

HEAD AND NECK

Pectoralis major myocutaneous flap for head and neck reconstruction: risk factors for fistula formation

Lembo miocutaneo di muscolo grande pettorale per le ricostruzioni del distretto testa-collo: fattori di rischio per la formazione delle fistole

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SUMMARY

The pectoralis major myocutaneous flap (PMMF) is a safe and versatile flap used widely for head and neck cancer reconstructions, but one of the major and most feared complications is oro- or pharyngocutaneous fistula. Herein, we attempt to establish risk factors for fistula formation in reconstructions of mucosal defects in the head and neck using PMMF through retrospective analysis of PMMF performed during 3 years at a single institution, with a total of 84 procedures. There were 69 men and 15 women, with a mean age of 59.5 years. There were 15 cases of partial flap loss, two total flap losses and 31 fistulas. The independent risk factors for fistula formation were preoperative serum hemoglobin < 13 g/dl, preoperative serum albumin < 3.4 g/dl and hypopharynx reconstruction. The PMMF is still a very useful flap and this is the first multivariate analysis analysing risk factors for fistula formation. These findings are helpful in selecting patients with elevated risk of fistula formation, and therefore preventive measures can be undertaken to avoid potentially serious complications.

KEY WORDS: Head and neck Neoplasms • Reconstructive surgical procedures • Pectoralis muscle • Fistula

RIASSUNTO

Il lembo miocutaneo di muscolo grande pettorale (PMMF) è sicuro e viene ampiamente utilizzato nella chirurgia ricostruttiva dei tumori del distretto testa-collo, nonostante la principale e più temuta complicanza sia la formazione di fistole oro e faringocutanee. Il presente studio ha come obiettivo quello di stabilire i fattori di rischio per la formazione di fistole nella ricostruzione dei difetti della testa e del collo mediante PMMF attraverso un'analisi retrospettiva delle ricostruzioni eseguite in 3 anni in un singolo centro. Sono entrati a far parte dello studio 84 pazienti, 69 uomini e 15 donne, con una età media di 59,5 anni. Complessivamente si sono verificati 15 casi di parziale perdita di sostanza, 2 perdite totali di lembo e 31 fistole. I fattori di rischio indipendenti per la formazione di fistole sono stati: Emoglobinemia preoperatoria < 13 g/dl; albumina sierica preoperatoria < 3.4 g/dl; ricostruzioni dell'ipofaringe. Il PMMF è versatile e molto utile. Questo studio rappresenta la prima analisi multivariata che valuta i fattori di rischio correlati alla formazione di fistole. I risultati derivanti da questo studio potrebbero essere utili per selezionare i pazienti con rischio elevato di formazione di fistole e quindi prendere preventivamente misure atte ad evitare gravi complicanze.

PAROLE CHIAVE: Neoplasmi della testa e del collo • Procedure di ricostruzione chirurgica • Muscoli pettorali • Fistula

Acta Otorhinolaryngol Ital 2014;34:389-393

Introduction

Since it was first described in 1979 by Stephen Aryan, the pectoralis major myocutaneous flap (PMMF) has been considered the workhorse for head and neck reconstructions. Many qualities, such as its proximity to the head and neck region, the reliability of its pedicle and the short learning curve, have contributed to the widespread use of this technique and its overall good success rates¹⁻⁴. Complication rates vary in the literature, ranging from 13 to 65%. However, there is no consensus on the definition

of complications, and there is a great variety of scenarios, ranging from minor to major complications, with very different implications on surgical outcome⁴⁻¹².

When the PMMF is used to reconstruct mucosal defects, one of the most feared complications is dehiscence of the suture, which can lead to salivary leakage and the formation of orocutaneous or pharyngocutaneous fistula. It may lead to prolonged hospital stay, infection, wound dehiscence and vascular rupture, with a marked increase in morbidity.

Many authors describe risk factors associated with fistula formation, such as nutrition status, comorbidities, extent of the resection and prior irradiation⁴⁻¹⁴. However, there is no description of risk analysis for fistulas in cases in which the PMMF was used.

The objective of this study is to analyse variables associated with postoperative fistula formation in head and neck resections in which the PMMF was used for reconstruction of a mucosal defect, as well as establish independent risk factors for fistula formation.

Materials and methods

We retrospectively reviewed the records of all head and neck resections in which a PMMF was used for mucosal reconstruction in a single institution (Instituto do Câncer do Estado de São Paulo - ICESP) from January 2010 to December 2012, for a total of 84 surgeries.

The PMMF was harvested with the usual technique described previously^{2,8,15}. The dermis and subcutaneous tissue of the flap were sutured to the underlying muscle with interrupted stitches to avoid any displacement of the skin from the muscle during flap harvesting. An additional skin incision from the superior border of the skin paddle to the midclavicular point was made, and fasciocutaneous flaps were elevated to expose the entire pectoralis major muscle. The PMMF was based only on the pectoralis branch of the thoracoacromial artery, which was dissected until its origin, near the midclavicular point. The pedicle was dissected and the pectoralis major muscle was cut as much as needed to obtain the necessary reach of the flap in each case, although the muscle adjacent to the pedicle was always preserved. After this step, the flap was rotated to the head and neck over the clavicle¹⁶. The PMMF was inserted into the oral cavity or oropharynx underneath the mandible when this was preserved and through the neck in cases of mandibulectomy. The skin portion of the PMMF was sutured to mucosal borders and the underlying pectoralis muscle was used as replacement for the resected musculature. When employed on hypopharynx defects, the PMMF was not folded as a tube; it was fixed at the vertebral fascia forming a reconstruction of 270° of the hypopharynx. No pharyngeal devices, such as the Montgomery salivary tube, were used on circumferential repairs of the hypopharynx and no variants to the fasciocutaneous flaps were performed.

Demographic data (sex and age), primary location of the tumour, staging based on TNM classification, region reconstructed with the PMMF, previous treatments (radiotherapy, surgery or both) were recorded. Additionally, variables associated with nutritional status were analysed in cases in which the data was available, such as body mass index (BMI), percentage of weight loss from the normal weight to weight when admitted for surgery, preoperative serum haemoglobin and preoperative serum albumin.

The presence of orocutaneous or pharyngocutaneous fistula was established when there was evident salivary leakage through the neck or drainage. Also, an active test for fistula was performed with administration of methylene blue dye orally at the fifth to seventh post-operative day, and any leakage through the neck or drainage was recorded as fistula. All the cases in which fistula was diagnosed were recorded and analysed for variables significantly associated with this outcome. We also conducted multivariate analysis to find independent risk factors for fistula formation.

The SPSS program version 17.0 (SPSS Inc; IL, USA) was used for statistical analysis. Distributions were defined as nonparametric by the Kolmogorov-Smirnov test. The values obtained from the study of each continuous variable were organised and described using means and standard deviation, and relative and absolute frequencies were used for categorised variables. In the comparison of frequency of the phenomenon between groups of categorised variables, Fischer's exact test or chi-squared test were used. Comparison between independent continuous variables was performed using Mann-Whitney's test. The variables that presented $p < 0.2$ in the univariate analyses were eligible for multivariate analysis in which the *odds ratio* and confidence interval were calculated using logistic regression. The cutoff values determined for the risk analyses of serum albumin, serum hemoglobin, percentage of weight loss and BMI were obtained using the Receiving Operator Characteristics curve. In all analyses, we considered a chance of 5% or less to commit a type I or α error ($p \leq 0.05$).

Results

The study group included 69 men and 15 women with a mean age of 59.5 ± 9.5 years. The most common primary tumour location was the oral cavity, followed by the oropharynx, while the least common was the hypopharynx. The majority of cases had advanced stage (III or IV). Free surgical margins were acquired in 75 patients (89.3%). Eighteen patients had been previously treated with radiotherapy and nine patients had been previously submitted to surgery. Ninety-one percent of patients were smokers (Table I).

Regarding complications, there were 15 cases of partial flap loss and two total flap losses. The two total flap losses were due to technical fault in one case and secondary to venous thrombosis of the pedicle in the other. Thirty-one patients developed fistula. In these cases, 12 (38.7%) also presented flap ischaemia, 14 (45.2%) partial flap losses, 22 (71.0%) dehiscence, 13 (41.9%) local infection and 15 (48.4%) were submitted to another surgery. Hospital stay varied from 5 to 81 days, with a mean of 14.6 days. Comparing patients that developed fistula with those without fistula, the median hospital stay was 7 days (range 4-29

Table I. Clinicopathological data of patients in the study.

Variable	(n = 84)
Gender*	
Male	69 (82.1)
Female	15 (17.9)
Reconstructed region*	
Oral cavity	60 (71.4)
Oropharynx	14 (16.7)
Hypopharynx	10 (11.9)
Stage*	
I-II	9 (10.7)
III-IV	75 (89.3)
Age**	59.5 ± 9.5
Prior radiotherapy*	18 (21.4)
Prior surgery*	9 (10.7)
Body mass index**	21.6 ± 5 kg/m ²
Serum haemoglobin**	12.95 ± 1.8 g/dl
Serum albumin**	3.66 ± 0.8 g/dl
Weight loss (%)**	10.9 ± 9.5

* Number (percentage); ** Average ± standard deviation.

days) and 16 days (range 6-81 days) ($p < 0.0001$, Mann-Whitney's test), respectively.

In univariate analysis of factors associated with fistula formation, we identified preoperative serum haemoglobin < 13 g/dl, preoperative serum albumin < 3.4 g/dl and use of the flap for hypopharynx reconstruction as having a positive association with postoperative fistula ($p = 0.007$; $p = 0.006$ and $p = 0.011$ respectively). Sex, age, stage, prior treatment, weight loss, or BMI did not have a statistically significant association ($p > 0.05$) (Table II).

When multivariate analysis was performed, we confirmed the findings of preoperative serum haemoglobin, preoperative serum albumin and use of the flap for hypopharynx reconstruction as independent risk factors for fistula formation (Table III).

Discussion

Many authors defend that considering the current panorama of head and neck reconstructions, the new workhorse is the free flap. Despite this fact, PMMF remains an important tool for complex reconstruction of head and neck defects¹⁷⁻¹⁹, especially in locations where free flaps are not routinely available, such as Brazil.

At Instituto do Câncer do Estado de São Paulo there is a microvascular reconstruction team, but because of the large volume of oncologic head and neck resections it is not possible to use microvascular flaps in all patients. Therefore, priority is given to the most complex reconstructions (e.g. mandible resections involving the chin or craniofacial resections), and many pedicled flaps are still performed.

As another option, in the last decade there have been reports on the use of the internal mammary artery perforator

Table II. Factors associated with oro- or pharyngocutaneous fistula.

Variable	Number of fistulas/total (%)	p
Gender		0.275
Male	27/69 (34.2)	
Female	4/15 (26.7)	
Age		0.275
> 70 years	4/15 (26.7)	
≤ 70 years	27/69 (39.1)	
Reconstructed region		0.011
Oral cavity	19/60 (31.7)	
Oropharynx	4/14 (28.6)	
Hypopharynx	8/10 (80)	
Stage		0.281
I-II	2/9 (22.2)	
III-IV	29/75 (38.6)	
Prior surgery		0.281
Yes	2/9 (22.2)	
No	29/75 (38.6)	
Prior radiotherapy		0.455
Yes	8/18 (44.4)	
No	23/66 (34.8)	
BMI		0.928
< 20 kg/m ²	13/35 (37.1)	
≥ 20 kg/m ²	17/47 (36.1)	
Weight loss		0.264
> 10%	9/33 (27.3)	
≤ 10%	17/43 (39.5)	
Haemoglobin		0.007
< 13 g/dl	19/36 (52.8)	
≥ 13 g/dl	11/46 (23.9)	
Albumin		0.006
< 3.4 g/dl	15/26 (57.7)	
≥ 3.4 g/dl	11/44 (25)	

flap (IMAP) for head and neck reconstructions. IMAP has been shown to be a reliable pedicled flap with a wide rotation arc that can be used for cutaneous, pharyngeal and tracheostomal reconstruction. Therefore, it is becoming another important tool for the head and neck surgeon²⁰⁻²². It is common knowledge that the PMMF is a reliable and versatile flap for head and neck reconstructions. When microvascular reconstruction is not available it is the most important reconstruction tool, and it is also very useful in elderly patients or in those with poor clinical conditions. Deganello et al.¹⁸ showed that using alternative non-microvascular techniques, in high-risk patients, the PMMF is functionally and oncologically sound, and can even produce cost savings.

Even if it is one of the most commonly used flaps by the head and neck surgeons, there is still much controversy about which factors lead to complications and therefore worse outcomes during the use of the PMMF⁴⁻¹⁴.

Amongst these complications are orocutaneous and pharyngocutaneous fistulas, which we chose to focus on in this report because of their high impact on morbidity.

The incidence of fistula is also quite variable, with values ranging from 10.7% to 45%^{3 4 7 9 12 23}. We report a slightly

Table III. Multivariable analysis of risk factors associated with oro- or pharyngocutaneous fistula.

Variable	OR	95% CI	p (Logistic regression)
Hypopharynx	17.0	1.4-202.3	0.025
Haemoglobin < 13 g/dl	5.2	1.5-17.4	0.008
Albumin < 3.4 g/dl	5.5	1.6-18.9	0.007

higher rate than most papers (36%). This may be attributed to the fact that we analysed only mucosal reconstructions, while other authors included skin reconstructions, and the fact that at our institution we perform an active test for fistula with the ingestion of methylene blue dye. Therefore, even minimal salivary leakage is diagnosed. Most studies on risk factors for complications of PMMF have not independently analysed risk factors for fistula formation. You et al. analysed 120 PMMFs and found that preoperative albumin levels below 3.8 g/dl were associated with increased fistula formation, similar to our findings, but multivariate analysis was not performed, which limits the value of the finding¹².

In the 31 cases of fistula presented, some were associated with infection, partial flap losses, ischaemia and suture dehiscence. However, these findings must be cautiously considered because many cases had multiple complications and it was not possible to establish which started the process and led to the others.

The present paper also documents the association of fistula with preoperative serum haemoglobin levels below 13.0 g/dl, which to our knowledge there are no previous reports of this finding.

It is widely believed that nutritional, haemoglobin and albumin status may influence the outcome of anastomosis, and there are some reports of this association in colorectal surgery^{24,25}, although few such reports in head and neck surgery, especially when flaps are used.

There has been some research on risk factors for fistula after total laryngectomies and some reports that associate it with abnormally low albumin and haemoglobin, but these studies are not specifically on PMMFs^{26,27}.

The most significant risk factor in our analysis was the use of the PMMF for hypopharyngeal reconstruction, with a 17-fold increase in the risk of fistula formation. Some authors showed that tumours primarily from the hypopharynx and large hypopharynx resections had a higher rate of fistula formation even without the use of PMMF, an indication of the difficulty in reconstructions of this region²⁷⁻²⁹. Moreover, Qureshi et al. reported on risk factors associated with fistula after total laryngectomy, and PMMF was significantly associated with fistula formation³⁰.

To our knowledge this is the first report to perform multivariate analysis for risk factors of fistula on head and neck reconstructions using the PMMF. Our findings of preoperative serum haemoglobin of < 13.0 g/dl, preoperative serum albumin < 3.4 g/dl and hypopharynx reconstruc-

tion as independent risk factors for fistula formation are of great value. Even though the cutoff levels for albumin and haemoglobin we found are high, there is great importance in the finding that values below normal are already risk factors for fistula, and not only much lower levels as might be expected. Based on these results, the surgeon can identify patients with an increased risk of fistula prior to surgery and focus on actions that may lower the risk, such as nutritional supplementation, or changing the surgical approach, such as preserving the Bakanjiam flap in hypopharynx reconstructions.

Conclusion

The pectoralis major myocutaneous flap is useful for head and neck reconstructions. Independent risk factors for orocutaneous or pharyngocutaneous fistula formation are serum albumin < 3.4 g/dl, serum haemoglobin < 13.0 g/dl and use of the flap for hypopharynx reconstruction.

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Received: June 16, 2014 - Accepted: November 24, 2014