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ORIGINAL ARTICLE

Does Pectoralis Major Myocutaneous Flap Cause the Shoulder Morbidity: A Clinical Comparative Study

Venkatesh Anehosur[1] · Hitesh Vadera[2] · Adithi Bhat[3] · S. Satyanarayana[4] · Niranjan Kumar[5]

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Abstract The aim was to compare the morbidity of shoulder function following modified radical neck dissection with and without Pectoralis Major Myocutaneous muscle flap (PMMC) harvest in head and neck cancer patient to determine the effect of PMMC flap harvest on shoulder function and also to determine the effect of physiotherapy. Materials and methods: Prospective study involving two groups study group of 20 patients with MRND, with PMMC flap reconstruction as part of head and neck cancer surgery and control group of 20 patients who had undergone MRND(IJV & SAN sparing) without PMMC flap in same period were included. All patients were assessed at 3rd and 6th month following completion of surgery using subjective (Shoulder Disability Questionnaire) and objective (goniometer and manual muscle testing) parameters. 40 patients were included in the study, 33 (82.5%) male and 7 (17.5%) female with a mean age of 49 years with stage III/IV carcinoma In Group-1 and Group-2 the shoulder disability decreased significantly after physiotherapy intervention and also at 6thmonth postoperatively both groups showed improvements in shoulder range of motion and muscle strength. Harvesting of PMMC flap does not intensify the morbidity of shoulder which is common in RND and during MRND. A regimen of home-based exercises and patient education are effective tools to reduce shoulder disability and improving shoulder function.

Keywords Shoulder morbidity · Modified radical neck dissection pectoralis major myocutaneous flap · Range of motion · Goniometer · Manual muscle test · Physiotherapy

✉ Venkatesh Anehosur
venkyrao12@yahoo.co.in

Hitesh Vadera
drhiteshvadera@gmail.com

Adithi Bhat
adithi.bhat@yahoo.co.in

S. Satyanarayana
sirigeri_satya@yahoo.com

Niranjan Kumar
drniranjankumar@sdmmedicalcollege.org

1 SDM Craniofacial Surgery and Research Centre, SDM College of Dental Science and Hospital, Shri Dharmasthala Manjunatheshwar University, Dharwad, Karnataka, India

2 Department of Oral and Maxillofacial Surgery, AMC Dental College Khokhara, Ahmedabad, India

3 SDM College of Dental Sciences and Hospital Shri Dharmasthala Manjunatheshwar University, Dharwad, Karnataka, India

4 Sumedh Physiotherapy Centre, Hubli, Karnataka, India

5 Department of Plastic and Reconstructive Surgery, SDM Craniofacial Centre, Shri Dharmasthala Manjunatheshwar University, SDM College of Medical Sciences and Hospital, Sattur, Dharwad, Karnataka 580009, India

Introduction

The Pectoralis Major Myocutaneous muscle flap has been the most commonly used pedicle flap in major head and neck cancer surgery and remains the ''workhorse flap'' for head and neck reconstruction [1]. Its advantages are reliability, speed and ease of harvest, rich vascularity, bulk and large area of skin territory [2]. Although free flap microvascular reconstruction often provides the reconstruction of choice in the modern era, the PMMC flap retains an important role in several reconstructive situations. These include salvage of free flap failure,

reconstruction in high-risk patients (e.g., after chemo-radiotherapy or cases in which there is significant vascular or general comorbidity), protection of great vessels, and use with free flap for bulk and/or coverage and protection of vascular anastomosis. It is mostly used as an island myocutaneous flap but can also be used as a myofascial island flap, the latter for neck vessel protection or when the myocutaneous flap is too bulky (using skin graft instead) [3].

Pectoralis major muscle is a fan-shaped muscle originating from median half of clavicle, sternum, and costal cartilages of ribs 2 to 6 and inserting into the bicipetal grove on the upper humerus. The dominant superior vascular supply to this muscle is from the thoracoacromial artery, which arises from the second portion of axillary artery. The nerve supply to this muscle is from lateral and median pectoral nerves. It has a role in shoulder movements along with other intrinsic and extrinsic muscles, specifically adduction, flexion, medial rotation of the shoulder and protraction of scapula [2].

It is often suggested that a drawback of this flap is its detrimental effect on shoulder function. Some authors have commented that any loss of function appears well tolerated, while others have reported that the loss of muscle function prevents manual workers returning to their work [4]. Shoulder disability, one of the most important morbidities of ND, is a major concern in the quality of life (QOL) of these patients [5]. Many explanations have been proposed to account for shoulder pain and loss of range of motion, including adhesivecapsulitis, paralysis of the muscle trapezius pars descendens, myofacial trigger points, acromioclavicular or sternoclavicular luxation and neuropathic disorders [6]. During Radical Neck Dissection all levels of lymph nodes on one side of the neck and several important surrounding non-lymphatic structures are resected, including the spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle [7, 9]. A number of reports have reviewed the functional sequel following Radical Neck Dissection. Undoubtedly, the most relevant functional aspect is the impairment of shoulder function as a result of the section of the spinal accessory nerve (SAN) [8]. The issue of functional disabilities after Radical Neck Dissection and PMMC flap has been addressed by several authors in the literature. Hypothesis of this study, to our knowledge, there are no studies that have strictly focused to know whether disabilities would be increased with PMMC flap harvesting after Modified Radical Neck Dissection and outcome after physiotherapy treatment. In the present paper, the results of a prospective study analysing the effect of PMMC flap harvest on shoulder function while taking into account the confounding effect of ND and also to determine the effect of physiotherapy in the patient with shoulder morbidity after Modified radical Neck Dissection.

Materials and Methods

Prospective study of two groups of 20 patients with MRND (IJV & SAN sparing) with PMMC flap reconstruction and control group of 20 patients with MRND (IJV & SAN sparing) without PMMC flap i.e. skin graft, and free flap in the same period were included as a part of head and neck cancer surgery from 2016 to 2018 were included. Study design was approved by Institutional Review Board.

All patients alive without recurrence and attending follow-up were involved. Patients with previous shoulder injury, shoulder surgery, myopathy, and neuropathy were excluded. All patients were assessed at a minimum of 6 months following completion of treatment in both the groups.

All the surgeries were performed by a single surgeon. Group-1 included patients with MRND and PMMC flap. In Group-2 included patients with MRND and other forms of reconstruction method such as free fibula, radial forearm, anterolateral thigh flaps and skin graft.

Assessment

Ethical clearance was obtained from research committee and a valid informed consent was taken from all the patients who were included in the study. Socio demographic data and information on tumour type, localization, staging, type and extent of surgery, type of reconstructive surgery, extent and side of neck dissection, RT and CT were derived from patient's records. All patients were assessed at 3rd and 6th month following completion of surgery. The subjects were invited to participate in the 30 min assessment in the outpatient setting. At 3rd month, a subjective assessment was carried out using Shoulder Disability Questionnaire SDQ (Table 1) and Visual analogue scale and objective assessment was done by obtaining Range of Motion (ROM) of shoulder with Goniometer and muscle strength using MMT by a single physical therapist. After the first assessment, physiotherapy was started immediately according to guidelines that were developed previously and comprised mild passive and active exercises to improve and maintain shoulder mobility and muscle function. These patients were given home exercises and were regularly followed up.

Table 1 Shoulder disability questionnaire

S. No	Questionnaire	3rd month			6th month		
		NY	Y	N	NY	Y	N
1	I wake up at night because of my shoulder						
2	My shoulder hurts when I lie on it						
3	I have difficulty putting on a jacket or sweater						
4	My shoulder hurts during my daily activities						
5	My shoulder hurts when I move my arm						
6	My shoulder hurts when I lean on my elbow or hand						
7	My shoulder hurts while or write or type						
8	My shoulder hurts when driving or riding a bike						
9	My shoulder hurts when I lift and carry stuff						
10	My shoulder hurts when I reach or grasp above my shoulder level						
11	My shoulder hurts when I open or close the door						
12	My shoulder hurts when I bring my hand towards my buttocks						
13	My shoulder hurts when I bring my hand towards my lower back						
14	My shoulder hurts when I bring my hand towards the back of my head						
15	I rub my shoulder more than once during the day						
16	I am irritable and bad tempered with people because my shoulder hurts						

Results

Out of 40 patients included in the study, male predominance was seen with 7 female patients with a mean age of 49 years. Descriptive analysis of patients' i.e. primary site of tumour, type of resection and reconstructive surgery and histopathological type of tumour are summarized in Table 2. All 40 patients included in study were in Stage III/IV carcinoma (AJCC, 2002). All patients completed the SDQ at 3rd month and 6th month postoperatively. In Group-1, 57.5% patients had shoulder disability according to SDQ at 3rd month and disability reduced to 33.8% at 6th month after physiotherapy intervention. In Group-2, 54.8% patients had shoulder disability at 3rd month and disability

Table 2 Descriptive difference between Group-1 and Group-2

Variables	MRND + PMMC flap Group-1	MRND + No PMMC flap Group-2
Age	51.7 years	46.6 years
Gender (Male: Female)	17:3	16:4
Primary tumor site		
Mandibular alveolus	8	6
Buccal mucosa	10	6
Retromolar trigone	2	2
Tongue	0	6
Histopathological study		
SCC-Well	13	13
SCC-Mod	6	7
SCC-poor	1	0
Radiotherapy	16	19
Chemotherapy	16	18
Right side MRND	11	9
Left side MRND	9	11

reduced to 28.1% at 6th month after physiotherapy intervention. Comparison of shoulder complaints obtained by SDQ between Group-1 and Group-2 at 3rd month as well as 6th month were not significant (Table 3). In Group-1, Seventeen patients complained about pain when they lay on the same side of surgery. These answers indicated that in group-1, patient's main complaints were during usual daily activities, on movement of the arm, on carrying something, to reach or grasp above shoulder level and during hand movements towards the back of their head. All these problems were reduced significantly in 6th month due to physiotherapy. These answers indicated that in group-2, patient's main complaints were same as we had seen with Group-1. In the 6th month follow-up all these problems improved due to physiotherapy (Fig. 1).

Range of Motion In group-1 and group-2, all active ROM of shoulder i.e. flexion–extension, abduction–adduction, internal and external rotation were reduced compared to normal value at 3rd month postoperatively. Table 2. Comparison between group-1 and group-2 in all ROM of shoulder did not show any statistically significant difference at 3rd month postoperatively except for adduction motion of shoulder.

At 6th month postoperatively both group-1 and group-2 showed improvements in shoulder ROM which was statistically significant compared to 3rd month but between Group-1 and Group-2, there was no significant difference in active ROM.

Manual Muscle Testing In both Group-1 and Group-2, MMT revealed decrease in strength in all ROM i.e. flexion–extension, abduction–adduction, internal and external rotation. At 3rd month postoperatively in Group-1 the muscle strength was 60.75% and in Group-2 it was 66.75%. There was no statistically significant difference in muscle strength in Group-1 and Group-2 ($p = 0.096$). During 6th month evaluation there was statistically significant increase in strength of shoulder motion in Group-1.

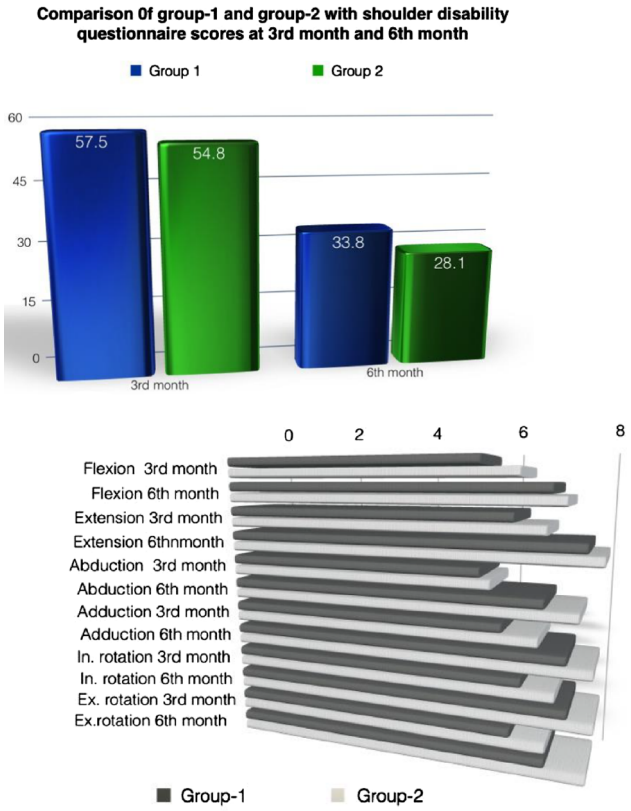

Fig. 1 Comparison of Group-1 and Group-2 with different muscle strength variables at 3rd and 6th month follow-up

Table 3 Comparison of group-1 and group-2 with different parameter scores of shoulder motion (in degrees) with Goniometer at 3rd and 6th month by *t*-test

Variables	Time	Group-1		Group-2		*t*-value	*p*-value
		Mean	S.D	Mean	S.D		
Flexion	3rd month	102.7500	9.3857	106.7500	11.3873	−1.2122	0.2329
	6th month	110.7500	9.6348	113.5000	9.6108	−0.9037	0.3718
Extension	3rd month	42.2500	4.1279	43.2500	2.9357	−0.8829	0.3828
	6th month	48.000	6.1559	48.7500	3.1933	−0.4837	0.6314
Abduction	3rd month	80.7500	15.8343	82.0000	15.5089	−0.2522	0.8022
	6th month	90.0000	10.3872	95.2500	13.3254	−1.3896	0.1727
Adduction	3rd month	37.7500	4.4352	44.8000	3.7360	−5.4369	0.0000
	6th month	45.7500	4.3755	46.7500	3.3541	−0.8112	0.4223
In. Rotation	3rd month	46.5000	7.0897	49.2500	8.9259	−1.0789	0.2874
	6th month	53.7500	5.8208	54.2500	5.9105	−0.2696	0.7890
Ex. Rotation	3rd month	50.2500	8.0255	51.5000	4.6169	−0.6038	0.5496
	6th month	55.5000	8.0948	57.2500	4.4352	−0.8479	0.4018

Discussion

A universally accepted adverse independent prognostic factor in head and neck cancer is the presence of cervical lymph node metastasis and therefore neck dissection is mandatory. The current philosophy is generally to preserve the SAN, if and when possible. If the tumour involves the SAN or the nerve cannot be separated from the tumour it needs to be sacrificed [10, 11].

Reported prevalence of shoulder complaints ranges from 47 to 100% after Radical Neck Dissection, 18 to 61% after Modified Radical Neck Dissection, and 29 to 52% after SND. Non-SND was a risk factor for shoulder pain and restricted abduction. Reconstruction (pectoralis major flap) was a risk factor for restricted forward flexion of the shoulder [12].

In our study 73% of group-1, and 68% of group-2 complained of pain postoperatively.

We used SDQ which was useful to know the disability during daily activities.

It is well accepted that the in RND where the spinal accessory is sacrificed will induce shoulder morbidity [13–15] but with the newer concepts of nerve preservation we did the study on MRND where the nerve was preserved and with a objective of correlation between PMMC flap with shoulder morbidity.

Present study SDQ was used as a subjective tool, as objective findings of physical dysfunction correlated well with perceived shoulder disability as measured by the SDQ, indicating that shoulder dysfunction results in performance problems in activities of daily living [6]. Winter et al. also suggested that SDQ appears to be a useful discriminative instrument, especially in the primary care setting [16].

In this study following Modified Radical Neck Dissection with PMMC flap reconstruction (Group-1), all patients complained of disability during their usual daily activities at 3rd month postoperatively. other complaints of pain on movement of arm, during lifting something, grasping above the shoulder level and during movement of hand towards the back of their head was noted. Similar findings were noted in (Group-2). The fact even without PMMC flap patients showing shoulder morbidity can be attributed to neuropraxia of the nerve during dissection also reported earlier [12]. The SDQ at 3rd and 6th months post-operatively group-1, 57.5% patients had shoulder disability and reduced to 33.8% at 6th months following physiotherapy. In Group-2, 54.8% patients had shoulder disability at 3rd month and 28.1% at 6th month after physiotherapy intervention. Comparison of shoulder complaints obtained by SDQ was found not significant. The results were same in both groups even after physiotherapy.

ROM of shoulder was obtained with Goniometer (Figs. 2, 3) which is a highly reliable instrument [17]. The values indicated that after MRND, flexion, abduction, internal and external rotation movements were commonly affected in both groups. The range was 60.6% in group-1 and 65.2% in group-2, the difference between group-1 and group-2 was statistically not significant in any kind of motion. At 6th month postoperatively in both group-1 and group-2 mean range of motion were improved significantly after physiotherapy. The comparison between both groups were statistically not significant.

MMT grading is based on a system in which the ability to hold the tested part in a given position against gravity establishes a grade referred to as fair or the numerical equivalent (depending on the grading symbols being used). More precise grading helps to establish the rate and degree of return of muscle strength and is also useful in determining the prognosis. This study muscle strength of the shoulder was examined in all ROM. Difference between muscle strength of shoulder of groups was not statistically significant. At 6th month postoperatively there was statistically significant increase in muscle strength in both groups. The difference between muscle strength at 6th month was not statistically significant between both groups except external rotation. The exact cause of this difference in external rotation is difficult to express but it may be attributed to less exercise during home exercise program by group-1.

The similar study done by Ashirwad Merve et al. and they found the difference in Group-1 and Group-2 shoulder morbidity appeared to be the least in the RND/Extended Radical Neck Dissection which was the largest group in the study. It may be that, in these patients particularly, given the impact of Radical Neck Dissection on shoulder function, the additional morbidity from PMMC flap transfer was found not significant [3].

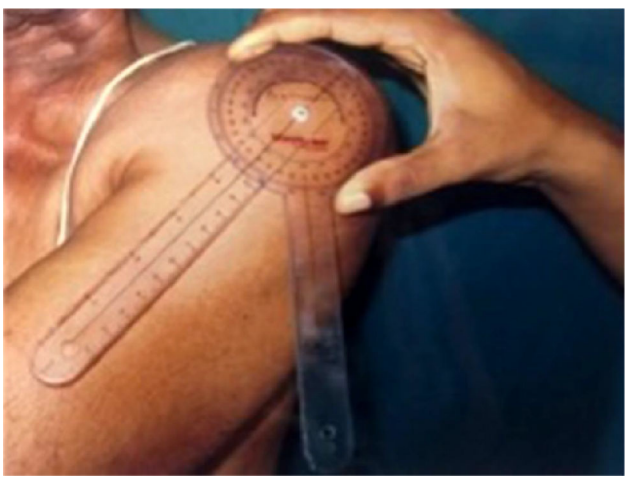

Fig. 2 Examination of range of motion using goniometer

Fig. 3 Goniometer measuring the extension of shoulder movement

In our series, a standard technique of PMMC flap harvest and transfer was employed, that is transection of the sternal head of the muscle and skeletonization of the pedicle which was then transferred over the clavicle. The clavicular head, with neurovascular pedicle was preserved to minimize the impact on shoulder function [4]. Sophisticated electromyographic studies of the muscles of the glenohumeral joint have demonstrated that the regional musculature combination adequately compensates for any functional loss of the pectoralis muscle when it is used as a myocutaneous flap [18, 19]. Magee etal reported that the loss of pectoralis major muscle is of minimal consequence [20].

The advantages and reliability of the PMMC flap are well documented [21]. The reduction in operating time compared with micro vascular free flaps and lack of reliance on micro vascular surgery in terms of expertise and equipment makes it suitable for high-risk patients because of co-morbidity or previous chemoradiation [1]. Minor problems with bulk of the flap either limiting rotation or by creating an unesthetic mass over the clavicle can easily be overcome by skeletonization of the pedicle and by reducing motor nerve activity by sacrificing the pectoral nerve which was done in this study.

In our study postoperative physiotherapy started immediately after assessment of shoulder function at 3rd month and was applied according to guidelines that were developed previously which comprise mild passive and active exercises to improve and maintain shoulder mobility and muscle function, active exercises to regain mobility of the neck, and patient education [6]. The main exercise programme was home based and patients were instructed to perform regular shoulder exercise at home. They were recalled every month for the physiotherapist consultation and evaluation.

The strength of this study was its prospective design, allowing investigating only those shoulder complaints that actually arose after the MRND and the combination of both objective and subjective findings regarding shoulder function. The results of this study suggest that harvesting of Pectoralis Major Myocutaneous muscle flap does not intensify the morbidity of shoulder which is documented in RND or MRND. This study was also designed to evaluate the efficacy of physiotherapy after MRND consequently, which lead to prove the improvement in shoulder ROM and muscle strength. A regimen of home-based exercises and patient education may suffice to reduce shoulder disability.

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Compliance with Ethical Standards

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

Informed Consent Valid informed consent has been obtained from all the patients included in the study.

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