



AN OBSERVATIONAL STUDY- TO EVALUATE HEALTHY SKIN FLAPS IN PATIENTS OF BREAST CANCER UNDERGOING MASTECTOMY – A STUDY OF 30 CASES

Surgery

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ABSTRACT

Background: Breast carcinoma is most common carcinoma among women in India accounting for 32% of all women cancers. The incidence is 35 per 100,000 women with 75000 new cases diagnosed and 40,000 deaths per year.¹ In India, age distribution of breast cancer has undergone a significant change over the last two decades. Now, most cancers occur in women aged 30-50 years of age, with premenopausal females constituting about 50% of all female patients. Mastectomy is often necessary for effective cancer management, it carries the potential risk of complications related to the skin flaps created during surgery. The commonest complication of mastectomy is skin flap necrosis (changes in skin flap), ranging from 8.6% - 30% in various studies. It is a significant complication but most of the time ignored. Skin flaps refer to the remaining skin envelope after the breast tissue is excised, and their viability is crucial for proper wound healing, minimizing the risk of complications such as skin changes resulting in infection, necrosis and wound dehiscence, and achieving satisfactory cosmetic outcomes. The health and quality of skin flaps can be influenced by various factors, including surgical technique, extent of tissue resection, and patient-related characteristics. Identifying and understanding these factors is essential for optimizing surgical planning, intraoperative decision-making, and postoperative care, ultimately leading to improved patient outcome.⁵ **Aims:** To determine factors affecting healthy skin flap after mastectomy. **Methods:** Prospective observational study of skin flaps of patients (age>18) having breast carcinoma undergoing mastectomy. Wound measurements will be recorded using Imito Measure App available on google play and sterilized Metal Scale. The wound will be examined on 5th day for skin changes. In case skin changes are present, it will be assessed using the SKIN (Skin Ischemia and Necrosis) score.¹⁰ **Depth:** will be seen with a four-point score, with None, no evidence of skin changes. Colour change of flap due to decreased perfusion or ischemic blood vessels (cyanosis or erythema). Partial thickness flap changes lead to at least epidermal sloughing. Full thickness changes in skin flap. Surface area of MSFN Score: % area Definition 1. 0% None 1–10 % of breast skin, NAC (Nipple Areola Complex) 11–30 % of breast skin, NAC, or total nipple involvement. 30 % of breast or NAC Each breast will be assigned both a number and a letter score to characterize the severity of skin changes in flap. **Results:** Many factors have been implicated affecting healthy flap, but none were significant statistically in this study, may be due to less sample size. Tight suturing was one of the important factors which couldn't be established objectively but based on observation it was found that all mild skin changes were at places of vertical mattress sutures in this study. Restriction to oncoplastic plane is the most important factor for both oncological safety and healthy skin flaps. If there are skin changes in 5th day after mastectomy there is more chance of gaping of that wound. It is a significant factor in this study. **Conclusion:** Restriction to oncoplastic plane is the most important factor for both oncological safety and healthy skin flaps. In this study it was shown that if oncoplastic plane restriction done then the chances of change in healthy skin flap were far less. Tight suturing was most common cause for change in healthy skin flaps.

KEYWORDS

Breast Carcinoma, Mastectomy, Modified Radical Mastectomy, SKIN Score, Healthy skin flap

INTRODUCTION

Breast carcinoma is most common carcinoma among women in India accounting for 32% of all women cancers. The incidence is 35 per 100,000 women with 75000 new cases diagnosed and 40,000 deaths per year.¹ Epidemiological studies have shown that the global burden of Breast Carcinoma is expected to cross almost 2 million by the year 2030.²

In India, age distribution of breast cancer has undergone a significant change over the last two decades. Now, most cancers occur in women aged 30-50 years of age, with premenopausal females constituting about 50% of all female patients. However, breast carcinoma can be detected at earliest stages by simple self-breast examination, in developing nations maximum (>90%) cases are diagnosed in later stages i.e. stage IIB, stage III and stage IV. Younger female has larger tumour size, higher number of metastatic lymph nodes, advanced tumour grade, low hormone receptor - positive status, earlier and increased locoregional recurrences, and decreased overall survival.

The incidence is rising across the urban areas mainly due to changing reproductive behaviour, westernization of lifestyle, postmenopausal obesity, and lack of physical activity. There are diagnostic and treatment-related challenges in young breast cancer patients.³

Mastectomy, the surgical removal of the breast, is often required as part of breast cancer treatment. During a mastectomy procedure, the breast

tissue is removed along with some overlying skin. Preservation of adequate skin flaps is crucial to minimize postoperative complications and achieve satisfactory cosmetic results.

The operative management is mainstay for locoregional control of carcinoma breast. At present nearly more than one third of women with breast carcinoma undergo mastectomy each year. The most common surgical option for most women with resectable breast carcinoma is resection, depending upon the spread of tumour. In discovery of early stage tumour, excision of that tumour should be by Wide Local Excision (WLE) and Sentinel Lymph Node Biopsy (SLNB) or Breast Conservation Surgery. For locally advanced cancers, total mastectomy and sentinel lymph node biopsy (SLNB) or axillary lymph node dissection (ALND) is done to attain locoregional control, accurate prognostication and staging.

While mastectomy is often necessary for effective cancer management, it carries the potential risk of complications related to the skin flaps created during surgery. The commonest complication of mastectomy is skin flap necrosis (changes in skin flap), ranging from 8.6% - 30% in various studies. It is a significant complication but most of the time ignored. Skin flaps refer to the remaining skin envelope after the breast tissue is removed, and their viability is crucial for proper wound healing, minimizing the risk of complications such as skin changes resulting in infection necrosis, wound dehiscence, and infection, and achieving satisfactory cosmetic outcomes.⁴

The health and quality of skin flaps can be influenced by various factors, including surgical technique, extent of tissue resection, and patient-related characteristics. Identifying and understanding these factors is essential for optimizing surgical planning, intraoperative decision-making, and postoperative care, ultimately leading to improved patient outcomes.⁵

Patient-related factors, including age, body mass index (BMI), smoking status, and comorbidities like diabetes and cardiovascular disease, can also influence skin flap viability. These factors may affect tissue perfusion, wound healing, and overall patient health, potentially compromising the viability of skin flaps.⁶ Adjuvant cancer treatments, such as chemotherapy and radiation therapy, affect tissue vascularity, wound healing, and overall patient health, increasing risk of having potentially skin flap complications.⁷

The gold standard for the assessment of healthy flap remains the clinical evaluation of skin colour, capillary refill, and temperature combined with blood flow in the flap using Doppler ultrasonography. However, such assessments changes with each clinician.⁸ Although a more objective measurement of tissue viability is advocated, currently no available method meets all the criteria for the ideal monitoring for skin flap as described by Creech and Miller in 1975.⁹

MATERIALS AND METHODS

Methodological entry of records of patients admitted and operated on GURU NANAK DEV HOSPITAL, Department of Surgery, Amritsar, Punjab will be done. Prospective Observational Study of 30 female patients (>18 years of age) of carcinoma breast undergoing mastectomy in Surgery Department of GURU NANAK DEV HOSPITAL, Amritsar, Punjab with exclusion of those refusing written informed consent, intra operative injury to flap, previous breast surgery, recurrent breast malignancy, cases requiring skin grafting for adequate cover. The study was conducted after approval from Institutional Ethical Committee and Thesis Committee. Proper informed and written consent will be taken from all the patients before including them in the study.

Skin flaps elevated aiming for a plane between tela subcutanea and superficial layer of superficial fascia of breast tissue using mono polar cautery without thinning and buttonholing of the flap. An incision made according to the location of disease will be used for mastectomy in all patients, but no compromise will be made regarding complete removal of tumour. Axillary dissection performed will be recorded in all cases. Skin will be closed with no tension, using suture and/or stapler.

- Skin flap viability assessment will be done accessing Dermal bleeding, Skin colour, Skin temperature, Capillary refill.
- Wound measurements will be recorded using Imito Measure App available on google play and sterilized Metal Scale.
- The wound will be examined on 5th day for skin changes. In case skin changes are present, it will be assessed using the SKIN (Skin Ischemia and Necrosis) score.¹⁰

Depth: will be assessed with a four-point score, with

- A. None, no evidence of skin changes (Mastectomy Skin Flap Necrosis)
- B. Colour change of flap due to decreased perfusion or ischemic blood vessels (cyanosis or erythema)
- C. Partial thickness flap changes lead to at least epidermal sloughing
- D. Full thickness changes in skin flap

Surface area of MSFN Score: % area Definition

1. 0% None
2. 1–10 % of breast skin, NAC (Nipple Areola Complex)
3. 11–30 % of breast skin, NAC, or total nipple involvement.
4. 30 % of breast or NAC

Each breast will be assigned both a number and a letter score to characterize the severity of skin changes in flap. Patients who developed skin changes will be managed by regular dressings and debridement for those who required it. Need for re-excision and grafting will be also noted.

OBSERVATION AND RESULTS

This prospective observational study evaluated skin flap viability in 30 female breast cancer patients undergoing mastectomy at Guru Nanak Dev Hospital Amritsar, following specific inclusion/exclusion criteria.

Skin flap health was assessed through various measurements and the SKIN score on 5th day, with follow-ups at one and three-months post-surgery. All patients were non-smokers, had no history of steroid use in the past year, and no collagen disorders. None had previous breast surgery, lymph node involvement, or chest X-ray abnormalities. No wound infections were reported. At discharge, 83.3% of patients had healthy SKIN scores and 16.7% had unhealthy SKIN scores, with no change in distribution over time.

Flow Chart:-

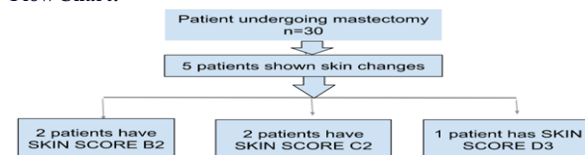


Table 1: distribution Of Skin Flap Assessment (skin Score) Of Patients

Skin flap assessment (Skin score)	Frequency	Percentage
A1	25	83.33%
B2	2	6.66%
C2	2	6.66%
D3	1	3.33%

In this study, among 30 patients 5 patients have shown skin changes in flap and based on SKIN SCORE 2 patients have B2, 2 patients have C2 and 1 patient has D3.

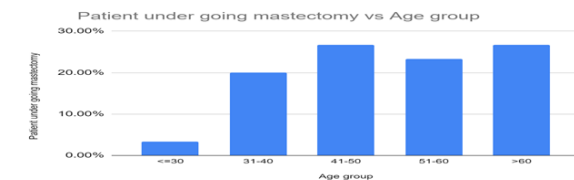


Figure 1: Age Group Distribution Among Patients Undergoing Mastectomy

Table 2: Comparison Of Skin Score Across Age Groups In Patients

Age group		SKIN SCORE		Total	P value
		Healthy (A1)	Unhealthy (B2,C2,D3)		
<=30	Frequency	1	0	1	0.948
	Percentage	4.0%	.0%	3.3%	
31-40	Frequency	5	1	6	
	Percentage	20.0%	20.0%	20%	
41-50	Frequency	6	2	8	
	Percentage	24.0%	40.0%	26.7%	
51-60	Frequency	6	1	7	
	Percentage	24.0%	20.0%	23.3%	
>60	Frequency	7	1	8	
	Percentage	28.0%	20.0%	26.7%	

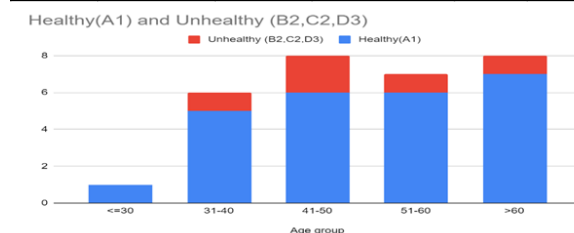


Figure 2: - Graph of skin changes in flap among various age groups.

Out of 30 patients 5 patients have SKIN SCORE other than A1 which means skin changes present in flap of these patients after mastectomy. Mean age group of patients who underwent skin changes was 50.40 ± 9.65 years and those with healthy skin flap was 52.84 ± 13.41 years. But the age is found to be insignificant factor for presence of skin changes in flap (p value=0.948).

Out of 30 patients -14 (46.67%) patients were hypertensives of which 4 (80%) developed skin changes in flap, 3 (10%) patients were diabetics of which 2 patients (40%) developed skin changes in flap, Other comorbidities includes 1 patient had hyperthyroidism, 2 patients had

hypothyroidism, 2 patients had history of heart disease.



Figure 3:- Distribution of co-morbidities in patients undergoing mastectomy

Table 3: Effect Of Hypertension And Diabetes In Skin Flaps Of Patients By Skin Score

		SKIN Score		Total	P value
		Healthy (A1)	Unhealthy (B2,C2,D3)		
Hypertension	Frequency	10	4	14	0.157
	Percentage	40.0%	80.0%	46.7%	
Diabetes	Frequency	1	2	3	0.064
	Percentage	4.0%	40.0%	10.0%	

But all these are statistically insignificant as the respective p values are 0.157 (HTN), 0.064 (diabetes). As no patients in this study were smokers or patients with steroid usage or collagen disorders, the statistical significance of these factors could not be assessed.

Table 4: Association Of Stage Of Breast Cancer With Skin Changes In Flap (skin Score)

		Skin score		Total	P value
		Healthy (A1)	Unhealthy (B2, C2, D3)		
T1NOMO	Frequency	1	0	1	0.933
	Percentage	4.00%	0.00%	3.30%	
T2NOMO	Frequency	18	4	22	
	Percentage	72.00%	80.00%	73.30%	
T3NOMO	Frequency	5	1	6	
	Percentage	20.00%	20.00%	20.00%	
T4BNOMO	Frequency	1	0	1	
	Percentage	4.00%	0.00%	3.30%	

Out of 30 patients 5 patients had skin changes in flap of which no patient belong to T1 stage, 4 (80%) patient belong to T2 stage, 1 (20%) patients belong to T3 stage, No patient belong to T4 stage.

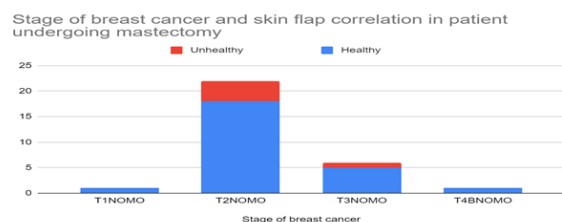


Figure 4:- Stage of breast cancer and skin flap correlation in patients undergoing mastectomy.

Table 5: Comparison Of Skin Flap And Surgical Characteristics By Skin Score

	SKIN Score (Skin Flap)	No. of patients	Mean	Std. Deviation	P value
Skin flap thickness	Healthy (A1)	25	9	1.34	0.62
	Unhealthy (B2,C2,D3)	5	9.33	1.58	
length of flap	Healthy (A1)	25	8.66	1.65	1.9
	Unhealthy (B2,C2,D3)	5	8.7	1.9	
Length of Incision after suturing (cm)	Healthy (A1)	25	16.2	1.78	0.104
	Unhealthy (B2,C2,D3)	5	17.6	1.14	
Duration of Surgery (mins)	Healthy (A1)	25	88.2	10.693	0.97
	Unhealthy (B2,C2,D3)	5	88	12.042	

Of the 30 patients. As above mentioned table the length of flap and length of incision after suturing are insignificant factor in determining

skin changes in flap of patients undergoing mastectomies as their p value is 1.9 and 0.104 respectively. The duration of surgery among these patients who have healthy skin flap is 88.20 ± 10.693 min and who developed skin changes is 88.00 ± 12.042 min and p value is 0.970. So duration of surgery is also insignificant determining factor in development of skin changes in flap of patients undergoing mastectomy.

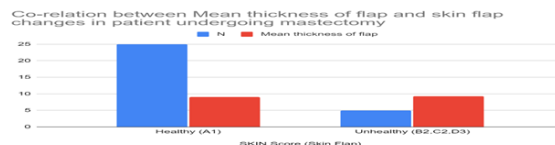


Figure 5:- Correlation between mean thickness of flap and skin flap changes

In 30 patients, 5 patients had skin changes in flap after mastectomy and the mean flap thickness among them has been found to be 9.33 ± 1.58 mm and 25 patients had healthy skin flap among them the mean flap thickness was found to be 9.00 ± 1.34 mm. As the p value is 0.62, flap thickness is not significant for determining skin changes in flap of patients undergoing mastectomy. In all patients there is use of cautery during the procedure so there is no comparing factor in view of skin changes in flap and healthy skin flap.

Table 6: Comparison of Surgical Site Condition at Discharge by SKIN Score

		SKIN Score		Total	P value
		Healthy (A1)	Unhealthy (B2,C2,D3)		
GAPING	Frequency	0	2	2	0.023
	Percentage	0.0%	40.0%	6.7%	
HEALTHY STICH LINE	Frequency	25	3	28	
	Percentage	100.0%	60.0%	93.3%	

Patients who showed skin changes at day 5 in skin flap after mastectomy, in 5 patients 2 patients had gaping at time of discharge and regular debridement and antiseptic dressing done daily and no surgical site infection developed. The skin changes in flap are significant factor in determining the gaping at time of discharge (p value = 0.023). Gaping at time of discharge in patients going mastectomy seen at the point where tension of sutures is high.

DISCUSSION

Breast is the most common diagnosed site for neoplasm. Breast carcinoma is one of the leading causes of cancer related deaths among females. One in eight women will be diagnosed with breast cancer in their lifetime. The operative management is the mainstay for loco regional control of carcinoma breast. Breast conservation techniques have been in debate for long, but Modified radical Mastectomy (MRM) is still the most commonly performed procedure. Wound complications like skin changes in flap is one of the common complications, having significant impact on both costs and cosmetic outcomes. This may prolong recovery, length of hospital stay, over-stretched health budget, delay in the initiation of adjuvant chemotherapy or radiotherapy, wound healing and predisposition to wound infection. The present study is to evaluate healthy skin flap of breast cancer patients undergoing mastectomy. It includes 30 breast carcinoma patients.

During the study period, the overall rate of skin flap changes after mastectomy was 16.66% and healthy skin flap was 83.3% and This is similar to previous studies. It represents a more accurate estimate because prospective data collection allowed us to identify mild skin flap changes, which by our definition, does not require debridement or a return to the operating room. Moderate and severe skin changes in flaps had a much larger impact on patient outcomes and were much less common.

Study	Type of study	No. of patients included	Type of surgery	Incidence of flap skin changes
Matsen et al ¹¹	prospective	606	Mastectomy with flap reconstruction	14%
Nykiel M et al ¹²	retrospective	204	mastectomy with autologous breast reconstruction	30%

Meretoja TJ et al ¹³	retrospective	207	skin sparing mastectomy with breast reconstruction	10.1%.
Harvard university	retrospective review	746	microsurgical breast reconstruction surgeries	13.4%
Mlodinow et al	retrospective		mastectomy and immediate breast reconstruction	8.6%
British Columbia	retrospective review	718	Mastectomy and breast reconstruction	12.9%
Schavarian et al ¹⁴	prospective study	50	Pre-mastectomy radiotherapy and immediate breast reconstruction	17%

In our study out of 30 patients, 1 (20%) patient belong to 31-40 years, 2 (40%) patients belong to 41-50 years, 1 (20%) patient belong to 51-60 years and 1 (20%) patient belong to >60 years with a mean age of patients undergoing mastectomy with skin changes in flap was 50.40 years and those with healthy skin flap was 52.84 years. So, age was not a significant factor for changes in skin flap which was similar to a study by Padubidri et al.¹⁵ that the complications in women older than 65 years were relatively minor by comparison.

In the present study, 14(46.67%) patients were hypertensive of which, 4(80%) patients developed unhealthy skin flap (SKIN Score other than A1) but it was found to be insignificant ($p=0.157$), which was in contrast to a retrospective study by Mc Carthy CM et al.¹⁶

In this study, 3 patients (10%) were diabetic, but all were euglycemic of which, 2(40%) patients developed skin changes in flap (SKIN Score other than A1) but it was insignificant ($p=0.064$). It is similar to a retrospective study from the MD Anderson Cancer Center, where 893 free TRAM flap reconstructions were done and they found no changes in flap skin complications in diabetic patients, in whom normal glucose level was maintained.¹⁷

As no patients in our study were smokers or having collagen disorders or steroid users these factors couldn't be assessed. Carlson et al. reported a higher rate of unhealthy skin flap (SKIN Score other than A1) in patients with history of smoking. Smoking status has been most consistent patient factor, doubling the risk of changes (SKIN Score other than A1) in skin flap in prior studies. Smoking impairs wound healing¹⁸. Other co morbidities like thyroid disorders or heart disease were also assessed but none were found to be significant.

There was no history of previous breast surgery in any of these patients, so this factor could not be accessed correctly. There was no history of radiotherapy to any of these patients, so this factor couldn't be assessed correctly. It was in contrast to previous studies like history of previous BCS (breast conserving surgery) which consist of wide local excision (WLE) and radiotherapy, increased the incidence of skin changes (necrosis), in patient who undergone chest wall radiation.¹⁹

Out of 30 patients,

		SKIN Score		Total
Stage of breast cancer		Healthy (A1)	Unhealthy (B2,C2,D3)	
T1NOMO	Frequency	1	0	1
T2NOMO	Frequency	18	4	22
T3NOMO	Frequency	5	1	6
T4BNOMO	Frequency	1	0	1

One patient received chemotherapy and did not develop skin changes in flap after mastectomy, p value has been found to be 0.141. The staging of cancer is also an insignificant factor as its p value has been found 0.933.

In our study, the mean haemoglobin among the patients with unhealthy skin flap was 10.4±0.9gm% and that with healthy skin flap was 10.1±0.9gm%, which was not statistically significant ($p=0.431$). The mean upper flap length and mean lower flap length were 9.0±1.73cm and 8.4±2.07 cm respectively, among patients of unhealthy skin flap, which were not significant statistically ($p=0.451$, 0.571). The mean length of incision after suturing was found to be 17.6±1.14 cm in patients with unhealthy skin flap (SKIN Score other than A1) and is insignificant ($p=0.053$).

The mean duration of surgery in patients who had healthy skin flap was 88.20±10.69 minutes and it is found to be insignificant ($p=0.970$) and with unhealthy skin flap (SKIN Score other than A1) was 88.00±12.04 minutes.

In the present study, all patients underwent dissection with electrocautery in which 25 had healthy skin flap and 5 had unhealthy skin flap so this factor couldn't be assessed. A study by Hoefer et al.²⁰ that higher thrombosis of sub-dermal vessels during cauterisation could lead to relative ischemia in flap tissues, along with improperly sealed lymphatics increasing the risk of seroma formation in wounds. Porter et al. verified this after undergoing modified radical mastectomy and SSM.²¹

Skin changes in flaps are assessed by SKIN score, 2 (40%) patients had mild skin changes, 2 (40%) patient had moderate skin changes and 1 (20%) patient had severe skin changes in flap in our study. This distribution is similar to a study by Cindy B Matsen et al in which 46 (8%) had mild, 6 (1%) had moderate, and 31 (5%) had severe skin changes in flap after mastectomy. In this study, 1 patient who had initial moderate skin changes in flap, later developed gaping at time of discharge and flap had no surgical site infection. In 1st and 3rd month follow up healthy scar is visible. One patient who had initial extreme skin changes in flap on 5th day developed gaping and which healed after 45 days.

The mean flap thickness in patients of skin changes in flap (unhealthy skin flap) was 9.33±1.58mm and mean flap thickness in patients with healthy skin flap was 9.00±1.34mm. Skin flap thickness is not a statistically significant factor affecting skin changes in flap ($p=0.62$). This is similar to a case series, where changes in skin flap rates approximated to 17% was reported with 4 to 5 mm flap thickness, rates of less than 5% with thickness of 10 mm flaps, suggesting that higher the thickness of flaps leads to decreased skin flap changes (ischemia and necrosis). Identifying oncoplastic plane can be challenging for certain patients, with around 44% of patients lacking a clear superficial fascial layer. Nevertheless, once pinpointed, strict adherence to it is essential in order to attain a surgically safe SSM and maintain the blood flow to the skin.

Neoadjuvant therapy can reduce the size of tumours near the skin, or adjuvant irradiation to chest wall may be used for near resection margins, potentially preventing the necessity of very thin skin flaps.

CONCLUSION

This prospective observational study evaluated skin flap viability in 30 female breast cancer patients undergoing mastectomy at Guru Nanak Dev Hospital, Amritsar following specific inclusion/exclusion criteria. From the present study we conclude that

- Skin changes in flap is one of the common complications after mastectomy with an incidence of 16.7%
- If changes in skin flap is diagnosed early can be managed accordingly and delay in the start of chemotherapy can be decreased. Mild changes in skin flap (according to SKIN Score B1-B3) is managed by observation and moderate and severe skin changes in flap (according to SKIN Score C1-D3) needs surgical debridement and regular dressings.
- Many factors have been implicated in causing flap necrosis, but none were significant statistically in this study may be due to less sample size.
- Tight suturing was one of the important factors which couldn't be established objectively but based on observation it was found that all mild skin changes were at places of vertical mattress sutures in this study.
- Due to skin changes in flap after mastectomy there is delay in adjuvant chemotherapy which leads to increased morbidity and increased duration of hospital stay.
- Flap thickness, Flap length and chemotherapy were thought to be some of the major factors affecting healthy flap but they were not statistically significant factors in this study.
- Restriction to oncoplastic plane is the most important factor for both oncological safety and healthy skin flaps.
- If there are skin changes in 5th day after mastectomy there is more chance of gaping of that wound. It is a significant factor in this study.

Limitations

1. Small sample size.

2. Limited time period.
3. This study does not include humoral, cellular and other parameters.

REFERENCES

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2021;71:209–49.
2. Mehrotra R, Yadav K. Breast cancer in India: Present scenario and the challenges ahead. *World J Clin Oncol* 2022;13:209–18.
3. Parmar V. Rising incidence of breast cancer in the young fertile Indian population-A reality check. *Indian J Surg Oncol* 2018;9:296–9.
4. Chen CM, Disa JJ, Sacchini V, et al. Analysis of 100 consecutive fibrosing conflicts in breast reconstruction involving skin preservation. *Ann Plast Surg*. 1999;43(3):279-285.
5. Andree C, Langer S, Henning M, et al. Flap viability and complications following breast reconstruction. *J Plast Reconstr Aesthet Surg*. 2020;73(7):1266-1273.
6. Chen CM, Disa JJ, Sacchini V, et al. Analysis of 100 consecutive fibrosing conflicts in breast reconstruction involving skin preservation. *Ann Plast Surg*. 1999;43(3):279-285.
7. Castañeda-Leeder M, Espinosa-Torres LM, et al. Complications in mastectomy and its impact on oncological management. *Ann Med Surg (Lond)*. 2022;76:103591.
8. Steele M.H. Three-year experience using near infrared spectroscopy tissue oximetry monitoring of free tissue transfers. *Ann. Plast. Surg*. 2011;66:540–545.
9. Creech B.J., Miller S. *Skin Flaps*. Little Brown; Boston, MA, USA: 1975. evaluation of circulation in skin flaps; pp. 21–38.
10. Matsen CB, Mehrara B, Eaton A, Capko D, Berg A, Stempel M, Van Zee KJ, Pusic A, King TA, Cody HS, Larson, David L, Basir, Zainab M.D. et al. Lemaire V, Hoskin TL, Farley DR, Grant CS, Boughey JC, Torstenson TA, Jacobson SR, Jakub JW, Degnim AC. Introducing the SKIN score: a validated scoring system to assess severity of mastectomy skin flap necrosis. *Ann surgoncol*. 2015;22(9):2925-32.
11. Pilewskie M. Skin flap necrosis after mastectomy with reconstruction: a prospective study. *Annals of surgical oncology*. 2016 Jan 1;23(1):257-64.
12. Nykiel M, Sayid Z, Wong R, Lee GK. Management of mastectomy skin flap necrosis in autologous breast reconstruction. *Annals of plastic surgery*. 2014 May 1;72:S31-4.
13. Meretoja TJ, Rasia S, Von Smitten KA, Asko Seljavaara SL, Kuokkanen HO, Jahkola TA. Late results of skin sparing mastectomy followed by immediate breast reconstruction. *British Journal of Surgery: Incorporating European Journal of Surgery and Swiss Surgery*. 2007 Oct;94(10):1220-5.
14. Schaverien MV, Singh P, Smith BD, et al. Premastectomy Radiotherapy and Immediate Breast Reconstruction: A Randomized Clinical Trial. *JAMA Netw Open*. 2024;7(4):e245217.
15. Padubidri, A. N., Yetman, R., Lucas, A., Papay, F., and Zins, J. Post mastectomy breast reconstruction in elderly patients: A ten year study. In *Proceedings of the 15th Annual Meeting of the American Society for Reconstructive Microsurgery*, in South Beach, Fla., January 8–11, 2000.
16. McCarthy CM, Mehrara BJ, Riedel E, et al. Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. *Plast Reconstr Surg*. 2008;121(6):1886–1892.
17. Miller RB, Reece G, Kroll SS, et al. Microvascular breast reconstruction in the diabetic patient. *Plast Reconstr Surg*. 2007;119(1):38–45.
18. Manchio JV, Litchfield CR, Sati S, Bryan DJ, Weinzeig J, Vernadakis AJ. Duration of smoking cessation and its impact on skin flap survival. *Plast Reconstr Surg*. 2009;124(4):1105–1117.
19. Khansa I, Colakoglu S, Curtis MS, et al. Postmastectomy breast reconstruction after previous lumpectomy and radiation therapy: analysis of complications and satisfaction. *Ann Plast Surg*. 2011;66(5):444–451.
20. Hoefer JR, DuBois JJ, Ostrow LB, Silver LF. Wound complications following modified radical mastectomy: an analysis of perioperative factors. *The Journal of the American Osteopathic Association*. 1990 Jan;90(1):47-53.
21. Rodd CD, Velchuru VR, Holly-Archer F, Clark A, Pereira JH. Randomized clinical trial comparing two mastectomy techniques. *World journal of surgery*. 2007 Jun 1;31(6):1166-70.