10-Year Experience with the Modified Pectoralis Major Flap: The Use of the Deltopectoral Flap to Reduce Skin Tension

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Abstract
Purpose: Pectoralis major myocutaneous flap has been the workhorse flap for head and neck reconstruction. However, due to the bulky nature of the pedicle it is not uncommon to struggle to achieve tension free closure of the neck skin incision. This case series presents a modified pectoralis major flap technique to overcome the difficulty of tight closure or the need to graft the residual cutaneous defect. Method: This 10-year study includes 73 patients who underwent modified pectoralis major flap reconstruction for complex laryngo-pharyngeal defects following resection of tumours involving larynx, hypopharynx oropharynx and cervical oesophagus. The modified technique involves accommodating a deltopectoral fasciocutaneous flap which rotates over the pedicle to insert into the neck incision providing extra tissue to achieve a tension free closure. Results: 73 patients underwent the procedure, 80% were male. Mean age of patients was 62.8 years. Larynx was the most common site and the average size of the tumour was 34.8 mm. 13 patients developed minor complications such as wound dehiscence out of which 10 were managed conservatively, 3 patients required additional reconstructive procedures. 13 patients developed pharyngocutaneous fistula and 6 developed Neopharyngeal stenosis. 51 patients achieved good swallowing and 55 developed intelligible speech following recovery. Conclusion: We recommend the use of this technique as an effective method to achieve tension free neck incision closure and improved cosmetic results especially in centres which do not have free flap facility readily available.

Keywords Pectoralis Major Flap · Myocutaneous Flap · Deltopectoral Flap · Fasciocutaneous Flap · Head and Neck Reconstruction
free flaps reconstruction. Despite the fact that the pectoralis major muscle makes a robust flap, its pedicle is usually bulky thus, at times it is difficult to close the neck skin incision which allows the flap to enter the neck without adding tension to the pedicle. Many surgeons use skin grafts to manage the potential cutaneous defect after pectoralis major flap placement or to decrease the thickness of the flap. A modified pectoralis major myofascial flap has also been used with varying success [11].

The study describes the surgical outcomes and technique of an alternative to the classic approach of primary or skin graft closure of the neck incision following insertion of the pectoralis major flap. This may help overcoming skin tension following closure of the defects with the above mentioned commonly performed techniques.

Methods

Patient Population

This is a 10-year prospective cohort study of all patients who underwent pharyngo-laryngectomy from February 2010 until March 2020, requiring a pectoralis major flap for reconstruction of complex laryngo-pharyngeal defects following resection of tumours involving larynx, hypopharynx, oropharynx and cervical oesophagus. All patients had a minimum of 1-year follow-up following cancer resection allowing us to present short and long-term outcomes of the modified pectoralis major flap reconstruction. Seventy-three patients were identified during the study period.

Data were collected on patients’ demographics, tumour staging, intra- and post-operative complications, long term morbidity and mortality. The database was analysed using the SPSS 23.0 statistical software.

Ethical Considerations

Institutional approval was attained following discussion at the local Head and Neck Oncology multidisciplinary team meeting and Caldicott Guardian approval was granted.

Surgical Technique

A modified shortened deltopectoral flap is used to close the defect created between the neck skin incision where the pedicled flap is placed across into the neck covering the rotated pedicle of the pectoralis major flap. (Fig. 1)

This technique involves marking a modified incision starting at the chest for pectoralis major flap extending supero-laterally towards the deltoid accommodating the deltopectoral flap. (Fig. 2a) The later extends medially over the clavicle to join the neck incision (Fig. 2b). As the pectoralis major flap is harvested, the skin paddle medial to the incision is raised as the fasciocutaneous deltopectoral flap simultaneously (Fig. 2c). The safe length of this flap reaches the deltopectoral groove. Care is taken to avoid damaging the perforating branches of the internal mammary artery which is the blood supply to the deltopectoral flap as well as the cephalic vein which lies into the deltopectoral groove.

After the pectoralis major flap is harvested and the reconstructive process is complete, the deltopectoral fasciocutaneous flap is used as a rotational flap to fill in the gap of vertical neck incision which was made for access of the pectoralis major flap pedicle. This technique reduces the pressure on the pedicle of the pectoralis major which is otherwise caused by tunnelling the flap or with primary closure. The flap aids in a tension free closure of the neck incision. (Fig. 3)

Results

A total of 73 patients underwent the modified deltopectoral flap closure during the study period. The majority of these were males (n = 59, 80.8%) with a mean age of 62.8 years. (range: 34–79 years). All patients underwent a neck dissection as a part of the primary procedure out of which 51 (69.9%) had bilateral neck dissection being unilateral neck dissection for the remainder (n = 22, 30.1%). Fourteen cases were salvage surgery (n = 19.2%) as patients had previous radiotherapy for their primary tumour. The average primary size for the tumours was 34.8 mm based on the final pathology report and larynx was the most common site of the primary tumour. A breakdown of the tumours’ sub sites and staging is available in Table 1.

Minor complications of superficial wound dehiscence (n = 13, 17.8%) was seen and managed conservatively, average healing time being 10 days. No skin dehiscence or fistula was seen in the region of the deltopectoral flap closure or the pectoralis major/deltpectoral skin crease closure. Thirteen (17.8%) patients developed pharyngocutaneous fistula out of which 10 were managed conservatively and 3 had to return to theatre for another flap. The 10 patient who were managed conservatively had an average fistula healing time of 10 weeks. This is reflected on the average hospital stay for our cohort which was 79 days (range: 12–90), 4 patients died post operatively as an inpatient. Details of complications according to subsite is available in Table 2.

The mean follow-up period was 9 months (range: 3 days – 66 months). All patients were seen at 6 weekly basis in the first year post-operatively, then 2–3 monthly thereafter. Six (8.2%) patients developed neopharyngeal stenosis out of which 4 have been managing soft diet with self-dilatation
Fig. 1 Deltopectoral flap converted into a rotational flap covering pectoralis major flap
Data on cause of death and complications has been tabulated in Table 4 according to the subsites.

Discussion

Reconstruction of pharyngeal defects following resection of advanced laryngopharyngeal cancer remains a challenge. Many techniques have been proposed and utilised over the years with free flap reconstruction being the current mainstay of treatment providing very good functional and cosmetic outcomes even though donor site morbidity and flap failures remains an issue [11–13]. Pectoralis major flap reconstruction is an alternative reconstructive option.
Table 1  Patients’ demographic details and clinical outcomes

| Mean Age/years (Range) | 62.8 | 34–79 |
|------------------------|------|-------|
| Gender                 | Male | 59 |
|                        | Female | 14 |
| Neck Dissection        | Bilateral | 51 |
|                        | Unilateral | 22 |
| Site of tumour         | Primary site | Sub site |
|                        | Larynx | 38 |
|                        | Hypopharynx | 31 |
|                        | Oropharynx | 3 |
|                        | Oesophagus | 1 |
|                        | Glottis | 8 |
|                        | Supraglottis | 32 |
|                        | Pyriform fossa | 17 |
|                        | Post cricoid | 5 |
|                        | Post Pharynx | 7 |
|                        | Tongue Base | 2 |
|                        | Tonsil | 1 |
|                        | Proximal oesophagus | 1 |
| Previous radiotherapy  | Yes | 14 |
|                        | No | 59 |
| Primary size/mm (range)| Average 34.8 mm | Range (12–76) |
| Pathological t stage   | T1 | 3 |
|                        | T2 | 10 |
|                        | T3 | 21 |
|                        | T4 | 39 |
| Pathological/radiological N stage | N3b | 8 |
|                        | N2a | 1 |
|                        | N2b | 14 |
|                        | N2c | 12 |
|                        | N1 | 10 |
|                        | N0 | 28 |
| Adjuvant treatment     | Radiotherapy | 11 |
|                        | Chemo radiotherapy | 9 |
|                        | No | 53 |
| Complications          | Fistula | 13 |
|                        | Minor wound Dehiscence | 13 |
|                        | Hematoma | 2 |
|                        | Flap Necrosis | 2 |
|                        | Neopahryngeal stenosis | 6 |
| Fistula healing time days/range | Managed Conservatively (10) | Average | Range |
|                         | 7 weeks | 3–10 weeks |
| Hospital stay days/range | Average 79 | Range (12–90) |
| Nutritional status     | Solid | 44 |
|                        | Oral soft diet | 8 |
|                        | Liquids | 9 |
|                        | Peg/NG fed | 12 |
| Speech                 | Tracheo-oesophageal | 56 |
|                        | (very good voice) | 16 |
|                        | No Speech | 1 |
|                        | Awaited | |

Table 2  Complications according to subsite

| Fistula healing time days/range | Average 7 weeks | Range 3–10 weeks |
|---------------------------------|----------------|-----------------|
| Hospital stay days/range        | Average 79     | Range (12–90)   |
| Nutritional status              | Solid          | 44              |
|                                 | Oral soft diet | 8               |
|                                 | Liquids        | 9               |
|                                 | Peg/NG fed     | 12              |

| Speech                          | Tracheo-oesophageal | 56 |
|                                 | (very good voice)   | 16 |
|                                 | No Speech           | 1  |
|                                 | Awaited             |     |

| Complications | Fistula | Minor wound Dehiscence | Hematoma | Flap Necrosis | Neopahryngeal Stenosis | Outcome in terms of recurrence (R) / metastasis (M) |
|---------------|---------|-------------------------|----------|---------------|------------------------|---------------------------------------------------|
| Larynx        | 7       | 10                      | 1        | 0             | 2                      | 3 x R 3 x M                                      |
| Hypopharynx   | 5       | 3                       | 1        | 2             | 3                      | 2 x R 1 x M                                      |
| Oropharynx    | 0       | 0                       | 0        | 0             | 0                      | 0                                                 |
| Upper Oesophagus | 1 0    | 0                       | 0        | 1             | 0                      | 0                                                 |
in regions where there is no availability of a microsurgical reconstruction team or if patient’s comorbidities preclude the use of a free flap. It can be used for repair of partial and circumferential pharyngeal defects. Large case series have reported fistula rates ranging from 0 to 57% and stenosis rates from 0 to 43%. Peri-operative mortality is less than 1% [14].

Total and partial pectoralis major flap necrosis has been reported in 2.4% and 9.7% respectively [15]. Fistula formation has been associated with flap necrosis especially in reconstruction of hypopharyngeal defects [16, 17]. Reduced tension over the region of the pedicle using our modified technique has shown much lower percentage of fistula being 17.3% in our series versus a mean of 27% reported in the literature [14]. Minor complications are comparable with the free flap reconstruction but local morbidity and cosmesis in the chest and arm region, and the muscle bulk which affects swallowing and voice outcomes especially following reconstruction of the base of tongue, oral cavity and hypopharynx defects remain worse using the pectoralis major flap [18–21]. Despite the fact that it remains second – choice reconstruction option for primary pharyngolaryngectomy, a systematic review of the literature has shown that pectoralis major flap significantly reduces the likelihood of fistulation following salvage laryngectomy, being primarily used in an on-lay fashion [22].

The muscle bulk of the pectoralis major flap is one of the main reasons that the free flap reconstruction gained popularity and developed as the mainstay of treatment for reconstruction. The bulk of the muscle makes difficult the closure

Table 3  Outcomes according to subsite

| Subsite          | Speech | Nutritional Status |
|------------------|--------|--------------------|
|                  | Good Voice | No Voice | Solid | Soft | Liquids | Peg/Ng |
| Larynx           | 33     | 8       | 24    | 6    | 4       | 6       |
| Hypopharynx      | 20     | 8       | 18    | 2    | 4       | 5       |
| Oropharynx       | 2      | 1       | 2     | 0    | 1       | 0       |
| Upper Oesophagus | 1      | 0       | 0     | 0    | 0       | 1       |

Table 4  Patients developing complications & cause of death

| Subsite         | Complication | Cause of death                           | Time after surgery |
|-----------------|--------------|------------------------------------------|-------------------|
| Larynx          | Discitis & pulmonary mets | Chest infection on background of mets | 4 months |
|                 | Pulmonary embolism | Pulmonary embolism/cardiac arrest | 3 Post-operative day |
|                 | Neck Hematoma | Multiple medical co morbidities | 1 month |
|                 | Chest infection & recurrence | Respiratory failure | 2 months |
|                 | Recurrence | Chest infection | 8 months |
|                 | Minor wound dehiscence | Chest infection | 2 months |
|                 | Recurrence left neopharynx | Disease process | 14 months |
|                 | Minor wound dehiscence | Synchronous lung primary | 6 months |
| None            | Recurrence / Pleural metastasis | 23 months |
| None            | Bilateral nodal recurrence | 11 months |
| None            | Late stomal recurrence | 7 months |
| None            | Respiratory failure | 8 months |
| None            | Recurrence tongue base | Bleeding from recurrence | 7 months |
| None            | Acute Kidney Injury Rhabdomyolysis | 5 months |
| None            | Liver Metastasis | 30 months |
| None            | Chest infection | 16 months |
| Hypopharynx     | Recurrence at tongue base | Recurrence at tongue base | 16 months |
|                 | Aspiration pneumonia | Sepsis/ Respiratory failure | 66 months |
| None            | Medical comorbidities | 15 months |
| New lung primary | -      | 15 months |
| Sepsis          | 2nd lung primary | 13 months |
| Chest infections | 2nd lung primary | 48 months |
| Aspiration pneumonia | Aspiration pneumonia | 4 months |
| Chest infection | Lung metastasis | 15 months |
| Recurrence of primary | 11 months |
| Hypercalcaemia – paraneoplastic syndrome | Multiple metastasis- pleura, lung, bone | 12 months |
| Aspiration pneumonia | 25 months |
| Mediastinal and local recurrence | 16 months |
| Chest infection | Recurrence local and mediastinal | 4 months |
of the defect following the flap insertion and it has also been linked to worse swallow and speech outcomes compared to free flap alternatives, especially since the utilisation of fasciocutaneous free flaps [11, 14]. The muscle bulk eventually atrophies, and the muscle shrinks in the months to come after surgery giving a comparable long-term post-operative neck cosmesis outcome to the free flap reconstruction. In our study we are describing a technique that deals with the problem of initial excess muscle bulk during closure of the skin defect following the insertion of the pectoralis major flap utilising the deltopectoral fasciocutaneous flap to reduce the skin tension around the pectoralis major pedicle during skin closure [23].

In our series of laryngectomies treated with this technique over a 10-year period, we did not experience problems with skin dehiscence or fistulation at the region of the deltopectoral flap modification, with only 2% of our flaps failing. Post-operative pharyngocutaneous fistulas were noted in 17.8% of patients. These statistics are comparable and even lower than in cohorts reported in the literature using free flap closures with a mean fistula rate of 20%, ranging from 2 to 53% [14, 24]. Comparing our results with other studies utilising the pectoralis major flap with the standard closure technique, our patients had a lower number of fistulation (17.8% vs. 27%) and our surgical series are one of the largest in the literature with the majority of them having less than 70 patients in their series [15] bar the landmark paper by Chan et al., having a total of 92 patients [19].

Our technique can be used in centres where the pectoralis major flap reconstruction remains the primary options for pharyngeal reconstruction due to unavailability of a local maxillofacial or plastic surgery team but also in salvage cases using the on lay pectoralis major technique. The deltopectoral flap for tension free closure can result in reduce intra and post-operative complications as was seen in our series, not only reducing the chances or partial or total flap necrosis leading to reduced number of fistulation but also, achieving good post-operative cosmetic and functional outcomes. The deltopectoral flap provides a robust protection in the form of a cutaneous cover to the pectoralis major flap pedicle. At the same time as it is a local axial flap there are no issues with post flap management such as with skin grafts used for closure of neck wounds when primary closure is not possible. The rotated deltopectoral fasciocutaneous flap also provides an additional advantage of supplementing the cutaneous defect created by advanced laryngeal cancers in some cases involving the cervical skin anteriorly. In patients who have multiple comorbidities, pectoralis major myocutaneous flap with deltopectoral flap modification provides a faster and a reliable alternate as compared to free flap reconstruction [9]. Moreover, over the past year and a half, during the covid-19 pandemic, there has been a resurgence of the regional head and neck flaps for reconstruction aiming to reduce surgical time and hospitalisation [25]. We believe that our modified technique can be utilised to reduced surgical morbidity, especially when looking at flap survival rates.

Conclusion

The modified pectoralis major flap technique should be known to the reconstructive head and neck surgeons as it can provide a tension and complication free, solution to the closure of the skin defect following the harvest and position of a pectoralis major flap. We recommend the use of the fasciocutaneous deltopectoral flap as an axial local flap in addition to the pectoralis major flap to help protect the flap pedicle as well as for better cosmetic results.

Key Points

1. Skin tunnelling or graft closure is used for skin closure following insertion of a pectoralis major flap for reconstruction of the pharyngeal defect following pharyngolaryngectomy.
2. The use of a deltopectoral flap for skin closure takes pressure off the pectoralis major pedicle as compared to the tunnelling technique.
3. Our technique provides additional cutaneous flap to fill in the skin incision and aids in the tension free closure of the neck incision.

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Data Availability Corresponding Author.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics Approval All procedures performed in this study involving human participants were in accordance of the ethical standards of the institute. Caldicott Guardian approval was obtained from Monklands University Hospital.

Consent Informed consent was obtained from all individual participants included in the study.

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