

*Original Articles*

## POSTOPERATIVE ORONASAL FISTULA FORMATION FOLLOWING THE FURLOW AND OTHER THREE PALATOPLASTY TECHNIQUES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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### ABSTRACT

**Introduction :** The technique for repairing a cleft palate depends on the length and width of the palate and the type of cleft palate according to the Veau classification. The most common surgical techniques include the Furlow double opposing Z-plasty, the Bardach palatoplasty, the von Langenbeck palatoplasty, and the V-Y pushback. One of the most frequent complications after cleft palate repair is an oronasal fistula (ONF). This article aimed to compare the risk of postoperative ONF formation following cleft palate repair.

**Method :** We searched for manuscripts involving patients with ONF formation following the Furlow, Bardach, von Langenbeck, and V-Y pushback palatoplasty. Electronic literature searching of the PubMed, Scopus, and Cochrane databases was conducted for the studies published up to November 2022.

**Result:** The meta-analysis used 17 studies, including the analysis of 3,207 repaired cleft palates. The Furlow technique was associated with a statistically lower risk of ONF formation when compared to the von Langenbeck and V-Y pushback techniques (RR=0.06[0.43-0.840], $p<0.01$  and RR=0.30[0.15-0.62], $p<0.01$  respectively). There were no statistically significant differences regarding ONF formation between the Furlow technique and the Bardach technique (RR=1.45[0.48-0.43], $p=0.51$ ).

**Conclusion:** The Furlow technique is associated with a lower risk of ONF compared to the von Langenbeck and V-Y pushback techniques. There were no statistically significant differences in ONF formation between the Furlow and Bardach techniques.

**Keywords:** Cleft palate; Surgical procedures; Palatoplasty; Postoperative complications; Fistula

**Latar Belakang:** Teknik untuk memperbaiki celah langit-langit mulut bergantung pada panjang dan lebar langit-langit serta jenis celah langit-langit menurut klasifikasi Veau. Teknik bedah yang paling umum meliputi Furlow double opposing Z-plasty, Bardach palatoplasty, von Langenbeck palatoplasty, dan V-Y pushback. Salah satu komplikasi yang paling sering terjadi setelah perbaikan celah langit-langit mulut adalah fistula oronasal (ONF). Artikel ini bertujuan untuk membandingkan risiko pembentukan ONF pascaoperasi setelah perbaikan celah langit-langit mulut.

**Metode:** Kami mencari manuskrip yang melibatkan pasien dengan pembentukan fistula oronasal (ONF) setelah palatoplasti Furlow, Bardach, von Langenbeck, dan V-Y pushback. Pencarian literatur elektronik dilakukan melalui basis data PubMed, Scopus, dan Cochrane untuk studi-studi yang diterbitkan hingga November 2022.

**Hasil:** Meta-analisis menggunakan 17 studi, termasuk analisis terhadap 3.207 langit-langit mulut yang telah diperbaiki. Teknik Furlow dikaitkan dengan risiko pembentukan fistula oronasal (ONF) yang secara statistik lebih rendah dibandingkan dengan teknik von Langenbeck dan V-Y pushback (RR=0,06 [0,43-0,84],  $p<0,01$  dan RR=0,30 [0,15-0,62],  $p<0,01$ , masing-masing). Tidak ada perbedaan yang signifikan secara statistik mengenai pembentukan ONF antara teknik Furlow dan teknik Bardach (RR=1,45 [0,48-4,33],  $p=0,51$ ).

**Kesimpulan:** Teknik Furlow dikaitkan dengan risiko yang lebih rendah untuk pembentukan fistula oronasal (ONF) dibandingkan dengan teknik von Langenbeck dan V-Y pushback. Tidak ada perbedaan yang signifikan secara statistik dalam pembentukan ONF antara teknik Furlow dan teknik Bardach.

**Kata Kunci:** Celah langit-langit mulut; Prosedur bedah; Palatoplasti; Komplikasi pascaoperasi; Fistula

### Conflicts of Interest Statement:

The author(s) listed in this manuscript declare the absence of any conflict of interest on the subject matter or materials discuss

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## INTRODUCTION

Cleft are common congenital craniofacial anomalies in children with significant effects on facial growth, speech, hearing, and psychosocial well-being.<sup>1,2</sup> The purpose of cleft palate repair is to maximize quality of life by supporting speech development and maxillofacial growth.<sup>3</sup> In a cleft repair, the optimal surgical results should be the preservation of facial growth, separation of the nasal and oral cavities, and competent velopharyngeal closure for speech recovery.<sup>4</sup>

The techniques used for cleft palate repair vary depending on various factors. Surgery for cleft palates has evolved beyond straightforward edge paring to intravelar veloplasty, which involves elevating soft tissue flaps.<sup>5</sup> Surgical techniques that are most frequently used are the Furlow, Bardach, Von Langenbeck, and V-Y pushback.<sup>2</sup>

Despite surgical advances over the years, oronasal fistula (ONF) occurrences remain one of the most frequent complications following palatoplasty that cause concern for cleft surgeons.<sup>5,6</sup> The presence of an ONF is linked to functional problems such as hypernasality or rhinolalia aperta, backflow of fluids through the nose, audible nasal escape, and recurrent infections that can require reoperation.<sup>3,7,8</sup>

This study aimed to compare the risk of postoperative ONF formation following cleft palate repair after the Furlow technique with the Bardach, von Langenbeck, and V-Y pushback techniques.

## METHOD

### Literature Search

This study is a systematic review and meta-analysis with comprehensive search strategies on the articles addressing oronasal fistula formation following the Furlow, Bardach, von Langenbeck, and V-Y pushback palatoplasty. Articles were screened according to "Preferred Reporting Items for Systematic Reviews and Meta-Analysis" (PRISMA) guidelines.

Randomized controlled trials (RCT), non-randomized controlled clinical trials, prospective and retrospective comparative cohort studies were included while case series and case reports were excluded. Key search terms which included "cleft palate", "palatoplasty", "fistula", "Furlow", "Bardach", "V-Y Pushback", and "von Langenbeck" were arranged using varying combinations of Boolean operators. We searched PubMed, Scopus, and Cochrane Library, for the published articles up to November 2022.

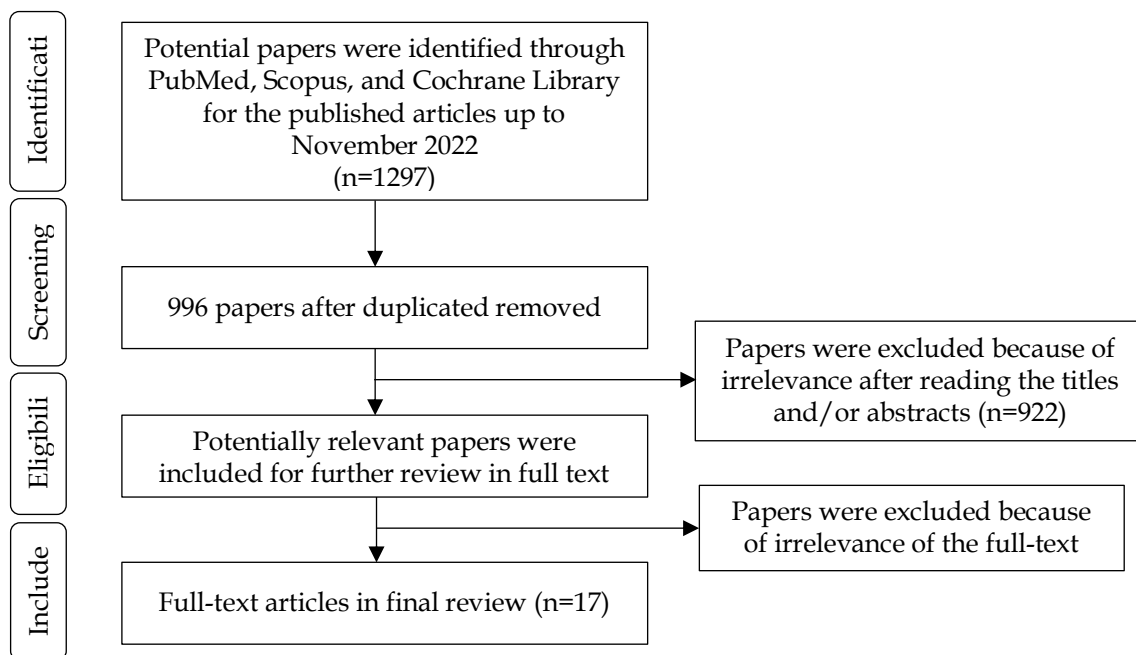


Figure 1. Study selection flow chart

Study Selection

Potential papers were identified and duplicate papers were removed. The selected papers were screened based on the eligibility criteria after a complete reading of their titles and abstracts. Full articles were obtained for all those meeting the inclusion criteria.

Study Eligibility Criteria

Inclusion criteria included (1) primary cleft repair using Furlow, Bardach, von Langenbeck, or V-Y Pushback techniques; (2) randomized controlled trials, prospective or retrospective cohort studies, case-control studies, or cross-sectional studies; (3) a description of an oronasal

fistula (ONF) as a failure of healing or a breakdown of the primary surgical repair of the palate; (4) have reported the number of ONF. Exclusion criteria included (1) non-English papers; (2) preclinical animal studies; and (3) case reports, case series, reviews, or editorials.

Data Extraction

The reviewers extracted information independently and populated a standardized template. Data extracted included study design, total patients, syndromic vs non-syndromic, type of cleft, surgical procedure, and number of fistula.

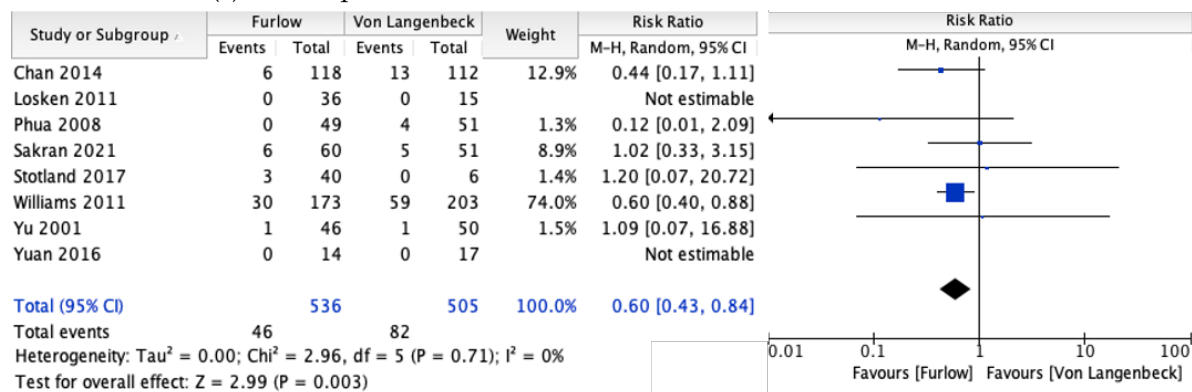


Figure 2. Postoperative ONF formation using the Furlow vs. von Langenbeck techniques

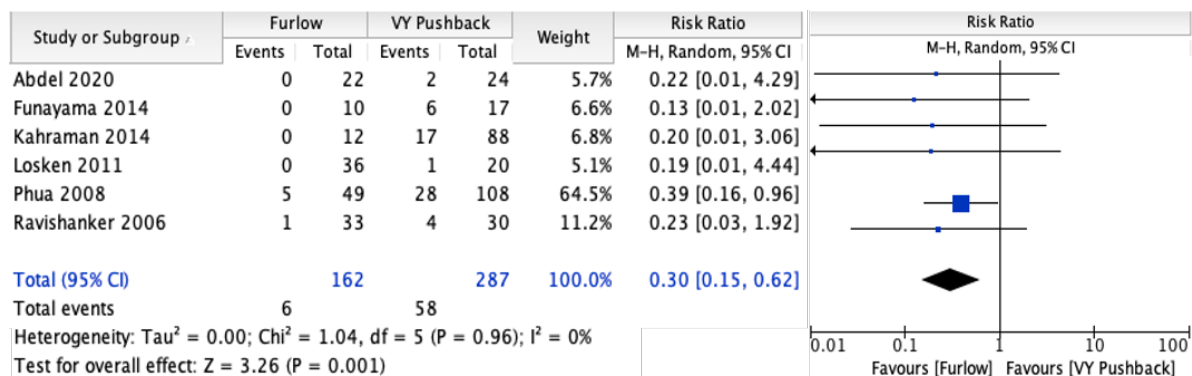


Figure 3. Postoperative ONF formation using the Furlow vs. V-Y pushback techniques

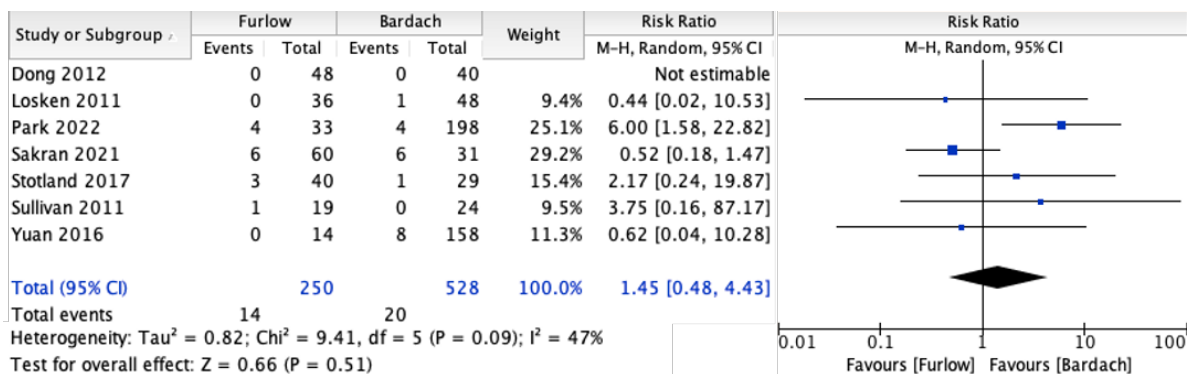


Figure 4. Postoperative ONF formation using the Furlow vs. Bardach techniques

Table 1. Study Characteristics

Author (year)	Study Design	N	Syndromic	Type of Cleft	Surgical Procedure											
					Furlow			Bardach			von Langenbeck			V-Y Pushback		
					Patient (n)	Fistula (n)	Patient (n)	Fistula (n)	Patient (n)	Fistula (n)	Patient (n)	Fistula (n)	Patient (n)	Fistula (n)		
Park et al. (2022) <sup>21</sup>	Retrospective	636	S/NS	All types	33	4	198	4	0	0	0	0	96	3		
Sakran et al. (2021) <sup>22</sup>	Prospective	142	NS	Veau II-III	60	6	31	6	51	5	0	0	0	0		
Dong et al. (2012) <sup>23</sup>	Retrospective	88	NS	Veau I-II	48	0	40	0	0	0	0	0	0	0		
Losken et al. (2011) <sup>24</sup>	Prospective	126	S/NS	Veau I-IV	36	0	48	1	15	0	0	20	1	1		
Stotland et al. (2017) <sup>25</sup>	Retrospective	75	S/NS	All types	40	3	29	1	6	0	0	0	0	0		
Sullivan et al. (2011) <sup>26</sup>	Retrospective	58	S/NS	Submucous cleft	19	1	24	0	0	0	0	0	0	0		
Yuan et al. (2016) <sup>27</sup>	Retrospective	177	S/NS	Veau I-IV	14	0	158	8	17	0	0	0	0	0		
Kahraman et al. (2014) <sup>28</sup>	Retrospective	100	NR	Veau I-IV	12	0	0	0	0	0	0	88	17	17		
Gustafsson et al. (2022) <sup>29</sup>	Retrospective	290	NS	All types	0	0	94	17	52	8	24	9	9	9		
Yu et al. (2001) <sup>30</sup>	Retrospective	69	NS	All types	46	1	0	0	50	1	0	0	0	0		
Ravishanker et al. (2006) <sup>31</sup>	Retrospective	63	NR	All types	33	1	0	0	0	0	30	4	4	4		
Phua et al. (2008) <sup>32</sup>	Retrospective	211	S/NS	Veau I-IV	49	0	0	0	51	4	108	15	15	15		
Williams et al. (2011) <sup>10</sup>	RCT	459	NS	All types	190	44	0	0	269	37	0	0	0	0		
Chan et al. (2014) <sup>12</sup>	Retrospective	230	S/NS	All types	118	6	0	0	112	13	0	0	0	0		
Deshpande et al. (2014) <sup>33</sup>	Retrospective	709	NS	Type I-IV	0	0	428	17	8	2	0	0	0	0		
Abdel et al. (2020) <sup>14</sup>	Retrospective	46	NS	All types	17	0	0	0	0	0	24	2	2	2		
Funayama et al. (2022) <sup>13</sup>	Retrospective	27	NS	All types	10	0	0	0	0	0	17	6	6	6		

Abbreviations: RCT, randomized controlled trial; N, total number of patients; S/NS, syndromic/nonsyndromic patients; NR, not recorded

### Statistical Analysis

The study findings were tabulated and summarized using the statistical software RevMan 5.4, according to reference guidelines in *The Cochrane Handbook for Systematic Reviews of Interventions*. Primary outcomes included the rates of post-operative oronasal fistula formation. Fistula formation rates were compared using relative risk ratios with 95% confidence intervals.

## RESULTS

### Study Characteristics

The literature search retrieved a total of 1297 potential studies. The final selection included 17 studies, which met the inclusion criteria. The selection process of the papers is shown in the flow chart (Figure 1). From the total of 17 studies, one study (5%) was randomized controlled trials (RCT), two studies (12%) were prospective, and 14 studies (82%) were retrospective studies.

The meta-analysis used 17 studies, including the analysis of 3207 repaired cleft palates (Table 1). Seven studies included syndromic and non-syndromic patients; eight included only non-syndromic patients; and the others were non-reported.

Based on cleft type; nine studies included all cleft types, five studies included Veau I-IV, one study included Veau I-II, one study included Veau II-III, and one study included submucous cleft. The patients that were included in this study underwent cleft palate repair with either the V-Y pushback (390 patients), the Von Langenbeck (631 patients), the Furlow (715 patients), or the Bardach technique (1050 patients).

### Postoperative Oronasal Fistula Formation

A comparative analysis was conducted to determine the relative risk of postoperative ONF formation using the Furlow, von Langenbeck, V-Y pushback, and Bardach techniques.

Our study showed that the Furlow technique was associated with a statistically lower risk of ONF formation when compared to the von Langenbeck and V-Y pushback techniques (RR=0.06[0.43-0.840], $p<0.01$  and RR=0.30[0.15-0.62], $p<0.01$  respectively) (Figure 2, 3). There were no statistically significant differences regarding ONF formation between

the Furlow technique and the Bardach technique (RR=1.45[0.48-0.43], $p=0.51$ ) (Figure 4).

## DISCUSSION

The most common postoperative complication is considered to be an oronasal fistula (ONF), which typically requires further surgical repair.<sup>9,10</sup> The primary causes of oronasal fistulas are closing under tension due to insufficient tissue mobilization, infection, and postoperative bleeding. Fistula rates can also vary depending on the method of palate repair procedure performed.<sup>11</sup>

This study aimed to investigate and compare postoperative oronasal fistula formation after cleft palate repair surgery. The most common surgical techniques include the Furlow, the Bardach, the Von Langenbeck, and the V-Y pushback. Several previous studies have assessed fistula rates following cleft palate repair. Our search extended until 2022, adding 5 more years of data and probably obtaining different results.

The overall oronasal fistula rate in our study was 7.98% which is considerably lower than the 9.94% reported in the systematic review of Tache et al.<sup>3</sup> Despite the variability, most authors in our included studies (15 of the 17 included studies) prefer the Furlow technique.

Our study demonstrated that the Furlow technique was associated with reduced oronasal fistula formation relative to the von Langenbeck and V-Y pushback techniques. These findings corroborate a previous study by Stein *et al*, 2018 which concluded that the Furlow palatoplasty was associated with a statistically significant reduction in oronasal fistula formation compared to the von Langenbeck and the V-Y pushback techniques.<sup>2</sup> Another study by Chan et al, 2014 concluded that Furlow palatoplasty appeared to have a superior outcome if compared with von Langenbeck (Fistula rate was 5.1% vs 11.6%).<sup>12</sup>

Funayama *et al*. and Abdel-Aziz *et al*. also concluded with similar results that the Furlow has a lower oronasal fistula rate than the V-Y Pushback.<sup>13,14</sup> A study by Abdel-Aziz *et al*. reported that ONF develops at the junction of the hard and soft palates in patients treated with the V-Y pushback technique. Mucosal tears may arise from the difficult elevation of the nasal and oral

mucosa, which are typically adherent along the midline of the posterior edge of the hard palate. This could be the reason for the formation of ONF. Cases treated using the Furlow technique did not develop ONF because surgeons often leave 2-3mm of soft tissue posterior to the bony margin and do not require mucosal elevation from the hard palate.<sup>14</sup>

On the contrary, a prospective randomized controlled trial study concluded that oronasal fistula occurrence was significantly higher in the Furlow group than in the von Langenbeck group (23.5% vs 13.7%).<sup>10</sup>

Our study found that the Furlow technique has no statistically significant differences regarding oronasal fistula formation compared to the Bardach technique. Other studies also yielded similar findings.<sup>15,16</sup> A retrospective study by Park et al. showed that fistula incidence was significantly higher in patients who underwent the Furlow techniques than in the Bardach techniques.<sup>17</sup>

Furthermore, Basilio et al. reported that the largest number of ONF was found with the Bardach compared to the Furlow technique. The reason for this could be that Furlow's technique uses oral sutures to cover nasal sutures and vice versa, whereas this technique uses overlaid suture lines.<sup>6</sup>

There are several factors associated with the formation of postoperative ONF. To improve patient outcomes and establish guidelines, it is crucial to evaluate the postoperative outcome and assess the risks and benefits of each method after using different cleft palate repair techniques.<sup>9</sup> Reduced ONF formation is associated with lower tension at the repair site. A tension-free palate midline closure is suggested as one of the keys to this cleft repair procedure.<sup>15</sup>

The key pitfall to the Furlow technique is tension at the junction of the hard and soft palates which is avoided by incorporating a layer of alloderm in the nasal layer repair, thereby eliminating the tension. One major drawback of the Furlow procedure is the tension that occurs at the junction of the hard and soft palates. This can be prevented by incorporating a layer of alloderm in the nasal layer repair, which can reduce the tension.<sup>11</sup>

Additionally, to lessen the tension and subsequent of dehiscence, radical muscle dissection, appropriate suturing of the distinct layers, and relaxing incisions were utilized.<sup>9</sup> LaRossa et al. mentioned that, due to the horizontal stress at the junction of the hard and soft palates, relaxing incisions were occasionally necessary, especially in broader clefts. By performing this, the formation of ONF may be avoided.<sup>18</sup>

According to Bae et al., palatal lengthening was greater following the Furlow technique as compared to the V-Y Pushback technique.<sup>19</sup> Significant and permanent velar length elongation following Furlow's palatoplasty was also confirmed by Guneren and Usal.<sup>15,20</sup> Losken et al. recommend the Furlow technique for narrower clefts and the Bardach technique for wider clefts.<sup>11</sup>

## CONCLUSION

Our present study showed the Furlow technique is associated with a lower risk of postoperative ONF formation compared to the von Langenbeck and V-Y pushback techniques. On the other hand, there was no statistically significant difference in ONF formation between the Furlow and Bardach techniques. Our data suggest that the Furlow technique may be considered as a viable option to reduce the risk of postoperative ONF formation following cleft palate repair.

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