

Assessment of the Pectoralis Major Myocutaneous Flap in Closure of Orofacial Defects After Excision of Oral Cancer

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ABSTRACT

Background: Oral cancer is one of the main causes of orofacial defects that need reconstruction after resection to restore cosmetic appearance and function, especially after glossectomy and cancer cheek resection.

Patients and methods: The study was done on 17 cases with oral squamous cell carcinoma (OSCC) who were evaluated for choice of the reconstruction method with pectoralis major myocutaneous flap (PMMF) according to tumor size (T). They were admitted to the General Surgery Department (Maxillofacial Unit), Assiut University Hospital, Egypt from March 2016.

Results: We observed that 58.8 % of the cases which reconstructed with PMMF were females and 41.2% of the cases were males. Most cases were from age group ≥ 50 years (82.4%) while 17.6% of cases were from the age group < 50 years. As regards smoking, 29.4% of the reconstructed cases were smokers and 70.6% of the cases were non-smokers.

Conclusion: Our study findings showed the safety, dependability, and adaptability of the pectoralis major myocutaneous pedicle flap as a reconstructive technique, with a manageable incidence of postoperative problems and related morbidity.

Keywords: Orofacial defects – PMMF – Smoking - Oral cancer.

INTRODUCTION

Oral cancer is one of the main causes of orofacial defects that need reconstruction after resection to restore cosmetic appearance and function, especially after glossectomy and cancer cheek resection⁽¹⁾. The location of the defect, the type of tissue needed, the functional and cosmetic effects of the defect, any accompanying comorbidities, and the availability of resources all have a role in the reconstruction method that is chosen. Pectoralis major (PM) flap is described by Ariyan (1979) as a substitute for microvascular repair in the context of head and neck reconstruction⁽²⁾.

The primary outcome of the current study is to assess the surgical outcomes of PMMF in reconstruction of orofacial defects after oral cancer resection (cosmetic and functional outcome) and to study the possible complications that result from its uses e.g. infection, tissue loss and fistula.

PATIENTS AND METHODS

The study was done on 17 cases with oral squamous cell carcinoma who were evaluated for choice of the reconstruction method with PMMF according to tumor size (T). They were admitted to the General Surgery Department (Maxillofacial Unit) at Assiut University Hospital, Egypt.

Inclusion criteria:

Patients that were not candidate for free flaps reconstructions, due to medical problem that cannot tolerate the long-time of the operation, patients that refuse free flaps or after failure of free flap.

Clinical information of cases were obtained from the medical charts. The following information were

collected: patient's age, sex, site of the tumor, TNM staging, and morphological differentiation of the tumor.

After preoperative assessment, patients who were medically fit for surgical resection and reconstruction had prepared well for the operation by raising the albumin level, hemoglobin level and good nutrition by Ryle feeding or even gastrostomy if needed. Under general anaesthesia, nasal intubation, supine positioning, block neck dissection, and removal of the main tumour with safety margin. The costal border and the midline of the chest were exposed. To reveal the lateral chest wall and anterior axillary fold, the upper arm is gently abducted. The surface marks of the vascular pedicle can be determined by drawing a line from the shoulder to the xiphisternum and another line vertically from the midline of the clavicle to intersect the first line. Along the pectoral branch of the thoracoacromial artery, the skin paddle is positioned across the pectoralis major muscle. The flap's outline is drawn onto the skin to make sure the pedicle is the right length. To mould the flap to the shape of the defect, the distal dark portion of the flap will be removed.

The location, size, and form of the surgical defect dictate the size and shape of the skin island of the myocutaneous flap as well as the length of its pedicle. The midclavicular region serves as the flap's pivot point. Measure the distance from this point up to the farthest part of the surgical defect using tape or thread. This measurement reveals the distance between the mid-clavicular point and the distal tip of the flap.

If more pedicle length is required, the flap may be extended inferiorly up to 2.5 cm beyond the pectoralis major muscle, but do so with the understanding that the flap will then have a random pattern and a weaker blood

supply. The skin paddle's surrounding the region is excised, and the surface of the pectoralis major muscle is then dissected. Because the vascular pedicle lies deep inside the muscle, monopolar diathermy should be used whenever possible to complete this surgery quickly and safely. The dissection must be bevelled radially rather than undercutting the skin paddle in order to include as many of the myocutaneous perforators that supply the skin paddle as possible. To reduce the possibility of shearing damage to the myocutaneous perforators, the skin paddle is stitched to the pectoralis major muscle beneath it.

In order to separate the pectoralis major muscle from the ribs and intercostal muscles, a cautery incision is made inferiorly and medially to the skin paddle. Because doing so would split the vascular pedicle, the muscle is not separated above the paddle of the skin. The sternum and pectoralis major muscle are then divided using cautery. Internal mammary artery perforators are transected and cauterised during this dissection. Electrocuting the lateral border of the pectoralis major muscle reveals the dissection plane between the vascular pedicle and the pectoralis minor and major muscles.

By stripping with a finger towards the direction of the clavicle, it is simpler to locate this intermuscular plane and separate the pectoralis major and its vascular pedicle from the pectoralis minor. The vascular pedicle, a branch of the thoracoacromial artery located inside the fascia on the deep surface of the pectoralis major muscle, is clearly visible in this image. The flap is frequently introduced into the neck superficial to the clavicle by a sizable subcutaneous tube. The tunnel must be large enough to allow for the passage of the flap into the neck without severing the musculocutaneous perforators that supply the skin paddle or strangling the vascular pedicle. A helpful adjunct to create more room is to divide the skin's subdermal connective tissue fibres above the skin tunnel using an inverted scalpel. Check to see that the pedicle is not twisted after inserting the flap into the neck.

For closure of the mucosal defect after resection of oral cancer, the skin island of the flap covered the mucosal defect. Excess skin from the distal aspect of the skin island is trimmed off as necessary. Interrupted 2-0 Vicryl sutures mark the beginning of the anastomotic

suture line connecting the cheek mucosa defect and the skin island of the flap. The common carotid artery is covered and shielded by the muscular paddle. The mucosal lining of the cheek oral defect has been completely restored thanks to the pectoralis major myocutaneous flap, and the carotid artery was shielded by the muscle paddle. Either a split skin graft is used to close the donor site predominantly or a closed suction drain. By weakening the surrounding skin, primary closure can be made easier.

Postoperative care and follow up for complications as flap necrosis, wound infection and dehiscence, seroma, haematoma, oro-cutaneous fistula or donor site morbidity.

Ethical Approval: The study was approved by The Ethics Board of Assiut University and an informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data analysis was accomplished using the Statistical Package for Social Sciences software program (SPSS), Version 21, USA. P-values equal or lower than 0.05 were considered acceptable for statistical significance. While qualitative data were represented by number and percentage, quantitative data were represented by mean and standard deviation. The study outcomes were analyzed using Chi-square test, Fisher Exact test, and Independent samples t-test.

RESULTS

Distribution of PMMF according to personal data:

As shown in table (1), we observed that 58.8 % of the cases, which reconstructed with PMMF were females and 41.2% of the cases were males. Most cases were from age group ≥ 50 years (82.4%) while 17.6% of cases were from the age group < 50 years.

As regard smoking, 29.4% of the reconstructed cases were smokers and 70.6% of the cases were non-smokers.



Figure (1): Elevation of pectoralis major myocutaneous flap

Table (1): Distribution of PMMF according to personal data

	PMMF	
	No.	%
Gender:		
Male	7	41.2
Female	10	58.8
Age: (years)		
< 50	3	17.6
≥ 50	14	82.4
Smoking:		
Smoker	5	29.4
Non-smoker	12	70.6

Of the 17 cases of OSCC, which were reconstructed with PMMF, there were 11 cases of tongue carcinoma (64.7%), 3 cases of cheek carcinoma (17.6%), only one case of carcinoma of the floor of the mouth (5.9%) and 2 cases of retromolar area (11.8%) as shown in table (2) and figure (2).

Table (2): Distribution of PMMF according to the site of lesions

	Tongue		Cheek		The floor of the mouth		Retromolar area	
	No.	%	No.	%	No.	%	No.	%
PMMF	11	64.7	3	17.6	1	5.9	2	11.8

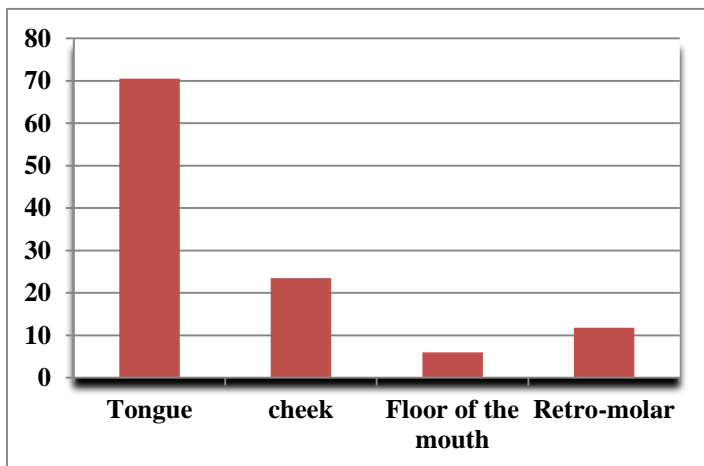


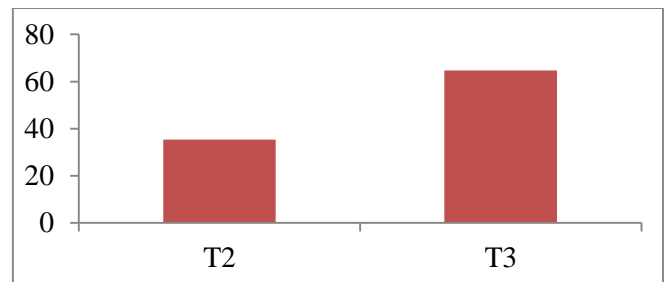
Figure (2) Distribution of PMMF according to the site of lesions

Most cases of OSCC needed for reconstruction were advanced cases, as 64.7% of the cases were T3, while the remaining 35.3 % of the cases were T2 as shown in table (3).

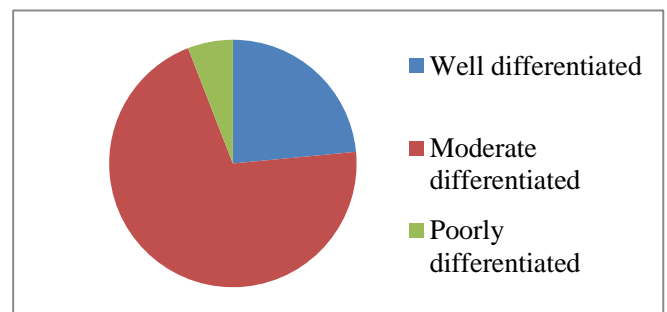
As regards grading of OSCC, we found 70.6% of the reconstructed cases were moderately differentiated carcinoma, 23.5% of the cases were well-differentiated carcinoma and 5.9% of the cases were poorly differentiated carcinoma (Figures 3 & 4).

Table (3): Distribution of PMMF according to pathological factors

	PMMF	
	No.	%
The TNM staging of SCC:		
T1	0	0.0
T2	6	35.3
T3	11	64.7
Grading of SCC:		
Well-differentiated	4	23.5
Moderate differentiated	12	70.6
Poorly differentiated	1	5.9



(Fig. 3) Distribution of PMMF according to the staging of OSCC.



(Fig. 4) Distribution of PMMF according to the grading of OSCC.

Of the 17 cases of OSCC which reconstructed with PMMF, we observed 7 cases of postoperative flap complications (41.2%) while 58.8 % of the cases were free from flap complications as shown in table (4).

Table (4): Frequency of pectoralis major myocutaneous flap (PMMF) complications

	Complications		No complications	
	No.	%	No.	%
Pectoralis major myocutaneous flap (PMMF) N= 17	7	41.2	10	58.8

Of these 7 postoperative PMMF complications, two cases of wound infection, two cases of hematoma and only one case of orocutaneous fistula as shown in table (5). Most of these flap complications were treated conservatively (5 cases), one case were needed for necrosis debridement with reclosure and only one case complicated with orocutaneous fistula, which was treated with simple closure of the fistula with

satisfactory cosmetic and functional results as shown in table (6).

Table (5) Postoperative PMMF complications

	No. (17)
PMMF complications:	
Total flap necrosis	0
Partial flap necrosis	1
Orocutaneous fistula	1
Hematoma	2
Wound dehiscence	0
Wound infection	2
Seroma	1
Donor site morbidity	0

Table (6) Management of postoperative PMMF complications

	No. (17)
Treatment of PMMF complications:	
Conservative treatment	5
Necrosis debridement	1
Fistula closure	1
New flap	0

During the study, we observed the mean of Hemoglobin level in non-complicated cases of PMMF were 4.12 ± 0.44 while in complicated cases were 11.83 ± 1.79 with no statically significant difference between the two groups (p-value = 0.14). As regard albumin level, we observed the mean of Albumin level in non-complicated cases of PMMF were 4.12 ± 0.44 while in complicated cases were 4.39 ± 0.61 with no statically significant difference between the two groups (p-value=0.18). Also, we assessed the postoperative duration of hospital stay and we observed the mean of the postoperative duration of hospital stay in non-complicated cases of PMMF were 10 ± 5 days while in complicated cases were 15 ± 6 with no statically significant difference between the two groups (p-value = 0.53) as shown in table (7).

Table (7) Distribution of PMMF complications according to laboratory data and post-operative duration of hospital stay

Parameters	Mean \pm SD		P-value
	No Complications (n=7)	Complications (n=10)	
Haemoglobin	10.86 ± 1.63	11.83 ± 1.79	0.14
Albumin	4.12 ± 0.44	4.39 ± 0.61	0.18
post-operative duration of hospital stay	10 ± 5	15 ± 6	0.53

In the study of pathological factors, which may affect the outcome of PMMF, we observed that PMMF complications occurred in 6 cases of T3, only one case of the flap complications occurred for T2. On the other hand, there were PMMF complications has occurred in 3 cases of moderate differentiated OSCC, 3 cases of poorly differentiated OSCC and only one case of well-differentiated OSCC as shown in table (8).

Table (8) Distribution of PMMF complications according to tumor staging, grading, and cervical lymph nodes metastases

The TNM staging of SCC:	No.
T1	0
T2	1
T3	6
Grading of SCC:	
Well-differentiated	1
Moderate differentiated	3
Poorly differentiated	3

In the study of the site of resection defect, we observed that PMMF complications had occurred after 3 cases of glossectomy and 3 cases of cheek carcinoma resections and one case after resection of carcinoma of the floor of the mouth as shown in table (9).

Table (9) Distribution of PMMF complications according to the site of pathology

Site of pathology:	No.
Tongue	3
Cheek	3
The floor of the mouth	1

Of these 7 postoperative PMMF complications, one of the two cases of wound infection was after tongue carcinoma resection. Two hematoma cases; one case after tongue and the other case after resection of carcinoma of the floor of the mouth. While, the remaining two cases after cheek carcinoma resection in which one case complicated with orocutaneous fistula and the other cases complicated with partial flap necrosis as shown in table (10).

Table (10) Types of PMMF complications according to the site of pathology

	Tongue	Cheek	The floor of the mouth
PMMF complications:			
Partial flap necrosis	0	1	0
Orocutaneous fistula	0	1	0
Hematoma	1	0	1
Wound infection	2	0	0
Seroma	0	1	0

CASES

Case (1)



a) intraoperative:



b) Postoperative

CASE 2



a) Preoperative



b) Intraoperative:



c) Postoperative

DISCUSSION

The reconstruction method selected is determined by the lesion's location, the type of tissue needed, the impact of the defect on function and appearance, any underlying comorbidities, and the availability of resources⁽³⁾. The PMMC flap's brilliance lies in the fact that it enables the removal of a sizable skin paddle that wraps around the entire muscle and reaches the rectus abdominal sheath⁽⁴⁾. It is a good substitute for a free flap if it cannot be used because of a patient's medical condition, which prevents them from tolerating prolonged surgery, or if a free flap has failed. Flap-related problems include complete or partial necrosis, orocutaneous fistula formation (salivary fistula), hematoma, infection, wound dehiscence, exposure of fresh reconstructive material, and donor site difficulties. Large tissue volumes can make swallowing and speech therapy more difficult and conceal recurrence⁽²⁾.

Many postoperative difficulties were linked to the flap's size and an insufficient circulatory supply to the skin island's distal portion. Hence some authors have suggested adding a lateral thoracic artery pedicle⁽⁵⁾. Its application is restricted by a bulky flap site that could be changed with another local flap, such as a submental flap or a temporalis muscle flap, to close a minor defect. Overall complication rates reported in the literature during the past 30 years have ranged from 17%⁽⁶⁾ to 63%⁽⁷⁾. The only problem that results in reconstructive failure and necessitates extra surgical therapy is total flap loss⁽⁸⁾.

Comparable to **Shah et al.**⁽⁹⁾ (63%), **Ijsselstein et al.**⁽¹⁰⁾ (53%), **Kroll et al.**⁽¹¹⁾ (63%) and **El Marakby et al.**⁽¹²⁾ (60%), our rate of overall complications was 41.2%. In our investigation, total flap necrosis didn't occur at all (success rate). Total flap necrosis was a rare occurrence in the literature, with incidence rates ranging from 0%⁽¹⁰⁾ to 7.7%⁽¹²⁾. Its incidence rate was barely 1.9% in the largest series published by **Milenovic et al.**⁽¹³⁾. Compared to **Shah et al.**⁽⁹⁾ and **Mehta et al.**⁽¹⁴⁾ patient's series, our patients' partial skin flap necrosis rates (5.9%) were lower⁽¹⁴⁾. One case (5.9%) had one or more post-operative orocutaneous fistulae, which was equivalent to several of the described series^(8, 6, 9, and 12). This case involved the repair of the cheek mucosa, which had partial flap necrosis, fistulae formation, and treatment with fistula closure only no new flap was required. Treatment of cases of partial skin flap necrosis and orocutaneous fistulae were done properly with satisfactory cosmetic and functional results.

Two cases developed a hematoma (11.8%); one after tongue carcinoma resection and the other after resection of carcinoma of the floor of the mouth, which was treated conservatively. This hematoma may be the result of inadequate hemostasis and apprehension about using diathermy to protect the vascular pedicle. Also,

there were two cases of infection (11.8%) which may be due to bad oral hygiene or diabetes mellitus as one the two complicated cases was diabetic. The cases were treated gently using daily hygiene, drainage, debridement, and antibiotics.

We didn't observe significant donor site complication in our study. There was another study showed that donor site complications were noted in 6.8% of patients⁽⁸⁾, while in other published studies (range: 5–8%)⁽¹⁵⁾.

To understand the causes of previous flap complications, we have been studied the clinical risk factors, which may affect the PMMF effectiveness e.g. age, sex, and smoking. In the previous study that was done on larger sample size (29 PMMC flap reconstructions), females experienced considerably greater rates of problems overall. Flap-related issues occurred in 5 (71.4%) out of 7 female patients and in 4 (18.1%) out of 22 male patients ($P = 0.0001$)⁽⁸⁾. An increased rate of complications in females was also observed in this study. Despite this finding was expected, it was not significant in the current study because all cases were preoperatively well prepared and in older females, the breast tissue were atrophied, which minimized the effect of breast tissue bulk on the vascularity of the skin island. In addition, the skin island in women was frequently placed further medially to reduce the quantity of breast tissue within the flap⁽¹⁶⁾.

Also, the frequency of PMMF complications was higher in the age group ≥ 50 years (29.4%) compared to the group of patients < 50 years (11.8%). This outcome was consistent with **Ziffren and Hartfordc'** study⁽¹⁷⁾, which found that older patients have much higher rates of postoperative problems than younger patients.

Similar to other studies, there was no evidence that smoking was connected significantly with greater complications rates⁽¹⁸⁾. Our study's findings confirm this, but the limited sample size of this group of patients can be blamed. To corroborate this tendency, a bigger series and/or multicenter research are needed. After head and neck reconstruction using free flaps, problems were thought to be most likely to occur in those with diabetes⁽¹⁹⁾. Diabetes patients had a 5-times-higher risk than those without it, according to **Bozikov**⁽²⁰⁾. It was most likely attributable to vascular damage brought on by dangerous substances like toxic, heterogeneous, and antigenic glycation end products, which developed after being stimulated for a prolonged period of time by unstable glucose levels⁽²¹⁾. People with diabetes had a higher likelihood of experiencing vessel thrombosis than patients without diabetes⁽²¹⁾. This condition might be caused by the venous system's poor flow and low tolerance for compression⁽²¹⁾. In our analysis, patients with diabetes had a greater frequency of major flap problems (23.5%) than patients without diabetes (17.6%), but there was no statistically

significant link between diabetes and PMMF complications. In a study on 37 patients in China, The number of people with diabetes who experienced flap issues was found to be 40%, which was far greater than the percentage of people without diabetes who had the same issues (29.52%)⁽²²⁾. Diabetes should be recognised as a major risk factor for pedicle flap problems. We also studied hemoglobin level, albumin level and post-operative duration of hospital stay. We didn't find any statistically significant association between these factors and PMMF complications (p-value =0.14, 0.18, 0.53 respectively).

This illustrates how effective PMMC flaps are even in patients who are undernourished. Similar findings were found in the study by **Tsai et al.**⁽²³⁾, which found no significant relationship between preoperative serum albumin level and severe wound infection. Preoperative hypoalbuminemia and a higher chance of wound infection were found to be significantly correlated by **Danan et al.**⁽²⁴⁾ in head and neck cancer patients. Pre-operative albumin levels were also found to be unrelated to complications. The study by **Fang et al.**⁽²²⁾ found that drug-induced liver injury did not affect the kind of pedicle flap used, age, cardiac score, hypertension, diabetes, post-operative hypoproteinemia, or other factors.

Studies that examined the significance of serum albumin level in postoperative wound infection among those patients found that low albumin level was connected to a higher propensity to develop postoperative complications in patients who underwent simultaneous reconstruction and head and neck cancer surgery⁽²⁵⁾. Another study discovered that problems following free flap transfer were connected to postoperative low albumin levels⁽²⁶⁾. Consequently, a key factor influencing wound infection was post-operative albumin level⁽⁸⁾. The authors suggested that in order to prevent potential wound issues and minimise hospital stays, it is essential to routinely check post-operative albumin levels and provide patients the right amount of post-operative nutrition via a feeding tube⁽²³⁾. For cancer patients, successful head and neck reconstruction is essential since delayed wound healing could harm their oncologic prognosis, lengthen their hospital stay, and raise their costs⁽²³⁾. Important immune system serum proteins, which are necessary for the prevention of infection and the treatment of tumours, are known to decrease as serum albumin levels drop⁽²³⁾. Postoperative albumin level remained a critical factor influencing wound infection even though there was no significant link between preoperative serum albumin level and major wound infection in our experiment. To limit hospital stays and associated wound complications, routine postoperative albumin measurements and appropriate postoperative nutrition delivery via tube feeding are indicated.

In our study, patients' average hospital stays were 12 days (range 10–15 days). Therefore, PMM flap has been consistently vascular, and the likelihood of

total flap loss was decreased. In the current study, we observed that 7 cases of complicated PMMF had occurred in T2 of OSCC (one case) and T3 (6 cases) of OSCC. This finding is consistent with the literature because, over the past 20 years, only significant deep defects resulting from the excision of stage III malignancy had been treated with the PMMPF flap⁽²⁷⁾. It is the first option in the reconstructive ladder in these cases because it is considerably easier to harvest and takes less time than free flaps due to the advanced or the recurrent illness at presentation⁽²⁸⁾.

The muscle can generate an unsightly supraclavicular bulge as it crosses the collarbone. Although muscle atrophy means that this issue usually goes away with time. Only the neurovascular bundle can cross if the flap is slid under the clavicle or the muscle above the vascular pedicle is cut⁽²⁹⁾.

CONCLUSION

Our study' findings demonstrated the safety, dependability, and adaptability of the pectoralis major myocutaneous pedicle flap as a reconstructive technique, with a manageable incidence of postoperative problems and related morbidity. Large orofacial abnormalities caused by primary or recurring oral cancer and advanced disease stages with more concomitant conditions are the best candidates for flap use. In addition, PMMF is an excellent substitute in this era of microvascular repair if it cannot be implicated. The pectoralis major flap has several benefits for primary and secondary soft tissue restoration in the head and neck.

The sternomastoid muscle must be excised during the radical neck dissection in order to employ this flap. From our research, we concur with the literature about the flexible use of PMMC flap in rebuilding different sub sites of oral cancer. To confirm the efficacy of PMMF in the reconstruction of orofacial abnormalities following oral cancer resections, a bigger sample size is needed. It was challenging to analyse the functional outcome because there were just a few patients.

DECLARATIONS

- **Consent for Publication:** I confirm that all authors accepted the manuscript for submission
- **Availability of data and material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of Interest:** The authors declared no conflicts of interest regarding the publication of this paper.

REFERENCES

1. **Lin S, Rabie A (2009):** Head and neck cancer-reconstruction, 34 (5): 211-31
2. **Rudes M (2012):** Pectoralis major myocutaneous flap in the reconstructive surgery of the head and neck--our experience. Collegium antropologicum, 36 (2): 137-142.

3. **Watkinson J, Gaze M, Wilson J (2000):** Stell and Maran's head and neck surgery, 25 (6): 344-10
4. **Ramakrishnan V, Yao W, Campana J (2009):** Improved skin paddle survival in pectoralis major myocutaneous flap reconstruction of head and neck defects. *Archives of facial plastic surgery*, 11(5): 306–310. doi: 10.1001/archfacial.2009.67.
5. **Wadwongtham W, Isipradit P, Supanakorn S (2004):** The pectoralis major myocutaneous flap: applications and complications in head and neck reconstruction. *Journal of the Medical Association of Thailand = Chotmaihet thangphaet*, 87 (2): S95-9.
6. **Nagral S, Sankhe M, Patel C (1992):** Experience with the pectoralis major myocutaneous flap for head and neck reconstruction in a general surgical unit. *Journal of postgraduate medicine*, 38(3): 119–123.
7. **Chaudhary R (2014):** Use of pectoralis major myocutaneous flap for resurfacing the soft tissue defects of head and neck. *Journal of Orofacial Sciences*, 6(2): 88.
8. **Sen S (2019):** Effectiveness of pectoralis major myocutaneous flap in the surgical management of oral cancer: A retrospective study. *Journal of stomatology, oral and maxillofacial surgery*, 120(1): 21–27. doi: 10.1016/j.jormas.2018.08.003.
9. **Shah J (1990):** Complications of the pectoralis major myocutaneous flap in head and neck reconstruction. *The American journal of surgery*, 160(4): 352–355.
10. **IJsselstein C (1996) :** Is the pectoralis myocutaneous flap in intraoral and oropharyngeal reconstruction outdated?. *The American journal of surgery*, 172(3): 259–262.
11. **Kroll S (1990):** Analysis of complications in 168 pectoralis major myocutaneous flaps used for head and neck reconstruction. *Annals of plastic surgery*, 25(2): 93–97. doi: 10.1097/0000637-199008000-00003.
12. **El-Marakby H (2006):** The reliability of pectoralis major myocutaneous flap in head and neck reconstruction. *Journal of the Egyptian National Cancer Institute*, 18(1): 41–50.
13. **Milenović A (2006):** The pectoralis major flap in head and neck reconstruction: first 500 patients. *Journal of Cranio-Maxillofacial Surgery*, 34(6): 340–343.
14. **Mehta S (1996):** Complications of the pectoralis major myocutaneous flap in the oral cavity: a prospective evaluation of 220 cases. *Plastic and reconstructive surgery*, 98(1): 31–37. doi: 10.1097/00006534-199607000-00006.
15. **Rikimaru H (2009)** New method of preparing a pectoralis major myocutaneous flap with a skin paddle that includes the third intercostal perforating branch of the internal thoracic artery. *Plastic and reconstructive surgery*, 123(4): 1220–1228. doi: 10.1097/PRS.0b013e31819f2967.
16. **McLean J, Carlson G, Losken A (2010):** The pectoralis major myocutaneous flap revisited: a reliable technique for head and neck reconstruction. *Annals of plastic surgery*, 64 (5): 570-3.
17. **Ziffren S, Hartford C (1972):** Comparative mortality for various surgical operations in older versus younger age groups. *Journal of the American Geriatrics Society*, 20(10): 485–489
18. **Liu R (2001):** Pectoralis major myocutaneous pedicled flap in head and neck reconstruction: retrospective review of indications and results in 244 consecutive cases at the Toronto General Hospital. *The Journal of otolaryngology*, 30(1): 34–40. doi: 10.2310/7070.2001.21011.
19. **Valentini V (2008):** Diabetes as main risk factor in head and neck reconstructive surgery with free flaps. *Journal of Craniofacial Surgery*, 19(4): 1080–1084.
20. **Bozиков K, Arnez Z (2006):** Factors predicting free flap complications in head and neck reconstruction. *Journal of plastic, reconstructive & aesthetic surgery*, 59(7): 737–742. doi: 10.1016/j.bjps.2005.11.013.
21. **Liu Z (2015):** Microvascular reconstruction in elderly oral cancer patients: does diabetes status have a predictive role in free flap complications?. *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons*, 73(2): 357–369. doi: 10.1016/j.joms.2014.08.009.
22. **Fang Z (2016):** Risk Factors for Pedicle Flap Complications in 251 Elderly Chinese Patients Who Underwent Oral and Maxillofacial Reconstruction. *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons*, 74(10): 2073–2080. doi: 10.1016/j.joms.2016.03.029.
23. **Tsai M (2018):** Clinical impact of albumin in advanced head and neck cancer patients with free flap reconstruction—a retrospective study. *PeerJ.*, 6: e4490.
24. **Danan D (2016):** Prognostic value of albumin in patients with head and neck cancer. *The Laryngoscope*, 126(7): 1567–1571.
25. **Lo S (2017):** Factors Influencing Postoperative Complications in Reconstructive Microsurgery for Head and Neck Cancer. *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons*, 75(4): 867–873. doi: 10.1016/j.joms.2016.09.025.
26. **Hoppe I, Abernathie B, Datiashvili R (2012):** Examination of possible predictors of complications after free tissue transfer to the head and neck for oncologic defects. *Annals of Plastic Surgery*, 69(4): 368–370.
27. **Chu P, Chang S (2002):** Reconstruction of circumferential pharyngoesophageal defects with laryngotracheal flap and pectoralis major myocutaneous flap. *Head & neck*, 24(10): 933–939. doi: 10.1002/hed.10149.
28. **Ferri T (1999):** The pectoralis major myocutaneous flap in head and neck reconstructive surgery: 16 years of experience. *Acta Bio-medica de L'ateneo Parmense: Organo Della Societa di Medicina e Scienze Naturali di Parma*, 70(1–2): 13–17.
29. **Ord R (1996):** The pectoralis major myocutaneous flap in oral and maxillofacial reconstruction: a retrospective analysis of 50 cases. *Journal of oral and maxillofacial surgery*, 54(11): 1292–1295.