



Outcome of Free Medial Sural Artery Perforator Flap (MSAP) for Head and Neck Reconstruction: A Systematic Review and Met Analysis

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JAMMR/2021/v33i330816

Editor(s):

(1) Dr. Mohamed Essa, Sultan Qaboos University, Oman.

Reviewers:

(1) Vadims Neļodovs, Riga Stradins University, Latvia.

(2) Guna Laganovska, Riga Stradins University, Latvia.

(3) Shafqat Ali Shah, Bacha Khan Medical College, Pakistan.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/65622>

Received 10 December 2020

Accepted 15 February 2021

Published 23 February 2021

Mini-review Article

ABSTRACT

Introduction: Since first described by Cadavas, A free medial sural artery perforator flap (MSAP) is getting popularity day by day. Specially, where the micro surgeons are desired to have thin, pliable flap with long pedicle and less donor site morbidities. For its above-mentioned characteristics and good outcome, it is now considered as one of the workhorse flaps for head and neck reconstruction.

Aims and Objectives: The aim was to find out the feasibilities and versatilities of this flap as workhorse in head and neck reconstruction. As well as taking into consideration of its low donor site morbidities.

Methods: A literature search has been performed in July 2020 in various data base including Pub Med, Trip database, Medline and Google Scholler to find out the outcome of head and neck reconstruction with free MSAP Flap. Data then were tabulated and analysed using Microsoft Excel datasheet.

Results: The results were promising. Overall, flap survival rate was 95%. Mean flap dimension was 9.3 cm x5.5 cm. Average pedicle length was 10.5 cm. Mean flap thickness was 6mm. Overall complication rate was 16% including 6% wound related and 2% donor site complication. Most of the cases donor site have closed directly (87%).

Conclusion: Free MSAP Flap is an ideal workhorse flap for head and neck reconstruction. However, as most of the literatures were case series or personal experiences of surgeons, a multicentre trial with large sample can give us more information.

Keywords: *M sap free flap; m sap flap; medial sural artery perforator flap; head and neck reconstruction; tongue reconstruction; oral cavity reconstruction; pharyngeal defect reconstruction.*

1. INTRODUCTION

Microsurgery is a relatively new specialty which has started in 1950's. Professor Sun Lee was the Pioneer of experimental microsurgery who is known to be the 'Father of Microsurgery' [1]. Currently it is an important tool of plastic and reconstructive surgeons [2]. As per reconstructive toolbox or reconstructive elevator concepts, microsurgical reconstruction can be the first option for certain defects [3]. The work with angiosome concept done by Taylor in 1987, has changed the micro surgeon's thought process tremendously. Subsequently, according to angiosome theory, micro surgeons are now more inclining towards perforator flaps [2]. Perforator flaps are gaining rapid popularity because of its versatility and less donor site morbidity. However, for most of the head and neck reconstruction require a thin pliable flap which can be moulded easily and avoid unnecessary bulkiness. With this necessity Radial Forearm Free Flap (RFFF) became workhorse flaps for head and neck reconstruction. However, it has significant donor site morbidity with unacceptable scar from skin graft, and possibilities of exposure of tendons. For this reason's micro surgeons were looking for the alternative of it. Cadavas first described MSAP flap and its advantages specially it got all qualities of RFFF with long pedicle and minimal donor site morbidity. Most of the cases we can avoid skin graft to the donor site [4]. Now a days this flap getting more popularity over its other counterpart e.g. Anterolateral Thigh Flap (ALTF) or RFFF. Surprisingly, in literature search, there were obvious lack of good quality paper about this topic. Mostly are case series and personal experiences, and some are about flap anatomy and cadaveric experiences.

1.1 Flap Anatomy and Design [5,6,7,8]

Flap anatomy

- Flap dimension: Average flap 12.9cm x 7.9 cm
- Origin of Perforators: Medial Sural artery (66% from the lateral branch and 34% from medial branch) arises from Popliteal artery

- Number of perforators: 1-3 (mean 1.9)
- Site of perforators: Area between 7-18 cm from the popliteal crease (90% were at 10cm+/-2 from crease), 13cm +/-2, from posterior midline 2.5cm+/-1
- Diameter of perforators: 0.3mm-0.8mm
- Pedicle length: 10-17cm (11.75cm)
- Pedicle diameter: Artery 1.7mm-3mm (2.2mm), Vein 2.3mm-3mm (2.6mm)

Flap design: (Fig. 1, Fig. 2)

- Draw a long axis from mid popliteal crease to prominence of medial malleolus.
- Locate the perforators and marked using a handheld doppler (usually 6-18 cm from popliteal crease along the axis mostly at 10cm+/-2)
- Draw a flap centred with perforator using templet of defect.

1.2 Objective

This systematic review is to find in depth about versatility of flap characteristics and outcome related to head and neck reconstruction as well as its donor sites morbidities.

2. MATERIALS AND METHODS

A Systematic review was performed in July 2020, according to Preferred Reporting Items for Systematic Reviews and Meta- Analysis (PRISMA) system (Fig. 3). A literature search has been done in Pub Med, Medline, Trip database and Google Scholar database, using key words (as below) on the basis of three part questions (Table 1) during the period of last ten years from January 2010 to July 2020.

The outcome of free MSAP for head and neck reconstruction has been quired.

Extracted data has been tabulated and analysed using Microsoft Excel sheet and discussed the findings along with tables and diagrams.

2.1 Key Word Search

(((((msap free flap) OR (msap flap)) OR (medial sural artery perforator flap)) OR (free

medial sural artery perforator flap)) OR (medial sural artery perforator free flap)) and (head and neck reconstruction)) OR (tongue reconstruction)) OR (oral cavity reconstruction)) OR (pharyngeal defect reconstruction)) OR (laryngeal defect reconstruction).

2.2 Search Outcome

Search results yielded a huge number of literatures counted 7892. After initial scanning of titles and by excluding repeated titles and irrelevant topics the most relevant 24 papers have been selected. Reading through the abstracts further 6 papers were excluded because of unavailability of full texts and further 3 were excluded as written in different language than English. 15 papers were finally shortlisted for review in details.

3. RESULTS

Total of 585 patients have received MSAP flap for head and neck and limbs reconstruction. 386 of them had head and neck reconstructions using free MSAP flap. Male were 74% and female were 26%. Mean age of the patients was 53.9 years (Range 15 to 87 years). All documented reconstructions were for post oncological defects. Site of the reconstruction stated 50% was tongue, 22% was lip and oral cavity, 11% were pharynx/larynx / oesophagus, 10% was Floor of mouth. Less common sites were parotid, face, scalp, ear, thyroid and nose.

As per documentation 32 patients had Chemotherapy (CT) or Radiotherapy (RT) or Combination. (Some citation hasn't documented about chemotherapy or radiotherapy. Flap length ranged from 4 cm to 22 cm (mean 9.3 cm). Flap width was ranged from 2.5 cm to 12 cm (mean 5.5 cm). The range of the pedicle length was 5 cm to 16 cm with an average of 10.5 cm. The mean thickness of flap was 6 mm with ranged from 3.5 mm to 12 mm. Female have significant higher thickness than male (6.75 mm vs 4.7 mm). The numbers of perforator were ranged from 1 to 5 (mean 1.5). Pedicle vessel diameter was 1.3 to 3 mm (mean 1.9 mm) for arteries and 1.5 mm to 6 mm (mean 2.9 mm) for veins. Facial and superior thyroid arteries carry same preference as recipient's artery comprises 43% facial artery, 39% Superior thyroid and 18 % External maxillary artery. Mean flap raise time was one and half hour and mean total operative time was 5 hours 45 minutes. Nearly all donor areas have closed directly (87%) and only 13 % patients needed donor area skin graft. Maximum width of defect closed directly was 8 cm. Documented Follow up period was 2-35 months. Flap success rate was 95% with 1% has partial flap loss. Overall, complication was 16%. Most of the post-operative threat to flap was venous congestion. 6% patients showed wound complications and 2% of patients had donor complications. 4 patients have died from cancer and one has died from heart failure. Only 1% patient expressed their dissatisfaction with their flap i.e., bulky flap or failure or hair growth.

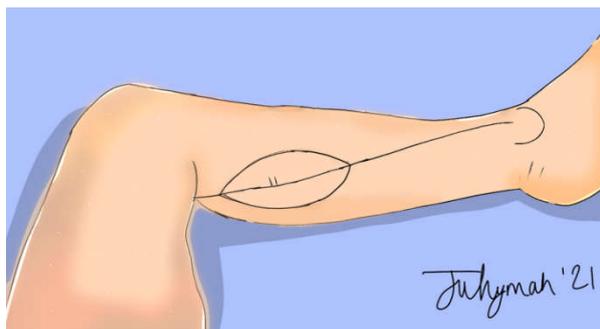


Fig. 1. Flap design

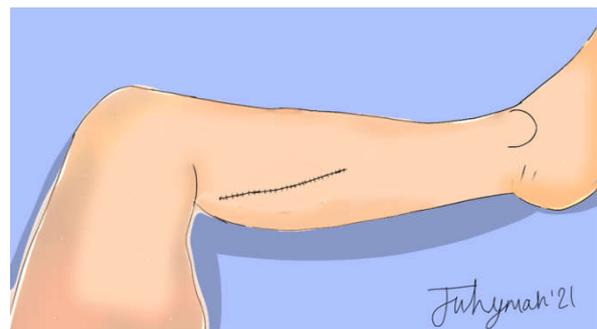


Fig. 2. Donor closure

Table 1. Three-part questions

Patient characteristics:	Patient with head and neck defect needed reconstruction
Intervention question:	Reconstruction of defect with Free Medial sural Artery Perforator Flap
Relevant outcome:	to show the best functional and cosmetic outcome with minimal morbidity.

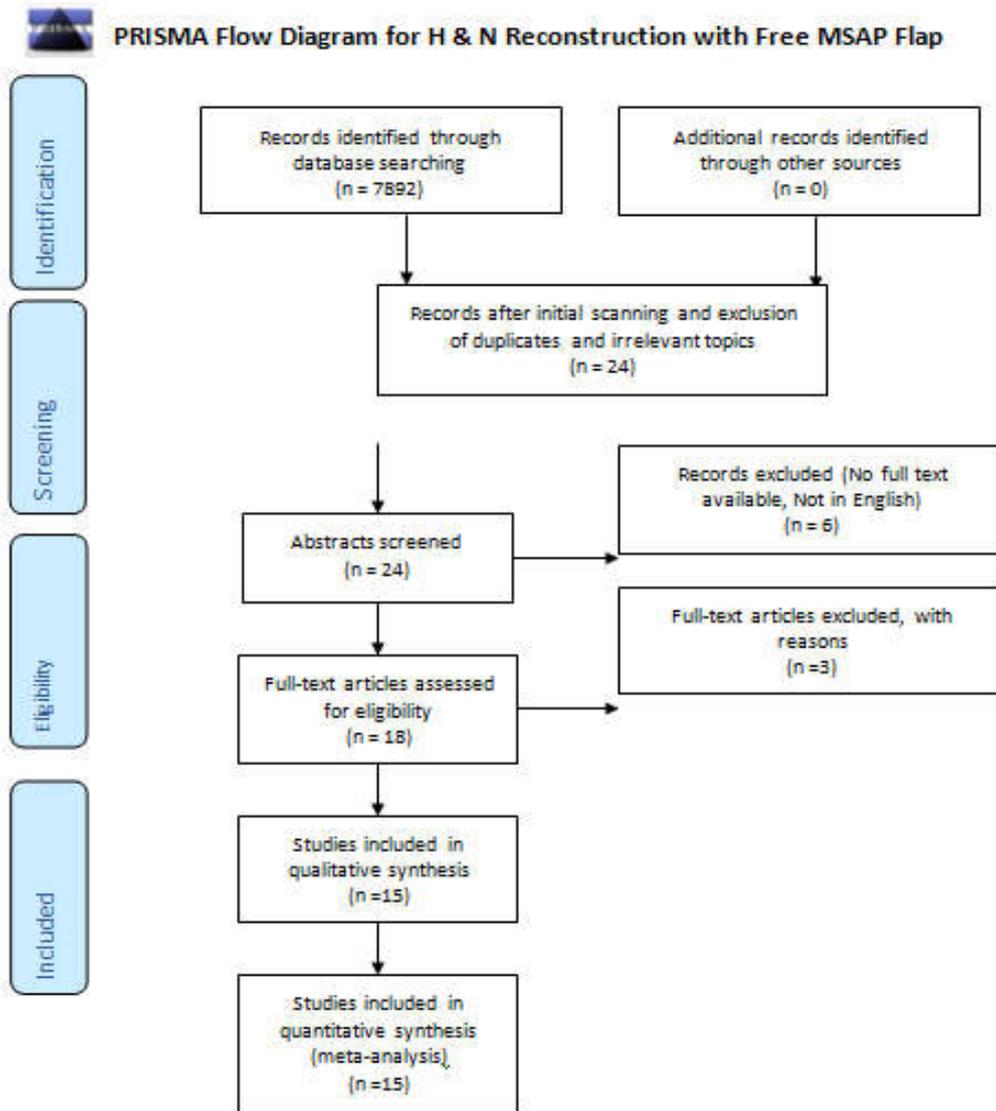


Fig. 3. PRISMA flow diagram

4. DISCUSSION

The reconstruction of head and neck mostly due to post oncological resection. These patients potentially receive pre- and/or post-operatively, chemo or radiotherapy treatment. Factors those are important for head and neck reconstruction include-a) Post oncological resection commonly leave composite defects with or without circumferential involvement .b) Usually, patients are older and can have multiple co morbidities including their active cancer. c) Limited local donor option after radical excision of tumour +/- neck dissection, d) Patients may have neo-adjuvant or adjuvant chemotherapy or

radiotherapy or combination treatment. e) Function f) Aesthetics. So, microsurgical free flap reconstruction becoming the first possible option for restoration of function in head and neck region [23]. Perforator flaps are getting popularity in head and neck reconstruction for its versatile characteristics. Most of them are soft, pliable vascularised tissue without need for sacrificing muscle or function. Some of them even have very minimal donor morbidities. Free MSAP flap is one of them which already gained confidence from many micro surgeons on head and neck and limb reconstruction. (Figs. 4 and 5) It is thin, pliable, easy to create a tube, long pedicle, durable and using as workhorse flap for head

Table 2. Relevant papersthose are included for full text review and discussion

S/N	Authors	Country	Journal	Year	Study type	Total patients	Flaps for H&N	Key outcome (Flap survival)	Weakness
1	Zahrah M Taufique, et al. [9]	USA	Otolaryngology-Head and neck surgery	2020	Retrospective Case series	5	5	100%	Very small case series with short follow up
2	Gloria R. Sue, et al. [10]	Taiwan	Microsurgery	2019	Retrospective study	246	170	94.1%	Combined study with extremities reconstruction
3	Farrukh Aslam Khalid, et al. [11]	Pakistan	J Ayub Med Coll Abbottabad	2018	Retrospective Case series	18	13	100%	Small case series
4	Gunjan Agrawal, et al. [12]	India	Ann Maxillofac Surg	2018	Pprospective Case series	10	10	90%	Small case series
5	Zahrah M. Taufique, et al. [13]	USA	The Laryngoscope	2018	Retrospective Case series	21	21	95.2%	Small Case series
6	Shao-Yu Hung, et al. [14]	Taiwan	Plos one	2017	Retrospective study	27	27	96.3%	Retrospective case series
7	Klaus-Dietrich Wolff, et al. [15]	Germany	Journal of Cranio-Maxillo-Facial Surgery	2017	Retrospective Case series	131	18	89%	Retrospective study with good number of patients however, very small number of head and neck reconstruction cohort

S/N	Authors	Country	Journal	Year	Study type	Total patients	Flaps for H&N	Key outcome (Flap survival)	Weakness
8	Heval Selman O'zkan, et al. [16]	Turkey	Eur Arch Otorhinolaryngol	2016	Retrospective Case series	11	11	91%	Small case series
9	Xiang-qian Shen, et al. [17]	China	JPRAS	2016	Retrospective Case series	18	18	100%	Perioperative data missed
10	Hui Shen, et al. [18]	China	Annals of Plastic Surgery	2016	Retrospective Case series	4	4	100%	Small case series, only circumferential reconstruction. poor data quality
11	Xiaomeng Song, et al. [19]	China	Journal of Reconstructive Microsurgery	2015	Retrospective Case series	24	24	95.8%	Scarcity of perioperative data
12	M. Nugent, et al. [20]	UK	BJOMS	2015	Short Communication	6	6	100%	Very small case series
13	M lves, et al. [21]	UK	JPRAS	2015	Retrospective Case series	18	13	100%	Study combined with limbs reconstruction
14	Choi JW, et al. [22]	South Korea	J Reconstr Microsurg	2013	Retrospective Case series	20	20	90%	Retrospective study with good number of patients however, very small number of head and neck reconstruction cohort
15	Huang-Kai Kao, et al. [23]	Taiwan	PRS	2010	Retrospective Case series	26	26	96.2%	No perioperative data.

Table 3. Summary of results

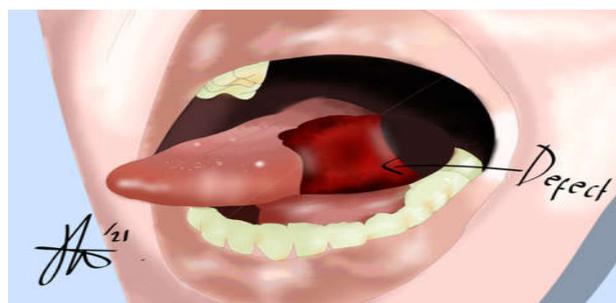
Data collection	
Total Number of Papers	15
Total Number of Patients	585 (Some papers have combination of H&N and limbs reconstructions)
Total number of Patients had head and neck reconstruction	386
Total number of Flaps in head and neck reconstruction	386
Patients Demographic	
M: F	3:1
Age of the Patient (Years)	15-87 (mean 53)
Recipient site data	
Cause of defect in H & N	Oncological resection (100%)
Common site of reconstruction	Tongue (50%), Lip & Oral cavity (22%)
Flap characteristics	
Flap Length (cm)	4-22 (mean 9.3)
Flap width (cm)	2.5-12 (mean 5.5)
Flap thickness (mm)	3.5-12 (mean 6)
Number of perforators	1-5 (mean 1.5)
Pedicle length (cm)	5-16 (mean 10.5)
Pedicle artery diameter (mm)	1.3-3 (mean 1.9)
Pedicle vein diameter (mm)	1.5-6 (mean 2.9)
Common Recipient artery	Facial (43%), Superior thyroid (39%)
Donor Closure	Direct closure (87%)
Operative time	
Mean flap raise time (mins)	92
Mean total operative time (mins)	345
Outcomes	
Total Flap failure	5%
Partial flap failure	1%
Patient satisfaction	99%
Overall flap success rate	95%

and neck reconstruction. Further advantage of two team approach can reduce the total operative time as well as minimal donor site morbidity. Many literatures also supported about its safety, reliability and aesthetic outcome [20,21,24].

RFFF is losing its popularity because of its unacceptable donor site morbidity. ALT flap is

bulky for the oral reconstruction. It is not an easy site for flap thinning procedure and also can cause vascular compromise [25,26]. Visual Analog Score (VAS) for donor site in case of free MSAP was 88% whereas ALTF was 56%, and RFFF was only 15% [19]

In this literature search, 15 papers related to head and neck reconstruction with free MSAP

**Fig. 4. Post resection tongue defect****Fig. 5. After flap reconstruction**

Flaps have been reviewed. It is found to be a reliable workhorse flap for head and neck reconstruction with good functional and aesthetic outcome.

4.1 Flap Anatomy

There were number of anatomical studies have been done for MSAP flap [6,10,22,27]. In this study, the dimension of flap was 9.4 cm x 5.5 cm, which shows close correlation with other similar studies [2,27]. Mean Pedicle length was found 10.5 cm, which is looked the same compared to others [2,5,6] In this study the range of perforators was 1 to 5, which is also similar compared to anatomical studies which was 1 to 8 [5,6,7,14,27]. Mean arterial diameter was 1.9 mm and vein was 2.9, it was also confirmed by other studies [5,6,7]. An average thickness of flap was 6 mm which has given its thin and pliability character. Its size, pedicle length, thin skin puddle and possibility of two team approach with low donor site morbidity are the point in favour for its versatility in head and neck reconstruction.

4.2 Outcome Measure

Donor site can close primarily in 87 % cases, also compared to other review article nearly same 76.2% [2].

Overall flap success rate is 95%. Total flap loss was 5% and partial loss 1% compared to other literature who stated total loss of 3.1% and partial loss 3.1% [2].

Overall complications in our study were 17%, compared to others, some of study found nearly same findings of 14.3 % (2), 16.7%. Donor complications 2% compared to other study of 1.9% [2].

Most common cause of flap failure was venous congestion compared to same as stated by Daar et al. [2].

4.3 Advantages and Disadvantages of the MSAP Flap

Advantages

- Flap is Thin and pliable and versatile in designing
- Long vascular pedicle helps to anastomosis away from zone of injury & zone of radiotherapy.

- Reliable pedicle with good number of perforators with satisfactory size
- Minimal donor site morbidity (2%), more than 80% cases can close directly.
- Can raise as chimeric, it can harvest with vascularised fascia can act as gliding surface. [16]
- Consistent anatomy
- Can raise as sensate flap with saphenous nerve or sural nerve
- Less need for flap thinning or adjustment operation.
- No donor site functional limitation

Disadvantages

- Variations in perforator anatomy
- Tedious intramuscular dissection
- Can't use for large area reconstruction (On an average flap size 9.4 cm x 5.5 cm)
- Scar stretching or notching, skin graft can leave unacceptable ugly scar which is one of the important drawbacks of this flap specially for female.

5. CONCLUSION

Free MSAP Flap becoming popular and getting more attention to head and neck microsurgeon. It is versatile, pliable and has long reliable pedicle with little donor site problem. Most of the patients were satisfied with their overall outcome on their reconstruction and donor site. However, literature search showed mostly single centre case series with small number of cases. A multicentre trial with large sample can give us more information about its outcome and variance.

CONSENT

No informed consent was required for the development of the literature.

ETHICAL APPROVAL

No ethical approval was required being a literature review.

ACKNOWLEDGEMENTS

My wife Dr Afsana Yasmin for her kind support and my two genius daughters Juyrah Ayeesa Hosain and Juhymah Aeera Hosain for their excellent drawings and illustration.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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