Journal of Plastic, Reconstructive & Aesthetic Surgery 102 (2025) 75–92

Review

FAMM flap in oral cavity and tongue defect reconstruction: A systematic review and meta-analysis

Luke R. Mattey [a,*,1], **Daniella Reyes** [b,1], **Umar Rehman** [c], **Shireen S. Gohari** [d], **Mohammad Sohaib Sarwar** [e], **Peter A. Brennan** [f]

[a] *Cardiff University, Wales, United Kingdom*
[b] *Barts and the London School of Medicine and Dentistry, London, United Kingdom*
[c] *UCL Division of Surgery and Interventional Sciences, University College London, London, United Kingdom*
[d] *Department of Otolaryngology and Head and Neck, St. George's Hospital, London, United Kingdom*
[e] *Department of Oral and Maxillofacial Surgery, Bradford Royal Infirmary, Bradford, United Kingdom*
[f] *Department of Oral and Maxillofacial Surgery, Queen Alexandra Hospital, Portsmouth, United Kingdom*

Received 24 October 2024; Accepted 18 December 2024

KEYWORDS
Oral cancer;
Reconstruction;
Flap success;
Facial artery musculomucosal flap;
Facial artery;
Tongue

Summary *Background:* The facial artery musculomucosal (FAMM) flap is a versatile flap based on the facial artery. It can be used to reconstruct the floor of the mouth, palate, tongue and alveolar ridge. The flap can be designed in various orientations and modified as an islanded or tunnelised flap. This study aimed to review the application of FAMM flap in the reconstruction of defects of the tongue and oral cavity, with specific focus on success rates and total complications.
Methods: A literature search was conducted by 2 independent reviewers on PubMed, Dynamed, DARE, EMBASE, Cochrane and British Medical Journal (BMJ) electronic databases (Registry CRD42024529989).
Results: Twenty-seven studies fulfilled the search criteria and data on 407 FAMM flaps performed on 402 patients were extracted for analysis. Overall, 1.7% (n=7) of flaps failed because of total necrosis (n=3), partial necrosis requiring surgical intervention and flap abandonment (n=2), total failure (n=1) and fistula formation (n=1). Overall, 26.0% (n=106) of patients experienced non-functional complications. The most reported complications were partial

Abbreviations: FAMM, Facial Artery Musculomucosal Flap; BMJ, British Medical Journal; IARC, International Agency for Research on Cancer; OSCC, Oral Squamous Cell Carcinoma; RFFF, Radial Forearm Free Flap; ALT, Anterolateral Thigh Flap; AHRQ, Agency for Healthcare Research and Quality; SCC, Squamous Cell Carcinoma; FOM, Floor of Mouth; TORS, Transoral Robotic Surgery

* Correspondence to: Cardiff University School of Medicine, Neuadd Meirionnydd, Cardiff, CF14 4YS Wales, United Kingdom.
E-mail address: matteylr@cardiff.ac.uk (L.R. Mattey).

[1] LM and DR contributed equally to the work and are Joint first authors.

https://doi.org/10.1016/j.bjps.2024.12.009

necrosis (n=23, 5.7%), wound dehiscence (n=18, 4.4%) and venous congestion (n=13, 3.2%). The pooled success rate in all studies using FAMM flaps for oral cavity and tongue reconstruction was 99.47% (95% CI, 98.26 to 100.00, P = 1.00; I^2 = 0%;). Pooled total complication rates were 30.18% (95% CI, 16.97 to 43.38, P < 0.01; I^2 = 91%). Only 35 flaps required re-operation.
Conclusions: With low complication and failure rates, FAMM flaps are a safe and versatile option to consider in oral cavity and tongue reconstruction.

Contents

Oral cancer (predominantly squamous cell carcinoma) remains a significant global health issue. According to the 2022 International Agency for Research on Cancer (IARC) GLOBOCAN cancer statistics, lip and oral cavity cancers rank as the second most common type of cancer by new cases and the fourth leading type of cancer in terms of mortality in South-Central Asia.[1] Similarly, the 2022 State of Mouth Cancer UK Report shows that there has been a 34% increase in new cases over the last decade with a staggering 103% increase in the last 20 years within England alone.[2] Approximately one patient is diagnosed with oral cancer every hour equating to 8846 people in the UK in 2022.[2] Mortality rates have also surged with a 46% increase in oral cancer-related deaths in the last 10 years.[2] Moreover, 90% of oral cancers are oral squamous cell carcinoma (OSCC) with 377,713 new cases per year according to 2020 IARC GLOBOCAN data.[3] The management of oral cancers, alongside traumatic injuries, infection and congenital anomalies often requires complex reconstructive procedures that pose significant challenges.

The mainstay of OSCC treatment is surgery with or without adjuvant radiotherapy.[4] Tumour resections often result in large defects which can affect functional restoration and aesthetic outcomes. Therefore, a delicate balance should be maintained between tissue resection and functional preservation.[5] Reconstruction options for oral and tongue defects generally fall into 2 main categories: microvascular free flaps and pedicled flaps.[6] Microvascular free flaps, such as the radial forearm free flap (RFFF) or anterolateral thigh (ALT) flaps, are considered the workhorse of free flap soft tissue oral reconstruction for large defects. These flaps can be thin, pliable and versatile, allowing for extensive soft tissue or bone reconstruction.[7] However, they require microsurgical expertise and have prolonged operative times.[8] Moreover, variations in the incidence of donor site complications were observed in

alternative reconstructive modalities such as RFFF (15%[9] - 40%[10]) and ALT (11%[11] - 21.3%[12,13]). Commonly observed donor site complications include partial graft loss and paraesthesia in RFFF and ALT, respectively.[14,15] In patients with existing comorbidities or smaller defects, pedicled flaps such as the pectoralis major or submental island flaps should be considered.[16] However, these are bulkier than the RFFF and can interfere with speech and swallowing, thereby, limiting their use in certain areas of the oral cavity.[7]

In recent years, the facial artery musculomucosal (FAMM) flap, a regional pedicled flap, has gained popularity for the reconstruction of the floor of the mouth, palate and alveolar ridge defects.[17] It is supplied by the facial artery and originates from the cheek mucosa and it can be designed in various orientations—superiorly, inferiorly or laterally based on the defect's location and size.[18] It emerges as a promising alternative due to its substantial versatility. The advantages of this flap are minimal donor site morbidity, a straightforward harvest technique, a reliable blood supply and obviating external scar formation.[19] This systematic review aimed to critically evaluate the existing literature on the FAMM flap's efficacy, indications and outcomes in reconstructing oral cavity and tongue defects.

Aims

This study reviews and evaluates the use of FAMM flap in the reconstruction of defects of the tongue and oral cavity, specifically focusing on the success rates and total complications.

Methods

Database registration

This systematic review and meta-analysis followed the recommendations of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. The review was registered with the University of York's Centre for Reviews and Dissemination International Prospective Register of Systematic Reviews (PROSPERO) to reduce bias (Registry ID: CRD42024529989).

Literature search

A literature search was conducted in April 2024 by 2 independent reviewers (LM and DR) and any disagreements were resolved by a third reviewer (UR). The search was performed using the PubMed, DynaMed, DARE, EMBASE, Cochrane, and British Medical Journal (BMJ) electronic databases for articles published between January 1970 and April 2024. The following search parameters were used to retrieve the relevant articles: 'FAMM', 'facial artery musculomucosal flap', 'tongue', 'orofacial defects', 'oral cavity', 'tongue base', 'craniofacial', 'head and neck' and 'facial reconstruction'.

Only original research articles were considered. The following study types were reviewed: randomised control trials, prospective cohort studies, retrospective cohort studies, case studies and case series. Two independent reviewers (LM and DR) screened titles and abstracts for eligibility and inclusion. They then screened relevant full papers before inclusion.

Inclusion

In this review, all completed clinical studies focusing on the use of FAMM flaps in reconstructing tongue and/or oral cavity defects were included. All causes of tongue and oral cavity defects were included (trauma, oncology and congenital).

Exclusion

In this review, studies focusing on FAMM flap use for non-tongue or oral cavity defect reconstruction and those focusing on paediatric (< 18 years) patients were excluded. Studies using alternative flaps for reconstruction were also excluded. Papers where the full text is not available in English, studies that did not report complications, and studies comparing flap types for oral cavity and tongue reconstruction with FAMM flap outcome data that could not be isolated were excluded.

Quality assessment and risk of bias

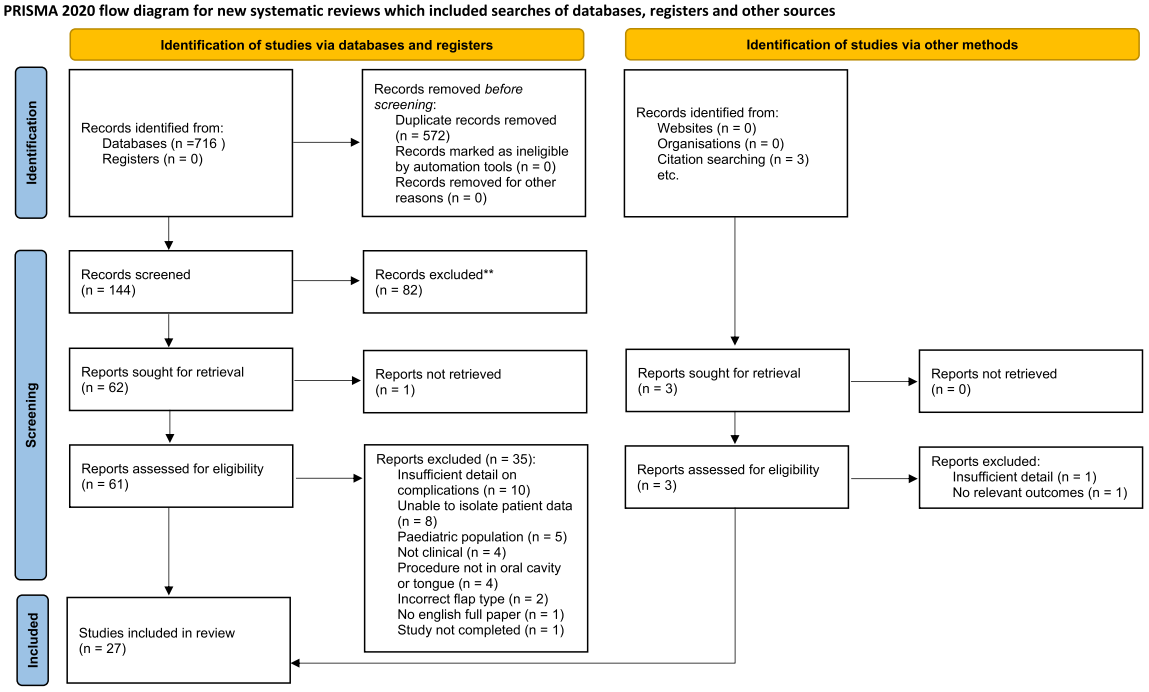
The Newcastle–Ottawa scale was used to assess studies individually for the risk of bias. The results from the Newcastle–Ottawa Tool were translated into the Agency for Healthcare Research and Quality (AHRQ) scores. Publication bias was assessed using R (version 4.4.0) to perform Egger's regression test, package meta version 7.0–0 to create funnel plots of the success rates and complications of using FAMM flaps in oral cavity and tongue reconstruction.

Statistical analysis

Pooled analysis estimates and 95% confidence intervals (CIs) were calculated for the outcomes of successful reconstruction rates and total complications in all studies using the FAMM flap, with the application of a random-effects model. Statistical analysis was performed using R (version 4.4.0), package meta version 7.0–0. Heterogeneity was assessed using R (version 4.4.0), package meta version 7.0–0 to determine the I^2 statistic (in percentage).

Results

As shown in the PRISMA flow diagram (Figure 1), the initial search yielded 716 results. After the removal of duplicates and ineligible studies, 61 articles were fully reviewed for inclusion. Grey literature searches identified 3 results. Two were removed on review of abstracts and one was fully reviewed. A total of 27 papers fulfilled the inclusion criteria and were included in the analysis.



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Figure 1 PRISMA flow diagram demonstrating systematic search results.

Study characteristics

A total of 27 articles with 454 patients were reviewed in full text for extraction. Seven studies contained mixed data where only certain patients matched the inclusion criteria. Patients matching the inclusion criteria in these studies were included in the study if all individual data could be extracted. Fifty-two patients in these studies were excluded due to the unsuitability of flap type/location (n=32) and inclusion of paediatric patients (n=20).

Overall, 407 FAMM flaps were performed on 402 patients for reconstruction of the oral cavity and tongue. Five patients had bilateral FAMM flaps. One study with 20 patients did not disclose their sex,[20] but the remaining studies reported 269 patients as men and 113 as women with a male-to-female ratio of 2.38:1. Mean age was 61.1 years, with a range of 18 to 90 years. The most common reason for reconstruction with a FAMM flap was malignancy (n=376, 92.4%). Furthermore, 19.7% (n=74) of malignancies were not described. Squamous cell carcinoma was the most described malignancy (n=292, 77.7%), followed by mucoepidermoid carcinoma (n=2, 0.5%). Other malignancies reconstructed with FAMM flaps are detailed in Table 1. Overall, 77.7% (n=292) of patients reconstructed because of malignancy underwent a neck dissection; among them, 271 were concomitant and 16 previously underwent neck dissections during the primary resection. Additionally, 1.1% (n=4) received a sentinel node biopsy and 7.7% (n=29) did not undergo neck dissection. Information regarding neck dissection was not reported in 3 studies involving 54 (14.2%) patients. Tumour staging was not consistently reported across the studies as seen in Table 1. Level, side and timing of neck dissections as well as defect locations are described in Table 1. Other reasons for reconstruction included fistula (n=9, 2.2%), non-malignant tumour (n=7, 1.7%), cleft palate (n=6, 1.5%), osteonecrosis of the jaw (n=2, 0.5%), trauma (n=1, 0.2%), and iatrogenic (n=1, 0.2%). The location and size of the defects can be seen in Table 2.[18,20–45]

Flap outcomes

Flap failure was defined as a flap that required salvage surgery, repeat flap coverage or *complete* loss of flap viability (e.g. through total necrosis, venous congestion or wound dehiscence). Conversely, flap success is defined as the absence of the aforementioned outcomes. Total necrosis was defined as a flap that turned black with no evidence of blood on incision, whereas partial necrosis was defined as a flap with blisters and dark or purplish red discoloration.[46] Among the 407 FAMM flaps performed on 402 patients, 98.3% (n=400) were successful, whereas 1.7% (n=7) FAMM flaps experienced failure according to the definition used in this study. Reasons for flap failure were total necrosis (n=3), venous congestion (n=1), partial necrosis requiring surgical debridement (n=1), partial necrosis requiring palatal swing flap coverage (n=1), total failure (n=1) and fistula formation (n=1).

The definitions of complication varied within the studies. To standardise the analysis, functional complications were separated from non-functional complications. Overall, 26.0% (n=106) of flaps experienced non-functional complications. The most reported complications were partial necrosis (n=23, 5.7%), wound dehiscence (n=18, 4.4%) and venous congestion (n=13, 3.2%).

Table 1 Study Characteristics.

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruction (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postoperative radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complications (n)	Functional complications (n)	Re-operations (n)
Zhao et al. 2003. China[14]	16	51.63 (38 - 70)	10:6	Cancer (16)	SCC (16)	T1N0M0 (1), T2N0M0 (1). Others not stated	Partial glossectomy (16)	Y (16)	Not stated	Post (12)	Islanded (16)	Superior (16)	0	Nil	Nil	Nil
Ayad et al. 2008. France[15]	57 (61 flaps)	(35 - 82)	50:7	Cancer (57)	SCC (56), Liposarcoma (1)	T1 (12), T2 (32), T3 (8), T4a (5)	Ablative surgery (57), Marginal mandibulectomy (26), Partial glossectomy (28)	Y (51), Sentinel node biopsy (4), N (2)	Previous (12), Concomitant ipsilateral (20), Concomitant bilateral (19)	Post (7), Pre (10)	Traditional (61)	Inferior (61)	0	Partial necrosis (15), Infection (1), Abscess (2), Haematoma (1), Tongue tethering by scar formation (3), Trismus (1)	Non-functional/ understandable speech (3)	Revision surgery (6)
Dolderer et al. 2011. Australia[16]	1	75	1:0	Cancer (1)	SCC (1)	Not stated	Resection 4 years previously with no repair (1)	Not stated	N/A	Not stated	Islanded (1)	Inferior (1)	0	Nil	Nil	Nil
O'Leary et al. 2011. Denmark[17]	22	(35 - 85)	17:5	Cancer (22)	SCC (18), Muco-epidermoid carcinoma (1), Cases of adenomatous carcinoma, malignant melanoma not specified (3).	Not stated	Tumour ablation no specifics stated	Y (12), N(10)	Not stated	Pre (4)	Traditional (22)	Inferior (16), Superior (6)	Total failure (1) Partial necrosis requiring palatinal swing flap (1)	Partial necrosis (1), Trismus (1), Bleeding due to manipulation of flap by patient (1)	Nil	Nasolabial flap (1), Re-operation, not stated (1), Palatinal swing flap (1)
Massarelli et al. 2012. Italy[18]	47 (n=1 excluded for age, n=4 excluded for location of defect, n=14 excluded for flap type)	63 (32 - 90)	39:8	Cancer (39), Fistula (4), ONJ (1), Non-malignant tumour (3 - Peripheral ossifying fibroma (1), Pleomorphic adenoma (1), Giant cell granuloma (1))	Squamous Cell Carcinomas (SCC) (39)	T1N0M0 (3), T2N0M0 (27), T3N0M0 (5), T2N1M0 (1), T2N2bM0 (1), T3N2bM0 (1), T4N2bM0 (1)	Not stated	Y (42)	Not stated	Timing not specified (4)	Traditional (18), Islanded (6) Islanded-arterialised (4), Islanded-tunnelised (19)	Superior (4), Inferior (43)	Total necrosis (1)	Venous congestion (2)	Nil	Data not extractable from subgroup (n=6 required z-plasty but indiscernible)

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruction (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postoperative radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complications (n)	Functional complications (n)	Re-operations (n)
Khan et al. 2013. UK[19]	5	Not stated	4:1	Cancer (5)	SCC (5)	Lymph node metastasis (3), Metastatic disease (3)	Not stated	Y (3), N (2)	II (2), II +III (1)	Not stated	Island flap n=5	Inferior (5)	0	Mild trismus (2)	Nil	Nil
Massarelli et al. 2013. Italy[20]	1	67	0:1	Cancer (1)	SCC (1)	cT2N0M0 (1)	Total soft palate resection (1)	Y (1)	I-IV (1)	Not stated	island free flap	N/A	0	Nil	Nil	Nil
Shetty et al. 2013. India[21]	2 (n=9 excluded due to age)	31 (23 - 39)	1:1	Fistula (2)	N/A	N/A	N/A	N/A	N/A	Not stated	Pedicle n=2	Superior (1), Inferior (1)	0	Partial necrosis (1)	Nil	Nil
Ferrari et al. 2015. Italy[22]	6 (n=6 excluded due to location of defect)	59.7 (38 - 79)	4:2	Cancer (2), Cleft palate (2), Fistula (2)	SCC (2)	Not stated	Not stated	Not stated	N/A	Not stated	Traditional FAMM n=6	Superior (6)	0	Partial necrosis (1) Wound dehiscence (3)	Nil	Nil
Bucknor et al. 2016. UK[23]	1	45	0:1	Fistula (1)	N/A	N/A	Not stated	N/A	N/A	Not stated	Not stated	Superior (1)	0	Nil	Nil	Nil
Ferrari et al. 2016. Italy[24]	50	62.2 (33 - 86)	33:17	Cancer (50)	SCC (50)	T1N0 (5), T2N0 (38), T3N0 (7)	Not stated	Y (50)	Unilateral supraomo-hyoid I-III (39), Bilateral Supraomohy-oid I-III (11)	Post (14)	Inferior based FAMM n=36, Buccinator island flap (Zhao flap) n=14	Inferior (36), Superior (14)	0	Wound dehiscence (12) Neck infection (2)	Nil	Nil
Lee et al. 2016. USA[25]	4 (n=10 excluded due to age)	20.5 (18 - 24)	3:1	Cleft palate (4)	N/A	N/A	N/A	N/A	N/A	Not stated	Spacer FAMM (single stage FAMM)	Not stated	0	Nil	Nil	Nil
Jeong et al. 2017. South Korea[26]	1	59	0:1	Cancer (Reconstruct-ing secondary soft palatal defect due to flap necrosis following two-flap palatoplasty) (1)	Epithelial myoepithe-lial carcinoma (1)	pT2N0M0 (1)	Simple mass excision with safety margin (1)	Y (1)	IB + II (1)	Post (1)	Tunnelised islanded FAMM flap n=1	Not stated	0	Nil	Nil	Nil

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruction (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postoperative radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complications (n)	Functional complications (n)	Re-operations (n)
Jowett et al. 2017. Germany[27]	6	60.3 (41 - 75)	3:3	Cancer (6)	SCC (5), Adenoid cystic carcinoma (1)	Pre/ post op staging: cT2cN2bM0/ pT2pN0M0 (2), cT2cN2cM0/ pT2pN2cM0 (1), cT2cN2bM0/ pT3pN1M0 (1), cT2cN0M0/ pT3pN0M0 (1), cT2cN1M0/ pT2pN2bM0 (1)	Not stated	Y (6)	Ipsilateral II-IV (1), Concomitent bilateral I-IV, with preservation of facial vessels/ipsi (4) Prior ipsilateral I-III with sacrifice of facial art + vein/ contra (intact vessels) (1)	70 Gy 1 year prior n=1. Adjuvant not stated	Single pedicle n=6	Inferior (6)	0	Ipsilateral upper lip anaesthesia (3), Muscular dysfunction causing loss of lip height (5)	Nil	Nil
Massarelli et al. 2017. Italy[28]	14 (n=3 excluded for flap type)	63.2 (50 - 75)	10:4	Cancer (14)	SCC (14)	pT2N0M0 (5), pT1N0M0 (1), pT4N2bM0 (1), pT3N0M0 (5), pT3N2bM0 (2)	Ablation (14)	Y (14)	Bilateral (14)	Post (4)	tunnelised island n=14	Not stated	0	Venous congestion (1), Wound dehiscence (1), Unable to discriminate between sharp and blunt stimuli (3), No thermal sensitivity (2)	Nil	Nil

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruc-tion (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postopera-tive radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complicatio-ns (n)	Functional complica-tions (n)	Re-operations (n)
Ibrahim et al. 2018. Canada[29]	55	66.8	38:17	Cancer (51), Non-malignant tumour (4)	Not stated (51)	Total T in situ (3), T1 (20), T2 (14), T3 (3), T4 (10). Traditional Group T in situ (2), T1 (7), T2 (11), T3 (1), T4 (5) Modified Group T in situ (25), T1 (13), T2 (3), T3 (2), T4 (5)	Not stated	Not stated	N/A	Not stated	Traditional FAMM n=29, modified FAMM n=26	Inferior (55)	0	Haematoma (2), Partial necrosis (1)	Nil	Pedicle sectioning and scar revision/ vestibulo-plasty (4), Pedicle sectioning only (4), scar revision/ vestibulo-plasty (5)
Moro et al. 2018. Italy[30]	5	67.8 (55 - 83)	3:2	Cancer (5)	SCC (5)	T2N2aM0 (1), T1N0M0 (2), T2N0M0 (1), T2N1M0 (1)	Wide tumour resection (1), Tumour resection (2), Surgical excision of lesion (1), Partial glossectomy (1)	Y (3), N (2)	I-III (3)	Post (3)	Arterialised Tunnelised FAMMIF	Inferior (5)	Total necrosis (1)	Trismus (1), Partial necrosis (2), Venous congestion (5), Transient weakness of mandibular branch of CNVII (1)	Speech problems with loss of intelligibility after 12 months (1)	Nil
Asairinachan et al. 2019. Australia[31]	13	61	9:4	Cancer (13)	SCC (13)	T1 (5), T2 (7), T4 (1)	Transoral robotic surgery resection (13)	Y (5), N (8)	Previous ipsilateral (2), Previous bilateral (2), Concomitant unilateral (1)	Previous (8)	inferiorly pedicled n=13	Inferior (13)	0	Infection (1)	Severe dysarthria (1), Moderate dysarthria (2), Severe dysphagia/ NG tube dependence (4)	Surgical haemostasis under general anaesthetic (1)

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruc-tion (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postopera-tive radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complicatio-ns (n)	Functional complica-tions (n)	Re-operations (n)
Benjamin et al. 2020. USA[32]	21	71.1 (46 - 90)	9:12	Cancer (21)	SSC (21)	All T1/T2. No mention of nodal or metastatic status	Partial glossectomy (21)	Y (21)	Selective - I-III or I-IV (21)	Not stated	Not specified	Not stated	Fistula formation (1)	Haemorrhage (1), Infection (1)	Nil	Minor revision and inset (1), Abscess drainage (1), Fistula revision with pectoralis muscle flap (1)
Joseph et al. 2020. India[13]	20	51.5	Not stated	Cancer (20)	Not stated (20)	T1 (5), T2 (15), N0 (12), N1 (3), N2a (1), N2b (4)	WLE (20)	Y (20)	Selective I-IV (20)	Post (4)	Island flap n=20	Inferior (20)	0	Venous congestion (1), Haematoma (1), Infection (3)	Nil	Re-operation, not stated (1)
Mannino et al. 2020. USA[33]	3 (n=3 excluded for location of flap)	55.7 (41 - 63)	0:3	Cancer (3)	clear cell carcinoma (1), SCC (1), Mucoepider-moid carcinoma (1)	Not stated (2), SCC T2N2b (1)	Partial maxillectomy (2), Radical tonsil-lectomy (1)	N (3)	N/A	Timing not specified (1)	Not specified	Inferior (3)	0	Trismus (1)	Nil	Z-plasty of scar at donor site (1)
Chakrabarti et al. 2021. India[34]	1 (2 flaps)	65	1:0	Cancer (1)	SCC (1)	pT2N0 (1)	Per oral resection including ventral tongue, floor of mouth, anterior marginal mandible with part of genioglossus and mylohyoid muscles (1)	Y (1)	Bilateral selective I-IV (1)	Not stated	Tunnelised islanded FAMM flap n=2	Not stated	0	Nil	Nil	Nil
Cuéllar et al. 2021. Spain[35]	22	62.4 (51 - 72)	15:7	Cancer (22)	SCC (22)	T2N0M0 (9), pT2N1M0 (7), T2N2aM0 (3), T2N2bM0 (3)	Not stated	Y (22)	Selective - I-III or I-IV (22)	Post (13)	Pedicled n=22	Inferior (22)	Partial necrosis requiring surgical debride-ment (1)	Venous congestion (2), Haematoma (1), Wound dehiscence (2)	Nil	Surgical debridement (1)

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruc-tion (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postopera-tive radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complicatio-ns (n)	Functional complica-tions (n)	Re-operations (n)
Gontarz et al. 2021. Poland[36]	5	69.8 (49 - 83)	2:3	Cancer (5)	SCC (5)	Clinical: T2N1M0 (2), T3N2cM0 (1), T3N0M0 (1), T3N1M0 (1). Pathological: T3N0 (2), T3N1 (1), T3N2b (1), T3Nx (1)	Intraoral excision with adequate margins (5), Distal part of floor of mouth excised (4)	Y (5)	Level I-IV ipsilateral and I-III contralateral (4), Previous (1)	Post (4)	double pedicled n=5	Double (5)	0	Restriction in protrusion of tongue and deviation towards operated side (5)	Nil	Nil
Myoken et al. 2021. Japan[37]	1	81	0:1	ONJ (1)	N/A	N/A	N/A	N/A	N/A	Not stated	Traditional FAMM flap	Superior (1)	0	Nil	Nil	Nil
Khismatrao et al. 2023. India[11]	8 (n=2 excluded due to location of flap)	(40 - 54)	7:1	Cancer (6), Trauma (1), Iatrogenic (1)	SCC (2), Plexiform ameloblas-toma (1), Polymorpho-us adenocarci-noma (1), Pleomorphic adenocarci-noma (1), Ameloblasto-ma (1)	cT4aN0Mx (2)	WLE (6), Subtotal maxillectomy (2)	Y (4), N(2)	Not Stated	Not Stated	single pedicle n=8	Superior (6), Inferior (2)	0	Marginal mandibular nerve and hypoglossal nerve weakness (1)	Nil	Pedicle release (4)

(*continued on next page*)

Table 1 (*continued*)

Author, year and country	Number of patients/ flaps (n)	Mean (range) age (years)	Gender ratio (M:F)	Reason for reconstruction (n)	Type of malignancy (n)	Staging (n)	Procedure for resection	Neck dissection (Y/N, n)	Level, side and timing of neck dissection (n)	Pre or postoperative radiotherapy (n)	Type of FAMM flap (n)	Type of pedicle (n)	Flap failure and reason (n)	Complications (n)	Functional complications (n)	Re-operations (n)
Lakhera et al. 2023. India[38]	15	46.5 (28 - 60)	10:5	Cancer (15)	SCC (15)	T1N0M0 (4), T2N0M0 (5), T1N1M0 (1), T2N1M0 (3), T2N2aM0 (2)	WLE (15)	Y (15)	I-IV (15)	Post (6)	Pedicle n=15	Inferior (15)	Total necrosis following venous congestion (1)	Partial flap necrosis (2), Fistula formation (3), Infection (2), Venous congestion (2), Haematoma (1)	Restricted tongue mobility (3); n=2 of these unable to protrude beyond incisors, Patient dissatisfaction with quality of speech (4); n=2 partially unintelligible speech; n=1, unintelligible speech; n=1 almost normal speech, Slight difficulty in opening mouth (5)	Re-operation, not stated (2)

Table 2 Size and Location of Defects.

Author, Year and Country	Location of Defect	Defect Size
Zhao et al. 2003. China[14]	Body of tongue n=2	4 × 4 mm n=5
	Left body of tongue n=1	4 × 3 mm n=1
	Right side of tongue n=4	Half of tongue n=9
	Left side of tongue n=8	Total body of tongue n=1
	Left side of tongue base n=1	
Ayad et al. 2008. France[15]	FOM n=53	Small to medium
	Gingiva n=2	
	Tongue n=2	
Dolderer et al. 2011. Australia[16]	Left side of soft palate n=1	2 cm
O'Leary et al. 2011. Denmark[17]	Floor of mouth n=16	Not stated
	Palate n=4	
	Retromolar trigonum n=1	
	Palatoglossal arch n=1	
Massarelli et al. 2012. Italy[18]	Hard palate n=3	4–7 cm n=62, individual sizes available on paper
	Right tongue mobile n=6	
	Post-lat maxillary alveolar edge n=1	
	Anterior mandibular alveolar ridge + FOM n=3	
	Left tongue mobile n=2	
	Lateral mandibular alveolar ridge + FOM n=2	
	Anterolateral FOM + Ventral tongue n=1	
	Anterior mandibular alveolar ridge n=1	
	Post-lat mandibular alveolar ridge n=1	
	Anterior mandibular alveolar ridge + FOM + ventral tongue n=1	
	Left FOM n=1, Anterolateral FOM n=3, Right hard palate n=3, Anterior FOM n=2	
	Uvula + left soft hemipalate n=1	
	Right retromolar trigone n=3	
	Right FOM + Ventral tongue n=1	
	Lateral maxillary alveolar ridge + right hard palate n=1	
	Anterior FOM + Ventral tongue n=1	
	Left soft hemipalate + tuber maxillae + retromolar trigone n=1	
	Lateral mandibular alveolar ridge + anterolateral FOM n=1	
	Uvual n=1	
	Soft palate + right and left tonsillar fossae n=1	
	Left hard palate n=1	
	Left anterolateral mandibular alveolar ridge + FOM n=1	
	Left tongue mobile + FOM n=1	
	Left soft hemipalate + hard palate n=1	
	Hard palate + posterolateral maxillary alveolar ridge n=1	
	2/3 hard palate + soft palate n=1	
Khan et al. 2013. UK[19]	Lateral pharyngeal wall n=3	Average flap size 3 × 5 cm
	Tongue base n=2	
Massarelli et al. 2013. Italy[20]	Uvula n=1	3.5 × 1.5 cm n=1
Shetty et al. 2013. India[21]	Anterior palatal fistula n=2	1.2 cm^2 n=1
		1.8 cm^2 n=1
Ferrari et al. 2015. Italy[22]	Anterior hard palate n=4	Not stated
	Superior alveolar crest and hard palate n=1 Palate n=1	
Bucknor et al. 2016. UK[23]	Hard palate n=1	3 mm
Ferrari et al. 2016. Italy[24]	Tongue n=26	Not stated
	FOM n=18	
	FOM and tongue n=6	
Lee et al. 2016. USA[25]	Palate n=4	2.5 cm^2 n=2
		2 cm^2 n=1
		3.75 cm^2 n=1
Jeong et al. 2017. South Korea[26]	Right posterior palate n=1	2 × 2.5 × 1 cm n=1
Jowett et al. 2017. Germany[27]	Left anterior tongue with FOM extension n=1	6.9 × 3.8 cm n=1
	Middle anterior FOM with ventral tongue extension n=1	3.5 × 2.4 cm n=1
	Right anterior FOM with ventral tongue extension n=1	5.5 × 2.2 cm n=1
	Right lateral oral tongue with lateral FOM n=1	5.8 × 5.2 cm n=1
	Left submandibular gland with extra-glandular extension + positive margins previous surgery n=1	6.9 × 3.0 cm n=1
	Right oropharynx extending to retromolar trigone, exposed inner mandibular angle post-TORS defect n=1	3.0 × 2.0 cm n=1

(*continued on next page*)

Table 2 (*continued*)

Author, Year and Country	Location of Defect	Defect Size
Massarelli et al. 2017. Italy[28]	Uvula + left soft hemipalate n=1	4 × 3 cm n=1
	Left soft hemipalate + maxillary tuberosity + retromolar trigone + left pharynx n=1	7 × 5 cm n=3
	Uvula n=1	6 × 3 cm n=1
	Right soft hemipalate + retromolar trigone n=2	5 × 3 cm n=1
	Total soft palate n=2	6 × 4 cm n=1
	Left soft hemipalate + hard palate n=1	7 × 6 cm n=1
	Right 2/3 hard palate + soft palate n=1	6 × 5 cm n=6
	Right soft hemipalate n=2	
	Right soft hemipalate + hard palate n=1	
	Left soft hemipalate n=2	
Ibrahim et al. 2018. Canada[29]	Oral cavity and oropharynx, not specified n=55	Not stated
Moro et al. 2018. Italy[30]	Left tongue n=3	2.5 × 1 cm n=1
	Right tongue n=2	Other defect sizes not specified. Flap sizes: maximum 4.5 × 3 cm, mean 3 × 2.5 cm
Asairinachan et al. 2019. Australia[31]	Base of tongue n=6	Large n=13
	Tonsil n=6	
	Posterior pharyngeal wall n=1	
Benjamin et al. 2020. USA[32]	Lateral/anterolateral tongue n=21	Small to Medium
Joseph et al. 2020. India[13]	Oral/ Tongue defects (not stated in paper)	Mean 6 × 4 cm
Mannino et al. 2020. USA[33]	Tonsil n=1	2.0 × 1 cm n=1
	Not stated in n=2 (oronasal fistula)	2.0 × 1.5 cm n=1
		1.8 × 1.5 cm n=1
Chakrabarti et al. 2021. India[34]	Floor of mouth encroaching on ventral Tongue n=1	3 × 2 n=1
		2 × 2 cm in n=1
Cuéllar et al. 2021. Spain[35]	FOM and tongue n=22	Medium sized defects
		Range 3.7 × 2.1 cm to 6.3 × 4.2 cm
Gontarz et al. 2021. Poland[36]	Tongue n=5	Moderate - type 2 according to Mannelli et al. classification[31]
Myoken et al. 2021. Japan[37]	Maxillary defect n=1	Not stated
Khismatrao et al. 2023. India[11]	Lateral tongue and FOM n=1	Size ranged from 1 × 0.8 cm to 5.8 × 3.7 cm
	Maxilla n=2	
	Lateral tongue n=1	
	Palate n=4	
Lakhera et al. 2023. India[38]	Tongue n=9	Small to medium. Maximum width < 3 cm
	FOM n=6	

Twenty-three functional complications were reported in 4 studies involving 94 patients. Most functional complications describe dissatisfaction with the quality of speech/ swallowing; however, no standardised tools were consistently used for assessment across the studies.

Overall, 9.7% (n=35) of patients from 26 studies required further surgical procedures. Details of re-operations could not be extracted from one study.[25] Pedicle sectioning (n=8, 2.2%) was the most described, followed by scar revision/ vestibuloplasty (n=5, 1.4%), and pedicle sectioning and scar revision/vestibuloplasty (n=4, 1.1%). The revision procedure type was not described in 9 patients.

Operating times

Further surgery was not consistently reported across studies and follow-up time varied. Operating time was reported in 3 studies and was found to be variable in individual reporting.[20,35,39] Massarelli et al. (2017) reported individual flap harvesting time, which ranged from 40 to 75 min with a mean time of 48.9 min[35] Benjamin et al. (2020) described a decrease in procedural time with experience in flap use from 181 min to 59 min by the end of the study.[39] Joseph et al. (2020) described a 56.5-minute average, compared to the 150.5-minute average for the fasciocutaneous free flap.[20]

Quality assessment and publication bias

Among the studies included in this review, 1 was of fair quality, 7 were of good quality and 18 were of poor quality according to the AHRQ rating (Table 3).[47] All studies (n = 26) had evidence of comparability bias, with (n=0) having selection bias and (n = 8) studies having evidence of outcome bias (Insert table number). Funnel plot analysis was conducted on the pooled survival and complication rates. Egger's regression test was used to assess potential publication bias in the included studies. For flap survival, the test yielded an intercept of −0.245 (95% CI: −0.49 - 0, p = 0.0616), suggesting unlikely publication bias (p > 0.05; Figure 2). For complication rates, the test yielded an intercept of 2.333 (95% CI: 0.49 - 4.18), p = 0.0204 (Figure 3), indicating publication bias. This bias could lead to an overestimation of the effect size for complications owing to the selective reporting of studies with more favourable results.

Meta-analysis

The random-effects model was used, given the heterogeneity and inability to assume equal effects of each study. Overall, the pooled success rate for using FAMM flaps in oral cavity and tongue reconstruction was 99.47% (95% CI, 98.26

Table 3 Newcastle-Ottawa scores and Agency for Healthcare Research and Quality (AHRQ) rating of included studies.

Author, Year and Country	Selection Score	Comparability Score	Outcome Score	AHRQ Rating
Zhao et al. 2003. China[14]	2	0	0	Poor
Ayad et al. 2008. France[15]	3	0	1	Poor
Dolderer et al. 2011. Australia[16]	2	0	2	Poor
O'Leary et al. 2011. Denmark[17]	3	0	1	Poor
Massarelli et al. 2012. Italy[18]	4	1	2	Good
Khan et al. 2013. UK[19]	3	0	1	Poor
Massarelli et al. 2013. Italy[20]	2	0	2	Poor
Shetty et al. 2013. India[21]	3	1	2	Good
Ferrari et al. 2015. Italy[22]	2	0	2	Poor
Bucknor et al. 2016. UK[23]	2	0	2	Poor
Ferrari et al. 2016. Italy[24]	3	1	2	Good
Lee et al. 2016. USA[25]	2	0	2	Poor
Jeong et al. 2017. South Korea[26]	2	0	2	Poor
Jowett et al. 2017. Germany[27]	2	1	2	Fair
Massarelli et al. 2017. Italy[28]	3	1	2	Good
Ibrahim et al. 2018. Canada[29]	3	1	2	Good
Moro et al. 2018. Italy[30]	2	0	0	Poor
Asairinachan et al. 2019. Australia[31]	3	0	2	Poor
Benjamin et al. 2020. USA[32]	3	0	0	Poor
Joseph et al. 2020. India[13]	4	1	2	Good
Mannino et al. 2020. USA[33]	3	0	2	Poor
Chakrabarti et al. 2021. India[34]	2	0	2	Poor
Cuéllar et al. 2021. Spain[35]	3	1	1	Poor
Gontarz et al. 2021. Poland[36]	3	1	0	Poor
Myoken et al. 2021. Japan[37]	2	0	2	Poor
Khismatrao et al. 2023. India[11]	3	1	2	Good
Lakhera et al. 2023. India[38]	3	1	2	Good

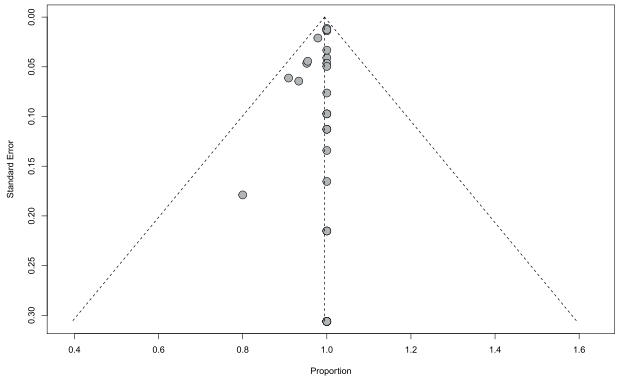


Figure 2 Funnel plot of success rates in oral cavity and tongue reconstruction using FAMM flaps.

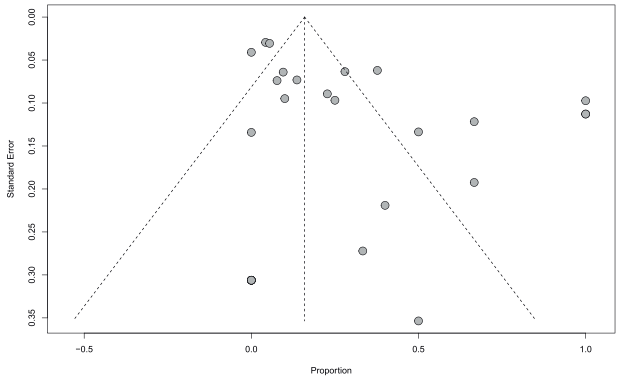


Figure 3 Funnel plot of complication rates in oral cavity and tongue reconstruction using FAMM flaps.

to 100.00, P = 1.00; I2 = 0%; Figure 4). The total complication rate for the use of FAMM flaps in oral cavity and tongue reconstruction was 30.18% (95% CI, 16.97 to 43.38, P < 0.01; I2 = 91%; Figure 5).

Discussion

Our analysis revealed promising efficacy of the FAMM flap in the reconstruction of the oral cavity and tongue. Total success rates were high (98.28%) and total non-functional complications were relatively low (26.0%), highlighting the robustness of this surgical technique in the reconstruction of the oral cavity and tongue. The FAMM flap has demonstrated similar survival rates compared to the most used flaps for oral cavity and tongue reconstruction, such as ALT (96.4%[48]- 98.6%[49]), pectoralis major flap (94%[50] - 98.6%[51]) and RFFF (96.0%[48] - 97.4%[52]).

Advantages of the FAMM flap

There are several advantages to using the FAMM flaps in oral cavity and tongue reconstruction. Primarily, these flaps are mucosal, allowing for tissue to be replaced like-for-like without hair. Additionally, the flaps are thin with a large axis of rotation, making the flap valuable for reconstructing defects across the entire oral cavity and tongue. The flap can also be based superiorly or inferiorly, giving the flap additional function in reconstructing the maxillary and mandibular regions. The FAMM flap has been modified in previous studies to increase its length and width and to reduce the need for pedicle sectioning in dentate patients. High survival and low complication rates also make the flap a more reliable choice. The flap is also easily harvested and less time-consuming when compared to free flap reconstructions which are becoming increasingly common. However, a case report described a free microvascular FAMM

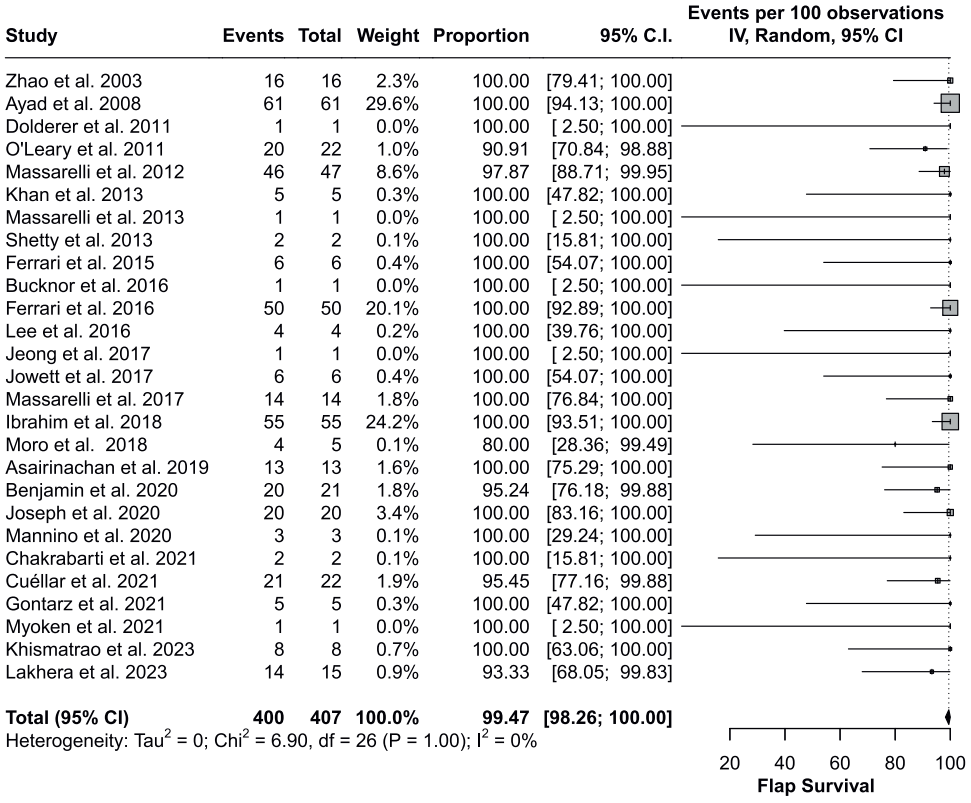


Figure 4 Forest plot of pooled meta-analysis of success rates in oral cavity and tongue reconstruction using FAMM flaps.

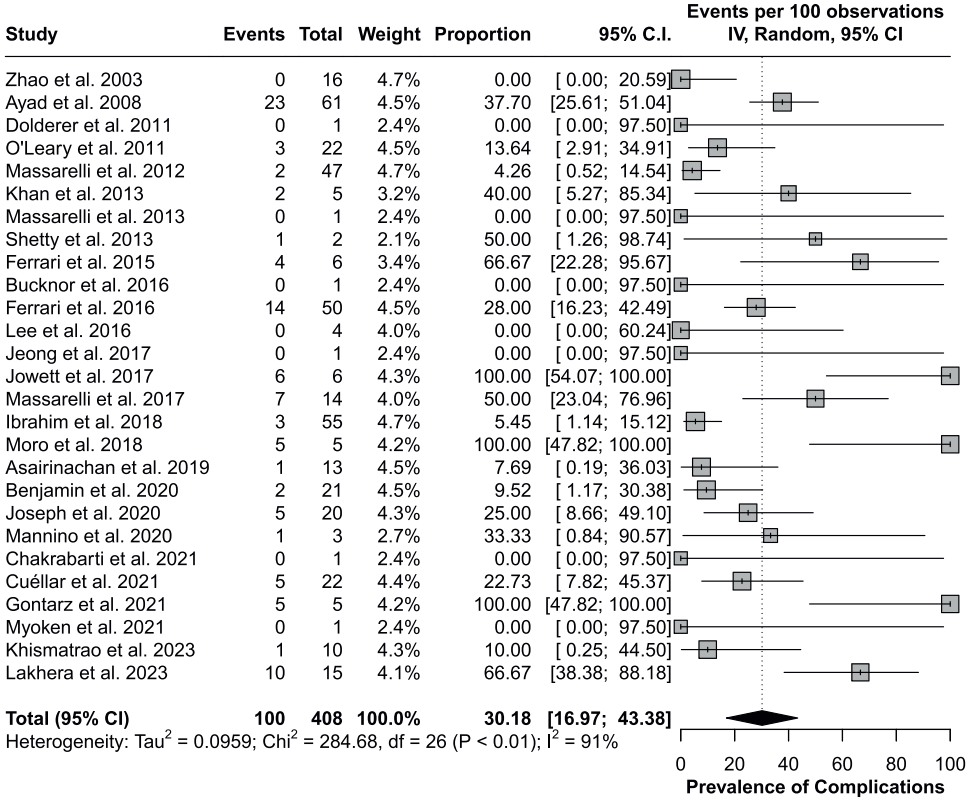


Figure 5 Forest plot of pooled meta-analysis of complication rates in oral cavity and tongue reconstruction using FAMM flaps.

flap used to reconstruct the cheek mucosa, which may improve aesthetic outcomes.[53]

Despite the FAMM flap demonstrating pooled complication rates of 30.8% in cases within this review, this rate is comparable to that of alternative flaps such as the RFFF, ALT, and pectoralis major flaps used for tongue and oral cavity reconstruction. The pectoralis major flaps have reported total complication rates between 21.4%[51] and 51.7%,[54] RFFF complications varying between 18.1%[52] and 24.0%[48] and ALT complications ranging from 13.0%[55] to 44.7%[48] in the literature.

Disadvantages of the FAMM flap

Historically, FAMM flaps were limited by their width and need for a two-stage procedure involving pedicle sectioning in dentate patients. With increased use, the development of techniques to reroute Stensen's duct allowed for increased width,[24] and to create a one-stage procedure, the FAMM flap was tunnelised.[27]

Operating time

The reporting of operating time varied across the studies given the varying definitions, reasons for procedures, additional flaps used in conjunction and experience of the operating surgeon. In one study, the mean flap harvesting time was 49 min, and the procedure length was 56 min in one study and 59 min in another study after increased experience with the procedure. Flap raising and inset times in the literature were reported to be between 20 and 60 min for the islanded variation of the FAMM flap.[56,57] It was demonstrated that harvesting the pectoralis major myocutaneous flap required 60 to 110 min[58] with a mean operative time of 76 min[59] A comparative study between FAMM flaps and RFFF demonstrated shorter operating times for FAMM flaps (7.2 h and 8.9 h, respectively).[60] The operating time likely included the time required for neck dissection and ablation as well. However, flap harvesting time is likely to be longer than that for the FAMM flap owing to the free microvascular nature of the flaps.

Limitations

Since its original use, the nomenclature of FAMM flaps has varied owing to its numerous modifications and similarities with other local flaps, resulting in confusion in the communication of surgical techniques. Literature reviews have been undertaken to standardise the language used[61]; however, a disparity still exists.

Studies included in the analysis varied in the reporting of patient characteristics and outcomes with varying follow-up times. Therefore, complete data are not available and actual outcomes may not be consistent with those reported in the literature. The reporting was particularly inconsistent regarding patient tumour staging, defect size, functional complications, actual complications, location of flap and flap size. Hence, it is not possible to draw conclusions based on specific defect sizes/types.

Few studies have compared the FAMM flap to other flaps that are commonly used to reconstruct the tongue and oral cavity.[20,60] Therefore, studies comparing these flaps to the FAMM flap in a controlled setting with consistent reporting of characteristics and outcomes will provide valuable information on the efficacy of FAMM flap.

The results of the pooled complication rates should be interpreted with caution due to the high level of heterogeneity observed ($I^2 = 91\%$, $p < 0.01$). The high heterogeneity suggests considerable variability across the included studies, which may be due to differences in study design, population characteristics, outcome measures or other methodological factors. Although random-effects models were used to account for this variability, the observed heterogeneity may limit the generalisability of the pooled estimates.

Two studies had small sample sizes (n=6 and n=5) and experienced greater numbers of complications than the study size (n=8 and n=9).[34,37] Continuity corrections were applied for the feasibility of meta-analysis within this study where the study complications were considered to estimate the sample size, which suggests smaller pooled complication rates from its true estimate.

Conclusion

The FAMM flap appears to be safe and versatile for the reconstruction of the oral cavity and tongue. It boasts numerous advantages such as 'replacing like-for-like' and reduced operating times compared to the commonly used microvascular free flaps, with comparable survival and complication rates. With its modifications for a larger defect cover and multiple pedicles to anchor from, the FAMM flap can be considered as an effective alternative to the conventionally used flaps in oral cavity and tongue reconstruction.

Ethical approval

Not required.

Funding

No financial support or funding of any kind was received to conduct, author, or publish this article.

Conflict of interest statement

The authors have no conflicts of interest or disclosures related to this article.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.bjps.2024.12.009.

References

1. Ferlay J, Lam F, Laversanne M, et al. Global cancer observatory: Cancer Today. ⟨https://gco.iarc.who.int/today⟩. Published 2024. Accessed September 4, 2024.
2. State of Mouth Cancer UK Report 2022: A report by the Oral Health Foundation. ⟨https://www.dentalhealth.org/Handlers/Download.ashx?IDMF=3d5ff14b-e667-4905-88a4-a3d0cebf05ad⟩. Published 2022. Accessed September 12, 2024.
3. Mauceri R, Bazzano M, Coppini M, Tozzo P, Panzarella V, Campisi G. Diagnostic delay of oral squamous cell carcinoma and the fear of diagnosis: a scoping review. *Front Psychol* 2022;**13**:1009080.
4. Mohamad I, Glaun MDE, Prabhash K, et al. Current treatment strategies and risk stratification for oral carcinoma. *Am Soc Clin Oncol Educ Book* 2023;**43**:e389810.
5. Hayler R, Sudirman SR, Clark J, et al. Oral cavity reconstruction over a 30-year period at a dedicated tertiary head and neck cancer centre. *Indian J Surg* 2023;**85**(1):33–8.
6. Teli ZA, Kantharia RA, Kantharia SR, Vyas SM, Bhatt Y, Doshi P. Oral cavity reconstruction with pedicled and free flaps: a single institutional experience. *Oncol J India* 2021;**5**(2):60–6.
7. Padha K, Dhawan A, Duggal P, Kakkar V, Bhullar R, Kaur T. PMMC flaps for reconstruction of oral defects in the age of microvascular flaps: a developing nation perspective. *J Oral Biol Craniofac Res* 2022;**12**(6):743–7.
8. Akhtar MS, Khurram MF, Khan AH. Versatility of pedicled tensor fascia lata flap: a useful and reliable technique for reconstruction of different anatomical districts. *Plast Surg Int* 2014;**2014**:846082.
9. Young AMH, Bache S, Segaren N, Murphy S, Maraka J, Durrani AJ. Free flap selection and outcomes of soft tissue reconstruction following resection of intra-oral malignancy. *Front Surg* 2019;**6**:53.
10. Jaquet Y, Enepekides DJ, Torgerson C, Higgins KM. Radial forearm free flap donor site morbidity: ulnar-based transposition flap vs split-thickness skin graft. *Arch Otolaryngol Head Neck Surg* 2012;**138**(1):38–43.
11. Hanasono MM, Skoracki RJ, Yu P. A prospective study of donor-site morbidity after anterolateral thigh fasciocutaneous and myocutaneous free flap harvest in 220 patients. *Plast Reconstr Surg* 2010;**125**(1):209–14.
12. Townley WA, Royston EC, Karmiris N, Crick A, Dunn RL. Critical assessment of the anterolateral thigh flap donor site. *J Plast Reconstr Aesthet Surg* 2011;**64**(12):1621–6.
13. Purnell CA, Lewis KC, Mioton LM, et al. Donor-site morbidity of medial and lateral thigh-based flaps: a comparative study. *Plast Reconstr Surg Glob Open* 2016;**4**(11):e1012.
14. Collins J, Ayeni O, Thoma A. A systematic review of anterolateral thigh flap donor site morbidity. *Can J Plast Surg* 2012;**20**(1):17–23.
15. Avery CM. Review of the radial free flap: is it still evolving, or is it facing extinction? Part one: soft-tissue radial flap. *Br J Oral Maxillofac Surg* 2010;**48**(4):245–52.
16. Sittitrai P, Ruenmarkkaew D, Klibngern H. Pedicled flaps versus free flaps for oral cavity cancer reconstruction: a comparison of complications, hospital costs, and functional outcomes. *Int Arch Otorhinolaryngol* 2023;**27**(1):e32–42.
17. Ayad T. Facial artery musculomucosal (FAMM) flap. *Oper Tech Otolayngol Head Neck Surg* 2019;**30**(2):112–9.
18. Khismatrao VN, Popat SP, Sharma P, Gupta A. Versatility of facial artery musculomucosal (FAMM) flap for reconstruction of oral cavity defects. *J Maxillofac Oral Surg* 2023;**22**(1):44–50.
19. Fatani B, Alhilal AI, Alzahrani HH, Alkhattabi RR, Alhindi M. Facial reconstruction using facial artery myomucosal flap: a comprehensive review. *Cureus* 2023;**15**(7):e42060.
20. Joseph ST, B.S N, Mohan MT, Tharayil J. Comparison of islanded facial artery myomucosal flap with fasciocutaneous free flaps in the reconstruction of lateral oral tongue defects. *Int J Oral Maxillofac Surg* 2020;**49**(8):1000–6.
21. Zhao Z, Zhang Z, Li Y, et al. The buccinator musculomucosal island flap for partial tongue reconstruction. *J Am Coll Surg* 2003;**196**(5):753–60.
22. Ayad T, Kolb F, De Monés E, Mamelle G, Temam S. Reconstruction of floor of mouth defects by the facial artery musculo-mucosal flap following cancer ablation. *Head Neck* 2008;**30**(4):437–45.
23. Dolderer JH, Hussey AJ, Morrison WA. Extension of the facial artery musculomucosal flap to reconstruct a defect of the soft palate. *J Plast Surg Hand Surg* 2011;**45**(4-5):208–11.
24. O'Leary P, Bundgaard T. Good results in patients with defects after intraoral tumour excision using facial artery musculomucosal flap. *Dan Med Bull* 2011;**58**(5):A4264.
25. Massarelli O, Baj A, Gobbi R, et al. Cheek mucosa: a versatile donor site of myomucosal flaps. Technical and functional considerations. *Head Neck* 2013;**35**(1):109–17.
26. Khan K, Hinckley V, Cassell O, Silva P, Winter S, Potter M. A novel use of the facial artery based buccinator musculo-mucosal island flap for reconstruction of the oropharynx. *J Plast Reconstr Aesthet Surg* 2013;**66**(10):1365–8.
27. Massarelli O, Gobbi R, Soma D, Tullio A. The folded tunnelized-facial artery myomucosal island flap: a new technique for total soft palate reconstruction. *J Oral Maxillofac Surg* 2013;**71**(1):192–8.
28. Shetty R, Lamba S, Gupta AK. Role of facial artery musculomucosal flap in large and recurrent palatal fistulae. *Cleft Palate Craniofac J* 2013;**50**(6):730–3.
29. Ferrari S, Ferri A, Bianchi B, Contadini E, Leporati M, Sesenna E. Head and neck reconstruction using the superiorly based reversed-flow facial artery myomucosal flap. *J Oral Maxillofac Surg* 2015;**73**(5):1008–15.
30. Bucknor A, Sawyer A, Atherton D. The facial artery musculomucosal flap in the reconstruction of the cocaine-induced hard palate fistula. *Eur J Plast Surg* 2016;**39**(6):463–6.
31. Ferrari S, Ferri A, Bianchi B, Varazzani A, Giovacchini F, Sesenna E. Oncologic safety of facial artery myomucosal flaps in oral cavity reconstruction. *Head Neck* 2016;**38**(S1):E1200–2.
32. Lee JY, Alizadeh K. Spacer facial artery musculomucosal flap: simultaneous closure of oronasal fistulas and palatal lengthening. *Plast Reconstr Surg* 2016;**137**(1):240–3.
33. Jeong H-I, Cho H-M, Park J, Cha YH, Kim HJ, Nam W. Flap necrosis after palatoplasty in irradiated patient and its reconstruction with tunnelized-facial artery myomucosal island flap. *Maxillofac Plast Reconstr Surg* 2017;**39**(1):24.
34. Jowett N, Hadlock TA, Sela E, Toth M, Knecht R, Lörincz BB. Facial mimetic, cosmetic, and functional standardized assessment of the facial artery musculomucosal (FAMM) flap. *Auris Nasus Larynx* 2017;**44**(2):220–6.
35. Massarelli O, Vaira LA, Gobbi R, Biglio A, Dell'aversana Orabona G, De Riu G. Soft palate functional reconstruction with buccinator myomucosal island flaps. *Int J Oral Maxillofac Surg* 2017;**47**(3):316–23.
36. Ibrahim B, Rahal A, Bissada E, et al. Decreasing revision surgery in FAMM flap reconstruction of the oral cavity: traditional versus modified harvesting technique. *Laryngoscope* 2018;**128**(8):1802–5.
37. Moro A, Saponaro G, Doneddu P, et al. The arterialized facial artery musculo-mucosal island flap for post-oncological tongue reconstruction. *J Craniofac Surg* 2018;**29**(8):2021–5.
38. Asairinachan A, O'Duffy F, Li MP, et al. Facial artery musculomucosal flaps in oropharyngeal reconstruction following salvage transoral robotic surgery: a review of outcomes. *J Laryngol Otol* 2019;**133**(10):884–8.
39. Benjamin M, Aliano K, Davenport T, Frank D. Functional outcomes regarding facial artery musculomucosal flap for reconstruction of partial glossectomy defects. *Ann Plast Surg* 2020;**85**(S1):S76–9.

40. Mannino EA, Rubinstein BJ, Dobratz EJ. Facial artery musculomucosal flap for nasopharyngeal and oropharyngeal reconstruction. *Fac Plast Surg Aesthet Med* 2020;**22**(6):449–55.
41. Chakrabarti S, Ghosh A, Bhukkar S, Mishra A. Bilateral tunnelized FAMM islanded flap for reconstruction of composite defect of tongue and floor of mouth: a case report. *J Maxillofac Oral Surg* 2024;**23**(1):49–52.
42. Cuéllar CN, Tousidonis Rial M, Antúnez-Conde R, et al. Functional outcomes with facial artery musculo-mucosal (FAMM) flap and dental implants for reconstruction of floor of the mouth and tongue defects in oncologic patients. *J Clin Med* 2021;**10**(16):3625.
43. Gontarz M, Bargiel J, Gąsiorowski K, et al. Extended, double-pedicled facial artery musculomucosal (dpFAMM) flap in tongue reconstruction in edentulous patients: preliminary report and flap design. *Medicina* 2021;**57**(8):758.
44. Myoken Y, Kawamoto T, Fujita Y, Toratani S. Use of the superiorly-based facial artery musculomucosal flap for defect reconstruction in stage 3 medication-related osteonecrosis of the maxilla: technical note. *J Dent Sci* 2021;**16**(4):1305–7.
45. Lakhera KK, Singhal PM, Patel P, et al. Reconstructing small-medium sized oral cavity defects- our experience with the versatile FAMM flap. *Indian J Otolaryngol Head Neck Surg* 2023;**75**(4):3432–8.
46. Ouyang S-b, Wu Z-h, Zhang Y-p, Lu X-l. Comprehensive analysis of risk factors for flap necrosis in free flap reconstruction of postoperative tissue defects in oral and maxillofacial tumors. *Sci Rep* 2024;**14**(1):18676.
47. Hartling L, Hamm M, Milne A, et al. Validity and inter-rater reliability testing of quality assessment instruments: Appendix E, Decision rules for application of the Newcastle-Ottawa scale. Agency for Healthcare Research and Quality (US). ⟨https://www.ncbi.nlm.nih.gov/books/NBK92291/⟩. Published 2012. Accessed September 3, 2024.
48. Lin CH, Chiu YH, Perng CK, Liao WC, Ma H. Experience with the use of free fasciocutaneous flap in through-and-through cheek-buccal defect reconstruction: surgical outcome and quality of life analysis. *Ann Plast Surg* 2016;**76**(1):S74–9.
49. Bussu F, Salgarello M, Adesi LB, et al. Oral cavity defect reconstruction using anterolateral thigh free flaps. *B-ENT* 2011;**7**(1):19–25.
50. Ord RA. The pectoralis major myocutaneous flap in oral and maxillofacial reconstruction: a retrospective analysis of 50 cases. *J Oral Maxillofac Surg* 1996;**54**(11):1292–5. discussion 1295-1296.
51. Jena A, Patnayak R, Sharan R, Reddy SK, Manilal B, Rao LM. Outcomes of pectoralis major myocutaneous flap in female patients for oral cavity defect reconstruction. *J Oral Maxillofac Surg* 2014;**72**(1):222–31.
52. Kesting MR, Hölzle F, Wales C, et al. Microsurgical reconstruction of the oral cavity with free flaps from the anterolateral thigh and the radial forearm: a comparison of perioperative data from 161 cases. *Ann Surg Oncol* 2011;**18**(7):1988–94.
53. Massarelli O, Gobbi R, Biglio A, Tullio A. Facial artery myomucosal free flap for cheek mucosa reconstruction: a case report. *Microsurgery* 2013;**33**(5):401–5.
54. Sen S, Gajagowni JG, Pandey JK, et al. Effectiveness of pectoralis major myocutaneous flap in the surgical management of oral cancer: a retrospective study. *J Stomatol Oral Maxillofac Surg* 2019;**120**(1):21–7.
55. Kamizono K, Kadota H, Yoshida S. Superthin anterolateral thigh flap for head and neck reconstruction. *J Craniofac Surg* 2025;**36**(1):167–71.
56. Ahn D, Lee GJ, Sohn JH. Reconstruction of oral cavity defect using versatile buccinator myomucosal flaps in the treatment of cT2-3, N0 oral cavity squamous cell carcinoma: feasibility, morbidity, and functional/oncological outcomes. *Oral Oncol* 2017;**75**:95–9.
57. Copelli C, Tewfik K, Cassano L, et al. Functional outcomes in tongue reconstruction with myomucosal buccinator flaps. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2022;**133**(6):e163–9.
58. Wei W, Qiu Y, Fang Q, Jia Y. Pectoralis major myocutaneous flap in salvage reconstruction following free flap failure in head and neck cancer surgery. *J Int Med Res* 2019;**47**(1):76–83.
59. Koh KS, Eom JS, Kirk I, Kim SY, Nam S. Pectoralis major musculocutaneous flap in oropharyngeal reconstruction: revisited. *Plast Reconstr Surg* 2006;**118**(5):1145–9.
60. Ibrahim B, Rahal A, Bissada E, Christopoulos A, Guertin L, Ayad T. Reconstruction of medium-size defects of the oral cavity: radial forearm free flap vs facial artery musculo-mucosal flap. *J Otolaryngol Head Neck Surg* 2021;**50**(1):67.
61. Massarelli O, Vaira LA, Biglio A, Gobbi R, Piombino P, De Riu G. Rational and simplified nomenclature for buccinator myomucosal flaps. *Oral Maxillofac Surg* 2017;**21**(4):453–9.