 9-12 months seems to have a more positive influence on speech development and early maxillary growth than the two-stage procedure -A non-significant difference was found in all measurements between the two groups -Early cleft palate repair enhances phonological development -Although maxillary growth is affected in cleft palate patients, appropriate orthodontic treatment can achieve normal maxillary growth as measured during adolescence
15.	Ysunza A, Pamplona MC, Quiroz J, Yudovich M, Molina F, Gonzalez S, Chavelas K. <sup>21</sup>	2010	Maxillary growth in patients with complete cleft lip and palate, operated on around 4-6 months of age	To study maxillary growth in a group of cleft palate patients operated on around 4-6 months of age, & receiving further orthodontic treatment	A group of cleft palate patients operated on around 4-6 months of age, & receiving further orthodontic treatment, & a group of subjects without cleft lip and palate, matched by gender & who were within the age range of the cleft palate group	20 patients	Longitudinal	Cleft patients in a hospital in Mexico	-In cephalometric analysis for maxillofacial growth, the early 2-stage group showed a larger maxillary length than the 1-stage push-back palatoplasty group -The ANS in the early 2-stage group was positioned more anteriorly than that in the 1-stage push-back palatoplasty group -The anterior facial height was significantly greater in the early 2-stage group than in the 1-stage push-back palatoplasty group -No statistically significant differences were observed in the incidence of either velopharyngeal incompetence or articulation errors between the 2 groups at 4 years of age -The early 2-stage protocol is advantageous with regard to maxillary growth compared with 1-stage push-back palatoplasty without compromising speech development as evaluated for all children at 4 years of age
16.	Yamanishi T, Nishio J, Sako M, Kohara H, Hirano Y, Yamanishi Y, Adachi T, Miya S, Mukai T. <sup>22</sup>	2011	Early two-stage double opposing Z-plasty or one-stage push-back palatoplasty?: comparisons in maxillary development and speech outcome at 4 years of age	To address whether the resulting maxillofacial growth and speech development obtained by an early 2-stage palatoplasty protocol are better than those obtained by conventional 1-stage push-back palatoplasty	A group of early 2-stage palatoplasty patients, and a group of 1-stage palatoplasty patients	72 patients	Retrospective	Cleft patients in a university hospital, Japan	-The goals of cleft palate repair can be efficiently achieved using a one-sided oral mucoperiosteal repair only -Omitting the nasal-side and vomer repair does not increase fistula formation or prove detrimental to velopharyngeal function, and may facilitate maxillary growth
17.	Steinbacher DM, McGrath JL, Low DW. <sup>23</sup>	2011	Is Nasal Mucoperiosteal Closure Necessary in Cleft Palate Repair?	To compare the outcome of palate repairs with and without nasal mucoperiosteal closure	Group 1: two-layer repair (oral & nasal vomerine mucoperiosteal flaps), & group 2: underwent one-layer closure (oral mucoperiosteal flaps) only. Both groups underwent double-	80 patients	Retrospective	Cleft patients in a children's hospital, USA	-The goals of cleft palate repair can be efficiently achieved using a one-sided oral mucoperiosteal repair only -Omitting the nasal-side and vomer repair does not increase fistula formation or prove detrimental to velopharyngeal function, and may facilitate maxillary growth

18.	Friede H, Lija J, Lohmander-Agerskov A. <sup>24</sup>	2012	Long-Term, Longitudinal Follow-Up of Individuals With Unilateral Cleft Lip & Palate After the Gothenburg Primary Early Veloplasty & Delayed Hard Palate Closure Protocol: Maxillofacial Growth Outcome	To study long-term maxillofacial development in a sample of patients born with unilateral cleft lip and palate treated according to a two-stage primary palatal protocol with early veloplasty and delayed hard palate closure	opposing Z-plasty posteriorly Patients who had undergone a two-stage palatoplasty protocol with early veloplasty & delayed hard palate closure	50 patients	Retrospective	Cleft patients in a university hospital, Sweden	The two-stage protocol with early veloplasty and delayed hard palate closure resulted in very satisfactory growth outcome
19.	Annigeri VM, Mahajan JK, Nagarkar A, Singh SP. <sup>7</sup>	2012	Outcome analysis of palatoplasty in various types of cleft palate	To analyse the factors affecting clinical and functional outcome of Veau-Wardill-Kilner palatoplasty in various types of cleft palate.	Patients who had undergone cleft palate repair	30 patients	Cross sectional	Cleft patients in a hospital, in India	-Derangement of speech was found in 66.6% of the patients who had undergone surgery after the age of 2 years as compared to the patients undergoing correction before 2 years of age -Mean maxillary arch length, arch circumference & maxillary inter-canine & inter-molar width were significantly reduced as compared to the control group -Socially acceptable quality of speech can be achieved in more than 85% of the patients -Maxillary growth was impaired in all the patients despite early surgery -In centre C (one-stage Palate repair) the patients had more constricted palates -In centre A (two-stage palate repair) the patients had least often an anterior cross-bite -One stage palate repair at age 1 year or less is interfering most with maxillary growth -Two-stage palatoplasty is a valuable treatment protocol, especially as guidance of speech development
20.	Gundlach KKH, Bardach J, Filippowa D, Castrillon FS, Lenz J. <sup>25</sup>	2013	Two-stage palatoplasty, is it still a valuable treatment protocol for patients with a cleft of lip, alveolus, & palate?	To evaluate the value of two-stage palatoplasty as a means to reduce the detrimental effects of surgery on palatal growth and at the same time to also enable early speech development	Operated cleft palate patients in 3 different cleft centres with 3 different treatment protocols. In centres A & B, the palates were closed in 2 stages, & in centre C palate repair was performed in just 1 operation	85 patients	Retrospective	Cleft patients in a university hospital, Germany	-The Bzoch speech quality score was superior in the study group, and the hypernasality was significantly reduced in the study group. -At the time of hard palate reconstruction palatal cleft width was significantly reduced. -Relative short-term follow up of maxillary growth was excellent. ---This technique is particularly encouraging, because of better speech outcome, absence of raw surfaces on the soft palate, and good maxillary growth.
21.	Nadjmi N, Erum RV, De Boodt M, Bronkhorst EM. <sup>26</sup>	2013	Two-stage palatoplasty using a modified Furlow procedure	To evaluate speech outcome and nasality, and short term maxillary growth	In the 1st cohort of 10 patients a Furlow Palatoplasty was used to repair the soft palate (control group). In the 2nd cohort of 30 patients, a unilateral Buccal myomucosal Flap was used to achieve a tension-free closure of the oral layer of the soft palate in combination with the Modified Furlow Palatoplasty	40 patients	Prospective cohort	Cleft patients in a university hospital, Belgium	-The successful treatment with the MG method suggests that improper palate repair is responsible for maxillary growth impairment -The MG method is considered to be effective for
22.	Torikai K, et al <sup>27</sup>	2015	Primary Palatoplasty for Unilateral Cleft Lip and Palate Using Mucosal Grafts and Flaps	to describe the mucosal grafts (MG) method for unilateral cleft lip and palate (UCLP) and discuss long-term treatment results.	UCLP patients with palate repair by MG methods. Cephalometric analysis was performed	35 patients	Prospective	Cleft patients in a university hospital, Japan	palate closure in terms of speech and maxillary growth
23.	Baek R, Koo Y, Kim B. <sup>28</sup>	2015	Limited Incision With Thorough Elevation Palatoplasty Technical Evolution for Superior Results in Cleft Repair of the Secondary Palate	To describe the limited incision with thorough elevation (LITE) palate repair that leaves the anterior margin of the hard palate intact, achieving a fully movable bipediced flap for complete closure and an adequate functioning velar muscular sling.	on 21 patients (13 boys, 8 girls). Speech was evaluated in age 4 to 6 years old Group of patients who consecutively underwent the LITE palate repair.	56 patients	Prospective	Cleft patients in a university hospital, Korea	-The average length of soft palate was 18.5 ± 3.1 mm preoperatively, and the increased length of the soft palate was 5.06 ± 2.41 mm (27.3 ± 17.4%) -The LITE palatoplasty gives satisfactory results in elongating the soft palate and reconstructing a functional velar sling without leaving any raw surfaces that can be detrimental to healing and facial growth -There was also a better speech outcome without complications
24.	Randag AC, Dreise MM, Ruettermann M. <sup>29</sup>	2014	Surgical impact and speech outcome at 2.5 years after one- or two-stage cleft palate closure	To compare surgical impact and speech outcome at 2.5 years of age between children who underwent either one- or early two-stage palate closure	Group 1 (one stage palate closure), Group 2 (two stage palate closure)	24 patients in Group 1, 24 patients in Group 2	retrospective observational cohort study	Cleft patients in a university hospital, The Netherlands	-The one-stage closure group showed significantly better articulation (p = 0.029) than the early two-stage closure group -One-stage palate closure is preferable over early two-stage palate closure with regard to surgical impact and speech development
25.	Rossell-Perry P, Cotrinal-Rabanal O, Cáceres-Nano E. <sup>4</sup>	2015	One-flap Palatoplasty: A Cohort Study to Evaluate a Technique for Unilateral Cleft Palate Repair	To evaluate the utility of the one flap palatoplasty technique for unilateral cleft palate repair	Patients who were operated on using the 2-flap and 1-flap techniques	120 patients	Retrospective	Cleft patients in a university hospital, Peru	-The 1-flap technique for unilateral cleft palate repair is comparable to 2-flap technique in terms of hypernasal speech.
26.	Dissaux C, Grollemund B, Bodin F, Picard A, Vazquez MP, Morand B, James I, Kauffmann I, Bruant-Rodier C. <sup>2</sup>	2016	Evaluation of 5-year-old children with complete cleft lip and palate: Multicenter study. Part 2: Functional results	To describe a comparison and analyzing procedure between primary surgical protocols in French centers	Cleft Lip and Palate patients from 4 French cleft centers	80 patients	Retrospective multicenter comparative study	Cleft patients in 4 cleft centers, France	-Veau-Wardill-Kilner palate repair involves a higher rate of transversal maxillary deficiency and retromaxillary -Malek and Talmant two-stage-palatoplasty techniques reach Goslon scores of 1 or 2. -Sommerlad intravelar veloplasty had higher speech outcomes -The two-stage palate repair, including a Sommerlad intravelar veloplasty seems to have the less negative impact on maxillary growth, and to give good speech outcomes