Journal of Plastic, Reconstructive & Aesthetic Surgery 99 (2024) 423–431

ELSEVIER

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

The impact of surgical technique and cleft width on the rate of secondary surgery and velopharyngeal function in children with UCLP at 5 years of age

Åsa Okhiria [a,*], Christina Persson [b], Monica Blom Johansson [c], Malin Hakelius [a], Fatemeh Jabbari [a], Daniel Nowinski [a]

[a] *Department of Surgical Sciences, Plastic Surgery, Uppsala University, Uppsala, Sweden*
[b] *Institute of Neuroscience and Physiology, Speech and Language Pathology Unit, Sahlgrenska Academy, University of Gothenburg. Region Västra Götaland, Department of Otorhinolaryngology, Sahlgrenska University Hospital, Gothenburg, Sweden*
[c] *Department of Public Health and Caring Sciences, Speech and Language Pathology, Uppsala University, Uppsala, Sweden*

Received 25 May 2024; Accepted 8 October 2024

KEYWORDS
Surgical technique;
Radical muscle dissection;
Cleft width;
Velopharyngeal function;
Unilateral cleft lip and palate

Abstract Several factors may influence speech outcome and the rate of secondary palatal surgery in patients with cleft palate. The aim of this study was to evaluate different types of intra-velar veloplasty within an otherwise uniform surgical protocol. The impact of cleft width and the surgeon's experience on outcome measurements was examined. This cross-sectional study included 62 individuals with unilateral cleft lip and palate born in 2000–2015. Based on the surgical technique used, they were divided into three groups. The cleft width was measured on dental casts. Blinded speech and language pathologists assessed velopharyngeal function with the composite score for velopharyngeal competence (VPC-Sum) for single words. They rated velopharyngeal function on a three-point scale (VPC-R) in sentences. Target consonants in words were phonetically transcribed. The percentage of correct consonants (PCC) was calculated. Surgical technique was not associated with any outcome. Cleft width was associated with the rate of secondary palatal surgery (OR 1.141, 95% CI 1.021–1.275, p = .020) and velopharyngeal insufficiency when using VPC-R (OR 2.700, 95% CI 1.053–6.919, p = .039) but not when using VPC-Sum (OR 1.985, 95% CI.845–4.662, p = .116). PCC was not associated with cleft width and did not differ between surgical techniques. Radical muscle dissection did not

Parts of this article have been presented at the following meetings/conferences: European Cleft Palate Craniofacial Association Congress held from June 24 to 28, 2024, in Milan, Italy.

* Correspondence to: Uppsala University, Department of Surgical Sciences, Plastic Surgery, Uppsala, Sweden.
E-mail address: asa.okhiria@uu.se (Å. Okhiria).

https://doi.org/10.1016/j.bjps.2024.10.016
1748-6815/© 2024 British Association of Plastic, Reconstructive and Aesthetic Surgeons. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

exhibit superiority over intra-velar veloplasty reinforced by the palatopharyngeal muscle. Follow-ups at later ages with larger groups will be necessary to evaluate and compare surgical techniques accurately. Cleft width had a greater impact on the rate of secondary surgery and velopharyngeal function than surgical technique, but neither affected the PCC.
© 2024 British Association of Plastic, Reconstructive and Aesthetic Surgeons. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creative-commons.org/licenses/by/4.0/).

Cleft palate surgery aims to facilitate normal speech and efficient velopharyngeal function, leading to improved articulation. Despite ongoing research, the methods for achieving optimal results are yet to be determined. Several factors have been suggested to influence speech outcome and the secondary palatal surgery rate, including the type of cleft,[1-3] the cleft's extent in isolated cleft palates,[4-6] and cleft width.[6-8] In addition to internal factors, various external factors, including the patient's age at the time of the procedure,[9-11] the surgeon's experience,[12,13] and the chosen surgical technique,[14,15] are also considered to influence the outcome.

Radical muscle dissection has been suggested to improve velopharyngeal function and articulation while also reducing secondary palatal surgery rates compared to other techniques.[16-18] However, comparing the effectiveness of various surgical techniques is difficult due to the multiple factors affecting outcomes described above, as well as differences in age at surgery or assessment.

The present research aimed to assess and contrast different types of intra-velar veloplasty within an otherwise uniform surgical protocol and to investigate the impact of cleft width and the surgeon's experience on outcome measurements. The following research questions were posed: 1) Is radical muscle dissection more effective than intra-velar veloplasty reinforced by the palatopharyngeal muscle in terms of a) reducing the need for secondary palatal surgery due to dehiscence, fistula, or velopharyngeal insufficiency (VPI), b) improving velopharyngeal function (VPF), and c) increasing percent of correct consonants (PCC)? Furthermore, does the cleft width or the surgeon's experience affect these results?

Methods

Ethical approvment was obtained from the Regional Ethics Committee in Region Uppsala (Reference no.: 2017/457).

Participants

A consecutive series of 109 individuals with unilateral cleft lip and palate (UCLP) born in 2000–2015 and treated at our unit from birth were reviewed at 5 years of age. Ninety individuals met the inclusion criteria of being non-syndromic and having undergone a two-stage palatal surgery with soft palate closure at 6 months (-2, +3 months) and hard palate closure at 24 months (±3 months). Twenty-eight of these individuals were excluded due to 1) missing or incomplete data (n = 22) or 2) having an additional diagnosis that may affect speech and/or language development (n = 6). The study finally included 62 individuals, 19 girls and 43 boys. The initial inclusion criteria were not met by 19 individuals who had either not followed our surgery protocol, relocated elsewhere, had a syndrome, or were deceased.

The participants were divided into groups based on the surgical technique. Because of the slight difference in technique in the group receiving radical muscle dissection, they were split into two groups. Consequently, there were three groups: the non-radical, transition, and Sommerlad groups.

Surgical treatment

Since 1984, a two-stage protocol has been used with soft palate closure at 6 months and hard palate closure at 2 years. Before 2007, the soft palate was closed with an intra-velar veloplasty reinforced by the palatopharyngeal muscle[19] (non-radical group). In this technique, intra-velar muscle retropositioning was achieved by releasing the muscle and nasal layer from the posterior edge of the hard palate without separating the levator muscle from the nasal mucosa. Radical muscle dissection was then introduced in 2007 and made progressively more radical (transition group). Since August 2009, radical muscle dissection, as described by Sommerlad,[12,20] has been performed consistently (Sommerlad group). Figure 1a and b illustrates the position of the levator palati muscles in the transition and Sommerlad groups, respectively. In all cases, incision lines were placed at the borders of the cleft without releasing incisions, but usually with an anterior-based vomerian flap to the nasal layer of the soft palate. Four surgeons have been involved during the study period (Table 1). Surgeons 1 and 2 performed the soft palate closure without loop magnification, while Surgeons 3 and 4 performed it under 3.5 loop magnification. Since 2014, all soft palate closures have been carried out by Surgeons 3 and 4 under a microscope with 2.3–14 times magnification. Usually, 6–10 times magnification is used.

In the analysis of the surgeon's experience, the results regarding rates of secondary palatal surgery and VPF, categorized by the type of surgery, will only be reported for Surgeon 3, who has been active throughout the study period.

The residual cleft in the hard palate was repaired in two layers at 2 years of age. If needed for closure without tension, releasing incisions were performed, as described by von Langenbeck.[21] When using releasing incisions, the incision lines were always placed along the cervical lines of the teeth.

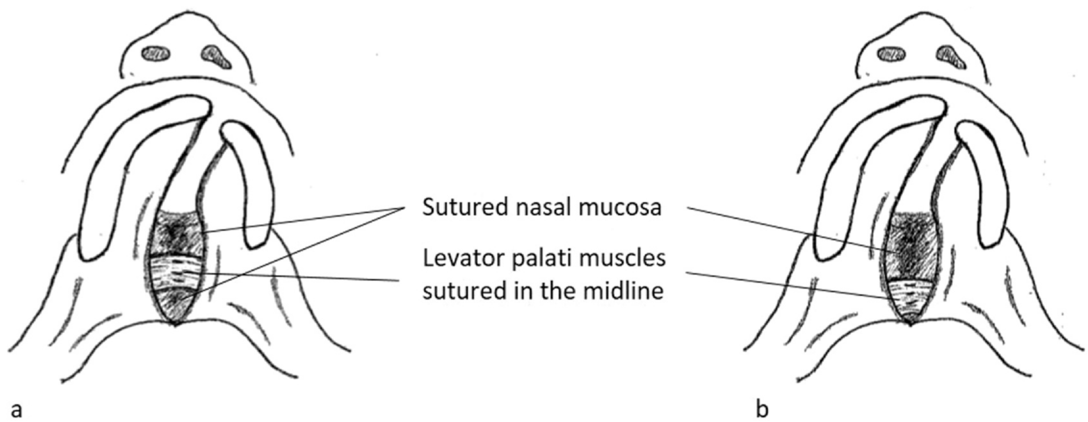

Figure 1 a) Transition group with the reconstructed levator sling crossing the mid-line approximately halfway between the posterior edge of the hard palate and the posterior limitation of the soft palate. (b) Intra-velar veloplasty according to Sommerlad, with the reconstructed levator sling positioned as far back as possible toward the posterior limitation of the soft palate and the anterior tonsillar pillars.

Speech-improving surgery was performed with a re-repair of the soft palate (only in children initially operated according to Sommerlad) or a pharyngeal flap. Before such surgery, the patients were evaluated with a speech assessment, nasoendoscopy, and, when possible, nasometry.

Cleft width measurement

A dental study cast was obtained at the time of the lip-plasty at 3 months. All casts were analyzed to determine the cleft width using reference points and linear measurements described earlier.[22-24] Using a digital caliper to the nearest 0.01 mm, the cleft width was calculated by dividing the measure A-A1 by the measure T-T1. T-T1 represents the posterior width of the alveolar arch in the tuber area, and A-A1 represents the width of the cleft at the level of T-T1. Thirty percent of the casts were randomly chosen for repeated measurements to establish intra-rater agreement. At the time of the present study, dental casts were available for 56 individuals; also included were measurements for six additional individuals whose dental casts had been previously measured in a previous study[8] using the same methodology and measurer as in this study. In the statistical analyses, cleft width is a continuous variable.

Speech material

A speech sample was recorded at the routine follow-up at 5 years of age. The audio recordings were made with Zoom H4n or a PC with Soundswell software (Saven Hitech, Stockholm, Sweden) and a condenser microphone (Røde NT4, Sydney, Australia or Philips SpeechMike Classic 6264Details) using the Swedish Articulation and Nasality Test (SVANTE).[25] Three sets of speech material were edited from the recordings using Praat software[26]: 1) 59 single words, each including one target consonant; 2) a 9-word string (the first nine monosyllabic words edited to a string of words with no pause between them) including high vowels for assessment of hypernasality; and 3) 12 sentences for perceptual assessment (10 including oral consonants, 2 including oral and nasal consonants) of velopharyngeal competence (VPC-R). All edited audio files were randomized and assigned codes to enable blinded assessments.

Speech assessment

Experienced speech and language pathologists (SLPs), two independent SLPs (Raters 1 and 2), and the first author (Rater 3) rated hypernasality and VPC-R. One of the independent SLPs (Rater 2) and the first author (Rater 3) also conducted phonetic transcriptions of target consonants in words. Before the speech assessments, a calibration session was conducted to ensure as equivalent assessments as possible.

Two different measurements for assessing VPF were used: the rating of perceived velopharyngeal competence in sentences (VPC-R) and a composite score for velopharyngeal competence (VPC-Sum) for single words.[27,28] For VPC-R, the SLPs rated VPF in sentences on a three-point ordinal scale: 0 = competent, 1 = marginally incompetent, and 2 = incompetent. The score for each child was classified based on the majority decision of the three SLPs' ratings. In case of total disagreement, the middle value was chosen.

VPC-Sum is a composite score including: a) perceptual ratings of hypernasality rated on a 4-point ordinal scale (0 = normal, 1 = mild, 2 = moderate, and 3 = severe), b)

Table 1 The number of soft palate surgeries grouped by surgeon and technique.

Technique	Surgeon 1	Surgeon 2	Surgeon 3	Surgeon 4
Non-radical (n)	6	3	7	
Transition (n)		4	10	
Sommerlad (n)			19	13

perceptual signs of VPI from transcriptions (audible nasal air leakage, weak pressure consonants, and nasal realization of voiced consonants), and c) active non-oral speech errors from transcriptions, used to assess VPF at the word level. Each of the three variables generated a score of 0-2 and was added to calculate VPC-Sum 0-6. In the statistical analyses, the results from VPC-Sum will be used according to the interpretation of VPC-Sum: 0-1 = 0: competent, 2-3 = 1: marginally incompetent, and 4-6 = 2: incompetent.

To accurately represent the results of the surgical techniques, we looked at the primary VPI.[6,29] The primary VPI included individuals with a VPC-R score of 2 or a VPC-Sum score of 4 or higher from the SLPs' assessment combined with those who underwent speech-improving surgery before the age of 5 years.

A semi-narrow phonetic transcription was performed, in this study defined as a phonetic transcription using the International Phonetic Alphabet (IPA),[30] and the symbols for nasal escape, velopharyngeal friction, weak articulation, voicing, devoicing, and active nasal fricative from the extended IPA symbols for disordered speech.[31] The transcriptions carried out by the independent SLP were used as the results for all participants. The percentage of correct consonants (PCC) was initially developed to evaluate PCC in conversational speech.[32] In this study, a modified version of PCC in single words was used to assess articulation[33-35] based on the transcriptions, where all consonant errors were weighted equally. The target consonant was scored as correct if the place and manner of articulation were correct. Signs of VPI were disregarded. The audio files were listened to through high-quality headphones and could be replayed as many times as needed. Thirty percent of the audio files were randomly selected for re-assessment to calculate intra-rater agreement.

Statistical analyses

A single-measure intra-class correlation coefficient with a two-way mixed-effects model (ICC) was used to determine intra-rater reliability for cleft width measurement. The levels of observed agreement were interpreted as follows: <.40 was poor, .40-.59 was fair, .60-.74 was good, and .75-1.00 was excellent.[36] To investigate the inter- and intra-rater agreement, descriptive statistics were used, and agreement was calculated as described in the next section. Logistic regression analysis was used to calculate the impact of surgical technique on the secondary surgery rate while controlling for cleft width. Ordinal regression analysis was used to estimate the association between surgical technique and VPF assessed with VPC-R and VPC-Sum, and cleft width was controlled for. VPC-R and VPC-Sum were categorized as 0 = competent, 1 = marginally incompetent, and 2 = incompetent in the statistical models. In the statistical analyses, primary VPI was used. Spearman correlation analysis was used to detect any association between cleft width and PCC. The Kruskal-Wallis test was used to detect any differences in PCC between surgical techniques. The results for the surgeon active throughout the study period will be presented descriptively. Statistical analyses were performed in IBM SPSS Statistics, version 29, or R. The level of significance was set at $\alpha < .05$ (two-tailed).

Reliability

Intra-rater agreement for cleft width measurement was good (.686, 95% CI.315-.874). Inter-rater agreement for hypernasality and VPC-R was calculated as the frequency of 1) agreement between all three raters, 2) agreement between two raters, and 3) no agreement. The intra-rater agreement was measured as agreement point by point for both hypernasality and VPC-R, as were the inter- and intra-transcriber agreement for the phonetic transcriptions. Comparisons were made for correctly articulated target consonants, manner of articulation, place of articulation, VPI symptoms, and non-oral articulation. Inter- and intra-rater agreement for hypernasality, VPC-R, and the transcriptions are shown in Tables 2 and 3. Minor differences between the transcribers that were considered as an agreement were /ʔ and b͡ʔ/ (glottal vs. glottal reinforcement), /ʔ and ∅* / (*omission of a consonant), /c and k/, and /ɟ and ɡ/.

Results

Surgery

Table 4 shows the age at primary surgery, mean cleft width, and the rate of secondary palatal surgery divided into the three groups according to the surgical technique. All reported surgery in Table 4 is made before the routine control at 5 years of age. Logistic regression analysis showed that the surgical technique was not significantly associated with the rate of secondary palatal surgery due to dehiscence, fistula, or VPI, but the cleft width was; see Table 5. The Omnibus test of model coefficients shows a moderate fit of the model (x^2 (3) = 7.036, p = .071).

Table 2 Inter- and intra-rater agreement for hypernasality and VPC-R.

		Hypernasality	VPC-R
Inter-rater agreement	All three raters agree (%)	48%	57%
	At least two out of three raters agree (%)	92%	98%
	No agreement (%)	8%	2%
Intra-rater agreement	Rater 1	80%	74%
	Rater 2	85%	95%
	Rater 3	70%	100%

VPC = velopharyngeal competence.

Table 3 Inter- and intra-transcriber agreements for transcriptions. Median percentages (min-max).

	Inter-transcriber agreement	Intra-transcriber agreement	
Agreement on		Rater 2	Rater 3
Correct/incorrect articulation	91% (65-100)	95% (85-100)	97% (84-100)
Manner of articulation	98% (76-100)	98% (88-100)	100% (96-100)
Place of articulation	90% (74-100)	95% (77-100)	96% (83-100)
Symptoms of VPI	93% (70-100)	97% (87-100)	97% (86-100)
Presence of non-oral articulation	100% (82-100)	100% (87-100)	100% (89-100)

VPI, velopharyngeal insufficiency.

Table 4 Primary and secondary surgery.

	Surgical technique		
	Non-radical, n = 16	Transition, n = 14	Sommerlad, n = 32
Soft palate closure (mean age)	6.8	6.9	6.8
Hard palate closure (mean age)	24.5	24.2	24.4
Cleft width (mean ratio, range)	30% (14%–43%)	33% (22%–44%)	35% (24%–45%)
Dehiscence (soft palate)	1 (6%)	1 (7%)	-
Dehiscence (hard palate)	1 (6%)	1 (7%)	1 (3%)
Fistulas (hard/soft palate junction)	-	-	2 (6%)
Fistulas (alveolar)	1 (6%)	-	-
Speech-improving surgery	1 (6%)	2 (14%)	3 (9%)*
Secondary palatal surgery (total)	4 (25%)	3 (21%)	5 (16%)

Age at surgery is given in months.
* One with pharyngeal flap, two with re-repair of the soft palate.

Table 5 Logistic regression analysis on how surgical technique and cleft width were associated with the rate of secondary surgery.

Variable	OR	95% CI	p
Non-radical (n = 16)	REF		.361
Transition (n = 14)	.659	.106-4.093	.655
Sommerlad (n = 32)	.309	.059-1.621	.165
Cleft width	1.141	1.021-1.275	.020

Speech

The SLPs' assessment showed that six individuals had VPI when using VPC-R and eight when using VPC-Sum. When primary VPI was used, the numbers increased to 11 and 12 individuals, respectively. The SLPs' assessments and the primary VPI are shown in Table 6.

Ordinal regression analysis showed no significant association between VPC-R and the surgical technique used, but VPC-R was significantly associated with cleft width. Neither surgical technique nor cleft width was associated with VPC-Sum; see Table 7. The goodness-of-fit test indicated a good fit for VPC-R (x^2 (8) = 63.629, p = .896) and VPC-Sum (x^2 (8) = 69.609 p = .766).

Figure 2 illustrates the distribution of cleft width for patients with and without secondary palatal surgery, and Figure 3 shows primary VPI and the distribution of cleft width on the scale steps in VPC-R and VPC-Sum.

There was no significant correlation between cleft width and PCC (rho = -.128, p = .329). A Kruskal-Wallis calculation found no differences in PCC between surgical techniques (H (2) = .070, p = .966).

Table 6 Individuals assessed as having velopharyngeal insufficiency (VPI) at the 5-year assessment and primary VPI (those assessed with VPI plus those who had speech-improving surgery before the 5-year assessment).

	VPC-R		VPC-Sum	
	VPC-R = 2 N (%)	Primary VPI N (%)	VPC-Sum > 4 N (%)	PrimaryVPI N (%)
Non-radical (n = 16)	1 (6%)	2 (13%)	2 (13%)	3 (19%)
Transition (n = 14)	3 (21%)	4 (29%)	5 (36%)	5 (36%)
Sommerlad (n = 32)	2 (6%)	5 (16%)	1 (3%)	4 (13%)

VPC, velopharyngeal competence.

Table 7 Ordinal regression analyses on how the surgical technique and the cleft width were associated with VPC-R and VPC-Sum.

Variable	VPC-R			VPC-Sum		
	OR	95% CI	p	OR	95% CI	p
Non-radical (n = 16)	REF			REF		
Transition (n = 14)	3.448	.663-17.932	.141	3.784	.731-19.585	.113
Sommerlad (n = 32)	.814	.164-4.039	.801	1.227	.270-5.566	.791
Cleft width	2.700	1.053-6.919	.039	1.985	.845-4.662	.116

VPC, velopharyngeal competence.

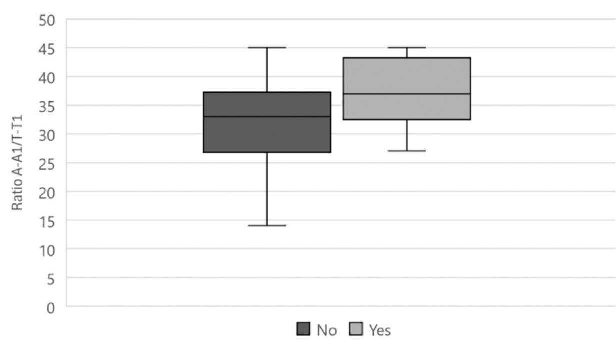

Figure 2 Cleft width distribution between individuals who did and did not undergo secondary palatal surgery.

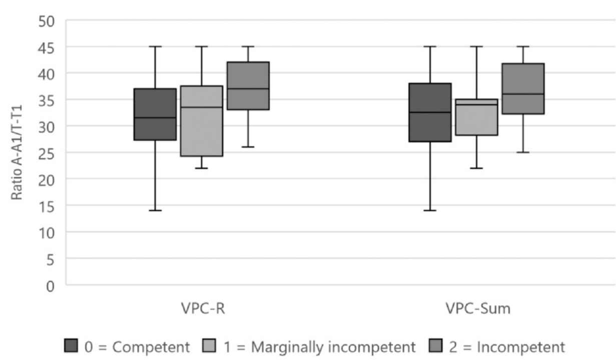

Figure 3 Primary VPI. Cleft width distribution on the scale steps in VPC-R and VPC-Sum.

Impact of surgeon's experience

The rate of secondary surgery for the surgeon active throughout the study period decreased from 28.5% to 10.5% over the years. Regardless of whether VPC-R or VPC-Sum was used, VPI was similar for the non-radical and transition groups but decreased in the Sommerlad group. Figure 4a-c displays results divided by the technique for the one surgeon active throughout the study period.

Discussion

This study analyzed the impact of radical intra-velar veloplasty within an otherwise uniform surgical protocol for palatal reconstruction and investigated the effect of cleft width and the surgeon's experience. In 2007, the radical intra-velar veloplasty technique was introduced and performed progressively more radically. Then, in late 2009, radical intra-velar veloplasty, as described by Brian Sommerlad,[12,20] was adopted. Therefore, the group undergoing radical muscle dissection was divided into two groups to demonstrate any differences between the two well-described techniques as well as to identify any effects of the transition period. The study found that the secondary palatal surgery rate and VPI risk when using VPC-R were determined by the cleft width rather than the surgical technique. Neither was associated with the risk of VPI when using VPC-Sum. No correlation was found between cleft width and PCC, and no significant difference was observed between techniques for the PCC.

Logistic regression showed no significant link between surgical technique and the rate of secondary palatal surgery. Repair of fistulas occurring at the junction between the soft and hard palate was observed only in the Sommerlad group, with two individuals (6%) having undergone surgery. This finding is consistent with other studies reporting similar rates of fistula occurrence requiring surgical intervention in individuals with UCLP after radical intra-velar veloplasty following Sommerlad's technique.[6,37] If a fistula does not affect speech or cause nasal regurgitation, surgery can be avoided, which means that the actual rate of fistulas may have been higher in all groups.

The surgical technique did not statistically affect VPF outcomes, but patients who underwent surgery during the transition period had higher VPI rates than the other two groups. The Scandcleft studies cautioned that new and complex techniques might potentially harm.[13,28] This was evident during the transition period where the VPI rates increased, but not after the technique described by Sommerlad[12,20] was adopted, where the initial results were comparable to the later ones. As radical intra-velar veloplasty had been used for over 2 years when the Sommerlad technique was adopted, the surgeon's increased experience could account for this. Still, it may also be because the surgeon who introduced the Sommerlad technique at our unit underwent training from Brian Sommerlad before implementing this technique. This highlights the importance of adhering to a systematic process with structured training when introducing new surgical techniques.

In this study, the primary VPI rates for the whole group that underwent surgery with the Sommerlad technique were 16% (VPC-R) and 13% (VPC-Sum). Doucet et al.[17] reported VPI in 15% at a mean age of 3:3 years; Dissaux et al.[18] reported VPI in 14% at 5 years of age, and Klintö et al.[37]

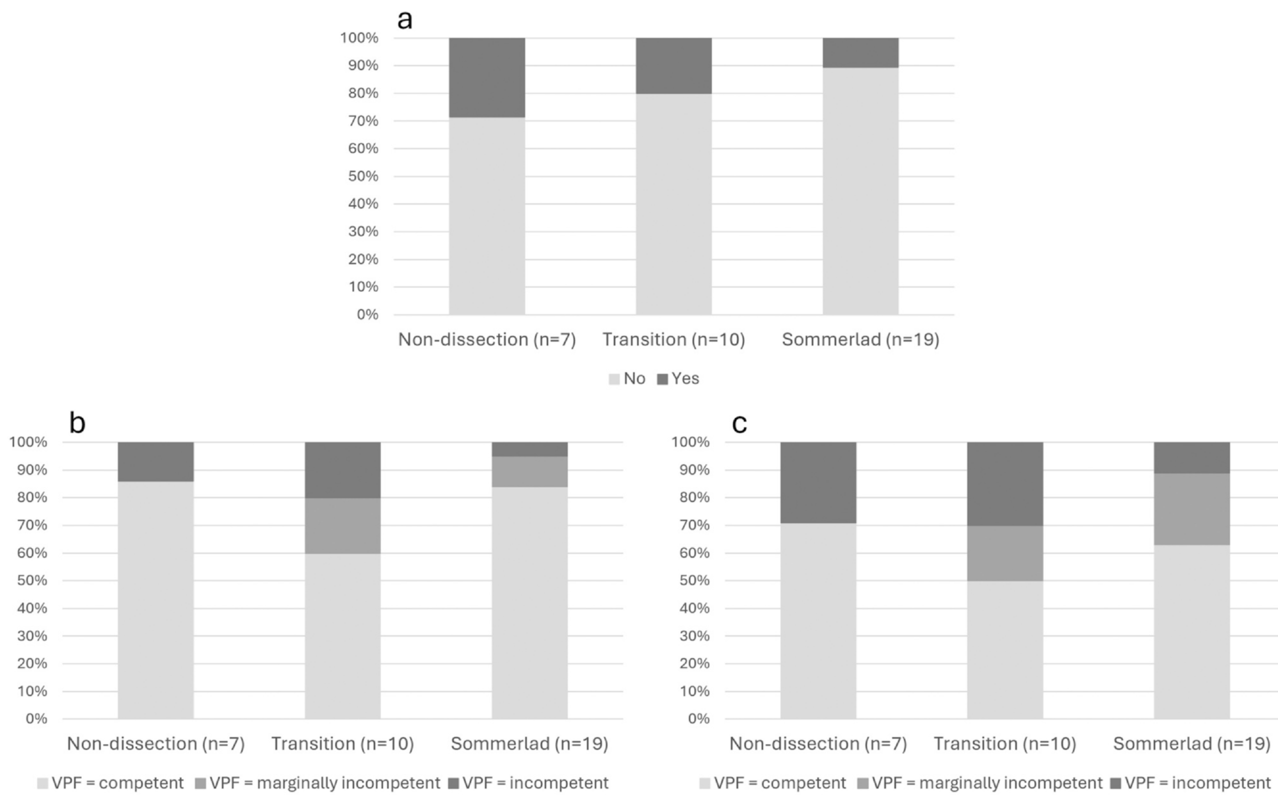

Figure 4 a) The rate of secondary palatal surgery. b) Velopharyngeal function (VPF) assessed using VPC-R. c) VPF assessed using VPC-Sum divided into surgical techniques for the surgeon active throughout the study period. Individuals who had undergone speech-improving surgery before the assessment are counted as having velopharyngeal insufficiency.

reported VPI in 15% at 5 years of age. Our results are similar to those mentioned above but higher than the 5.2% reported by Baillie and Sell.[6] However, our group had fewer participants, which may have impacted the results more. Another possible explanation may be individual differences within and between surgeons when executing the technique. Indeed, during interviews with 14 surgeons regarding the execution of the Sommerlad technique, it was discovered that there was sometimes variation in execution due to, for example, patient heterogeneity or differences in training experience.[38]

Research has shown that the cleft width is associated with the need for more secondary palatal surgery and VPI,[6-8] and this study partly supports that finding. The cleft width was significantly associated with the requirement for secondary palatal surgery, and individuals with wider clefts were more likely to have VPI when using VPC-R. However, when using VPC-Sum, it was not significantly associated. The difference between the two measurements is partly because they are based on different speech materials; VPC-Sum is based on target consonants in words, while VPC-R is based on continuous speech in sentences. The performance of an individual may vary depending on the speech materials used. VPC-Sum is more detailed but in an easier speech sample compared with sentences that are more demanding for the child and the velopharyngeal function. Both measurements were included to capture VPF in different contexts commonly used to assess VPF. The mean cleft width in the non-radical group was narrower than that in the Sommerlad group. Somewhat contradictory in this regard is the greater rate of secondary surgery in the non-radical group, suggesting that the surgical technique may also play a role, although evidence for this was not found in this study.

One limitation of this study is the involvement of four surgeons, which may lead to individual differences in evaluating the techniques due to their different surgical experiences and skills. However, upon examining the results of the only surgeon who was active throughout the entire study period, it became evident that using the Sommerlad technique resulted in better outcomes in relation to both the secondary palatal surgery rate and VPI. Although one might assume that the introduction of the Sommerlad technique would have led to worse results initially, it is crucial to note that radical muscle dissection, although not as radical as in the Sommerlad technique, had already been utilized for over 2 years. Therefore, any improvements observed after the transition period can possibly be attributed to increased experience, as well as, as discussed earlier, to the training received.

Another limitation of this study is the small sample size. Small sample sizes can reduce the statistical power and lead to underpowered analyses, so all results in this study should be interpreted cautiously. The sample size of this study could have been increased if the age range for the operations had been widened. However, this would have raised the question of whether age at surgery impacted the outcome.

Six dental casts were missing, and the cleft width measurements for those individuals were taken from a previous study. Because the same method and measurer were utilized in this study, this was deemed to have no impact on the results.

Conclusion and clinical implications

When a new surgical technique is introduced, the aim is to improve speech and reduce the burden of care. While the Sommerlad technique did not show significant superiority over the non-radical technique regarding speech outcomes, the rate of secondary palatal surgery decreased from 25% to 16%. However, long-term studies with larger sample sizes are needed to evaluate and compare surgical methods accurately, as final treatment results can only be assessed once patients have finished growing.

A systematic process with structured training is paramount when introducing new surgical techniques.

In this study, the cleft width was found to have a more significant impact than radical intra-velar veloplasty, with wider clefts being more vulnerable to secondary surgery and VPI. However, neither the cleft width nor the surgical technique affected the PCC, and future studies should consider other variables that may affect articulation ability.

Ethical approval

Ethical approval was obtained from the Regional Ethical Review Board, Uppsala University, Dnr: 2017/457.

Funding

This research was supported by funds administered by Uppsala University Hospital.

Declaration of Competing Interest

The authors declare no conflict of interest.

Acknowledgments

The authors express their gratitude to Anette Lohmander and Kristina Svensson for their assistance with rating and transcribing.

References

1. Butterworth S, Fitzsimons KJ, Medina J, et al. Investigating the impact of patient-related factors on speech outcomes at 5 years of age in children with a cleft palate. *Cleft Palate Craniofac J* 2023;**60**(12):1578–90.
2. Klinto K, Eriksson M, Abdiu A, et al. Inter-centre comparison of data on surgery and speech outcomes at 5 years of age based on the Swedish quality registry for patients born with cleft palate with or without cleft lip. *BMC Pedia* 2022;**22**(1):303.
3. Sainsbury DCG, Williams CC, Butterworth S, et al. Patient factors influencing speech outcomes in velopharyngeal function following initial cleft palate repair: a systematic review and meta-analysis. *Cleft Palate Craniofac J* 2023:10556656231191384.
4. Persson C, Elander A, Lohmander-Agerskov A, Soderpalm E. Speech outcomes in isolated cleft palate: impact of cleft extent and additional malformations. *Cleft Palate Craniofac J* 2002;**39**(4):397–408.
5. Persson C, Lohmander A, Elander A. Speech in children with an isolated cleft palate: a longitudinal perspective. *Cleft Palate Craniofac J* 2006;**43**(3):295–309.
6. Baillie L, Sell D. Benchmarking speech, velopharyngeal function outcomes and surgical characteristics following the Sommerlad protocol and palate repair technique. *Cleft Palate Craniofac J* 2020;**57**(10):1197–215.
7. Botticelli S, Kuseler A, Molsted K, et al. Influence of infant cleft dimensions on velopharyngeal function in 5-year-old Danish children born with unilateral cleft lip and palate. *Cleft Palate Craniofac J* 2020;**57**(4):420–9.
8. Okhiria AC, Jabbari F, Hakelius MM, Johansson MMB, Nowinski DJ. Greater palatal cleft width predicts an increased risk for unfavorable outcomes in cleft palate repair. *Cleft Palate Craniofac J* 2022;**59**(8):1030–7.
9. Chapman KL, Hardin-Jones MA, Goldstein JA, Halter KA, Havlik RJ, Schulte J. Timing of palatal surgery and speech outcome. *Cleft Palate Craniofac J* 2008;**45**(3):297–308.
10. Willadsen E. Influence of timing of hard palate repair in a two-stage procedure on early speech development in Danish children with cleft palate. *Cleft Palate Craniofac J* 2012;**49**(5):574–95.
11. Willadsen E, Boers M, Schops A, et al. Influence of timing of delayed hard palate closure on articulation skills in 3-year-old Danish children with unilateral cleft lip and palate. *Int J Lang Commun Disord* 2018;**53**(1):130–43.
12. Sommerlad BC. A technique for cleft palate repair. *Plast Reconstr Surg* 2003;**112**(6):1542–8.
13. Shaw W, Semb G. The Scandcleft randomised trials of primary surgery for unilateral cleft lip and palate: 11. What next? *J Plast Surg Hand Surg* 2017;**51**(1):88–93.
14. Anderson BJ, Fallah KN, Lignieres AA, et al. Predictive factors for velopharyngeal insufficiency following primary cleft palate repair. *Cleft Palate Craniofac J* 2022;**59**(7):825–32.
15. Timbang MR, Gharb BB, Rampazzo A, Papay F, Zins J, Doumit G. A systematic review comparing Furlow double-opposing Z-plasty and straight-line intravelar veloplasty methods of cleft palate repair. *Plast Reconstr Surg* 2014;**134**(5):1014–22.
16. Andrades P, Espinosa-de-Los-Monteros A, Shell DHt, et al. The importance of radical intravelar veloplasty during two-flap palatoplasty. *Plast Reconstr Surg* 2008;**122**(4):1121–30.
17. Doucet JC, Herlin C, Captier G, Baylon H, Verdeil M, Bigorre M. Speech outcomes of early palatal repair with or without intravelar veloplasty in children with complete unilateral cleft lip and palate. *Br J Oral Maxillofac Surg* 2013;**51**(8):845–50.
18. Dissaux C, Grollemund B, Bodin F, et al. Evaluation of 5-year-old children with complete cleft lip and palate: Multicenter study. Part 2: functional results. *J Craniomaxillofac Surg* 2016;**44**(2):94–103.
19. Henriksson TG, Hakelius M, Andlin-Sobocka A, Svanholm H, Low A, Skoog V. Intravelar veloplasty reinforced with palatopharyngeal muscle: a review of a 10-year consecutive series. *Scand J Plast Reconstr Surg Hand Surg* 2005;**39**(5):277–82.
20. Sommerlad BC. Surgery of the cleft palate: repair using the operating microscope with radical muscle retropositioning–the GostA approach. *B-ENT* 2006;**2 4**:32–4.
21. Goldwyn RM. Bernhard Von Langenbeck. His life and legacy. *Plast Reconstr Surg* 1969;**44**(3):248–54.
22. Hellquist R, Skoog T. The influence of primary periosteoplasty on maxillary growth and deciduous occlusion in cases of complete unilateral cleft lip and palate. A longitudinal study from infancy to the age of 5. *Scand J Plast Reconstr Surg* 1976;**10**(3):197–208.

23. Friede H, Persson EC, Lilja J, Elander A, Lohmander-Agerskov A, Soderpalm E. Maxillary dental arch and occlusion in patients with repaired clefts of the secondary palate. Influence of push back palatal surgery. *Scand J Plast Reconstr Surg Hand Surg* 1993;**27**(4):297–305.
24. Reiser E, Skoog V, Gerdin B, Andlin-Sobocki A. Association between cleft size and crossbite in children with cleft palate and unilateral cleft lip and palate. *Cleft Palate Craniofac J* 2010;**47**(2):175–81.
25. Lohmander A, Lundeborg I, Persson C. SVANTE - The Swedish Articulation and Nasality Test - normative data and a minimum standard set for cross-linguistic comparison. *Clin Linguist Phon* 2017;**31**(2):137–54.
26. Boersma P., Weenink D. Praat: doing phonetics by computer. 6.1 ed2018. p. retrieved 13 August 2019 from ⟨http://www.praat.org/⟩.
27. Lohmander A, Hagberg E, Persson C, et al. Validity of auditory perceptual assessment of velopharyngeal function and dysfunction - the VPC-Sum and the VPC-Rate. *Clin Linguist Phon* 2017;**31**(7-9):589–97.
28. Lohmander A, Persson C, Willadsen E, et al. Scandcleft randomised trials of primary surgery for unilateral cleft lip and palate: 4. Speech outcomes in 5-year-olds - velopharyngeal competency and hypernasality. *J Plast Surg Hand Surg* 2017;**51**(1):27–37.
29. Sell D, Grunwell P, Mildinhall S, et al. Cleft lip and palate care in the United Kingdom–the Clinical Standards Advisory Group (CSAG) Study. Part 3: speech outcomes. *Cleft Palate Craniofac J* 2001;**38**(1):30–7.
30. IPA. The International Phonetic Alphabet ⟨https://www.internationalphoneticassociation.org/sites/default/files/IPA_Kiel_2015.pdf2015⟩ [Internet].
31. extIPA. extIPA SYMBOLS FOR DISORDERED SPEECH ⟨https://www.internationalphoneticassociation.org/sites/default/files/extIPAChart2008.pdf2008⟩ [Internet].
32. Shriberg LD, Kwiatkowski J. Phonological disorders III: a procedure for assessing severity of involvement. *J Speech Hear Disord* 1982;**47**(3):256–70.
33. Scherer NJ, Williams AL, Proctor-Williams K. Early and later vocalization skills in children with and without cleft palate. *Int J Pedia Otorhinolaryngol* 2008;**72**(6):827–40.
34. Allori AC, Kelley T, Meara JG, et al. A standard set of outcome measures for the comprehensive appraisal of cleft care. *Cleft Palate Craniofac J* 2017;**54**(5):540–54.
35. Larsson A, Miniscalco C, Mark H, Scholin JS, Jonsson R, Persson C. Internationally adopted children with unilateral cleft lip and palate-consonant proficiency and perceived velopharyngeal competence at the age of 5. *Cleft Palate Craniofac J* 2020;**57**(7):849–59.
36. Cicchetti DV. The precision of reliability and validity estimates re-visited: distinguishing between clinical and statistical significance of sample size requirements. *J Clin Exp Neuropsychol* 2001;**23**(5):695–700.
37. Klinto K, Falk E, Wilhelmsson S, Schonmeyr B, Becker M. Speech in 5-year-olds with cleft palate with or without cleft lip treated with primary palatal surgery with muscle reconstruction according to Sommerlad. *Cleft Palate Craniofac J* 2018;**55**(10):1399–408.
38. Butterworth S, Hodgkinson EL, Sainsbury DCG, Hodgkinson PD. Surgical variation between consultant surgeons performing a Sommerlad radical intravelar veloplasty. *Cleft Palate Craniofac J* 2021;**58**(12):1490–9.