Original Article

Physiotherapy and Occupational Therapy Journal
Volume 6 Number 4, October - December 2013

Analyzing Strength & ROM Variations of Shoulder Complex in Mastectomy Subjects: A Pilot Study

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Abstract

Background and Objective: Impaired shoulder function after mastectomy and axillary dissection for breast carcinoma (Ca) is a well know problem. Researchers have analyzed group muscle strength of the shoulder joint and postulated that there is significant reduction of muscle strength around shoulder joint .So the following study was aimed at analyzing individual muscle strength and ROM of shoulder complex .Result of this study will help in formulating evidence based shoulder rehabilitation protocol for subjects undergoing modified radical mastectomy (MRM). **Method:** This experimental study was based on eleven subjects undergoing modified radical mastectomy.They were selected on basis of inclusion & exclusion criteria from the population of 30 subjects . Pre surgical reading for muscle strength and ROM were taken and compared post surgically after the removal of post-op drain. Readings for muscle strength were taken by a Kendall MMT technique and ROM by a half circle metal universal goniometer. **Results:** Significant reduction was found in ROM & strength of shoulder complex after MRM. Most significant reduction in ROM found in abduction (67.35±29.63) & flexion (59.77±1.70). Muscle strength were found for pectoralis major (3.54±1.36) (U.F), (4.27±1.34) (L.F), pectoralis minor (3.81±1.16), serratus anterior (4.18±1.60), Latissimus dorsi (3.90±1.37), & rhomboids (2.54±1.21) respectively. **Conclusion:** Significant reduction in muscle strength & ROM of shoulder complex occurs after MRM. Therefore individually tailored & specifically designed rehabilitation protocol will help in improving quality of life of breast cancer subjects.

Key words: Muscle strength; ROM; Breast Ca; Mastectomy; MRM; Shoulder dysfunction; Rehabilitation.

Introduction

Breast cancer is commonest malignancy in women & comprises 18% of all female cancers and 1 million new cases in world each year are added. According to Indian council of medical and research (ICMR), cancer of breast is most frequent site of cancer among urban females accounting for about 40% of all cancers. Presently 75,000 new cases occur in India each year. In united kingdom the incidence among women aged 50 approaches 2 per 1000 women per year and about 15 will have had a diagnosis made before the age of 50, giving a prevalence of breast cancer of nearly 2%.[1,2]

Breast cancer detection & management have undergone dramatic changes over recent decades, women are increasingly diagnosed with early stage disease leaving them with several treatment choices ranging from breast conserving options to mastectomy. Mastectomy is the procedure for removal of breast and modified radical mastectomy is the most commonly used procedure now a days which includes transverse or slightly oblique incision that extends to a point slightly beyond edge of latissimus dorsi muscle. It involves removal of entire breast, chest fascia and axillary lymph nodes but pectorals remain intact as there is retraction of these muscles to provide excellent exposure while minimizing danger of traction injury to neurovascular structures supplying these muscles.[3]

Mastectomy procedures cause many complications despite improved surgical

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techniques. Its consequences are lymphedema, seroma formation, decrease in arm mobility and strength of shoulder complex, difficulties related to post-op scar, distinct adverse changes in body posture of women mainly asymmetry of trunk, altered position of scapula on operated side as well as forward leaning of trunk.[4]

Several physical therapy measures commonly used are general ROM and strengthening exercises of affected upper extremity, complex decongestive physical therapy (CDPT) for lymphoedema which includes meticulous skin and nail care, manual lymphatic drainage, low stretch multilayer bandaging along with active ROM exs with bandage. Other treatment techniques are directed towards postural correction, breathing exs to increase efficiency of respiratory system and psychological councelling.[5]

Various researches have shown that there is significant reduction of muscle strength around shoulder joint after mastectomy.[6] But there is lake of depth in literature regarding evidence that can shows exact deterioration in individual muscle strength in mastectomy subjects.

Therefore this study aims at evaluating individual muscle strength and range of motion of shoulder complex in pre and post modified radical mastectomy subjects to find out exact deterioration which will help in upgrading and designing specific & structured evidence based rehabilitation protocol for mastectomy subjects.

Methodology

a) Inclusion Criteria

- Subjects between the age group of 28 to 56 years
- Subjects undergoing modified radical mastectomy
- Subjects undergoing MRM on one side

b) Exclusion Criteria

- Any neurological condition affecting spine & shoulder joint. Eg:-Cervical radiculopathy, Disc prolapse.
- Any orthopaedic deformity & complications of upper quadrant. Eg:-Frozen shoulder, recent surgery & fracture.
- Uncooperative patients.

Instrumentation

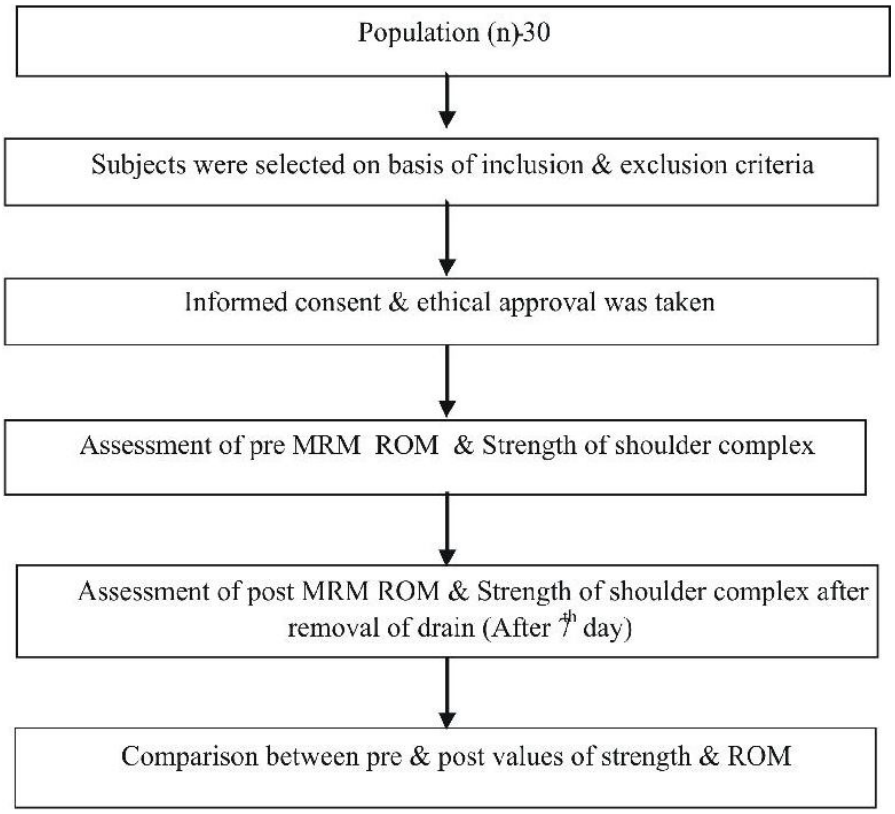
- Half circle metal goniometer
- Couch
- Stool
- Towel roll

Procedure

On the basis of inclusion and exclusion criteria eleven subjects were selected. Informed consent & ethical approval was taken. Pre MRM strength & ROM of shoulder complex were assessed using MMT (Acc. to Kendall grading) & goniometer respectively. ROM were measured for shoulder Flexion, Extension, Abduction, Horizontal adduction, Medial & Lateral rotation & MMT of following muscles were done:- Upper, Middle & Lower trapezius, Rhomboids, Serratus anterior, Pectoralis minor, Pectoralis major (Upper &Lower fibers), Latissimusdorsi, Middle deltoid & Supraspinatus, Anterior deltoid, Posterior deltoid, Teres major & Subscapularis, Teres minor & Infraspinatus and Coracobrachialis. Post MRM after removal of drain (After 7th day) strength & ROM were assessed again & at the end comparison between pre & post values of ROM & MMT were done & was evaluated. A stretching & stregthing exercise protocol was given to the subjects after the assessment.

Protocol

ROM of shoulder complex was measured using half circle universal goniometer &



method of measuring ROM was as follows:

a) Flexion: Normal range:- 0°-180°

- *Testing position:* Supine over the couch with knees flexed & palm faces the trunk.
- *Goniometer alignment:* Fulcrum over the lateral aspect of greater tubercle , proximal arm in line with midaxillary line of thorax & distal arm with the lateral midline of humerus

b) Extension: Normal range: 0°-60°

- *Testing position:* Prone over the couch/Standing
- *Goniometer alignment:* Fulcrum over the lateral aspect of greater tubercle, proximal arm in line with midaxillary line of thorax & distal arm with the lateral midline of humerus.

c) Abduction: Normal range: 0°-180°

- *Testing position:* Supine over the couch with knees flexed & palm of the hand faces the ceiling
- *Goniometer alignment:* Fulcrum close to anterior aspect acromial process, proximal arm is parallel to anterior aspect of sternum & distal arm with the anterior midline of humerus.

d) Horizontal adduction: Normal range: 0°-120°

- *Testing position*: Sitting on stool
- *Goniometer alignment*: Fulcrum over the acromion, proximal arm parallel to floor in line with neck & distal arm with the midline of humerus.

e) Medial Rotation: Normal range: 0°-70°

- *Testing position*: Supine over the couch with arm being tested in 90 degrees of shoulder abduction & forearm perpendicular to supporting surface such that palm of hand faces the feet. Towel roll or pad was placed under the humerus
- *Goniometer Alignment*: Fulcrum over the olecranon process, proximal arm perpendicular to floor & distal arm in

line with the ulna

f) Lateral Rotation: Normal range: 0°-90°

- *Testing position*: Supine over the couch with arm being tested in 90 degrees of shoulder abduction & forearm perpendicular to supporting surface such that palm of hand faces the feet. Towel roll or pad was placed under the humerus
- *Goniometer Alignment*: Fulcrum over the olecranon process, proximal arm perpendicular to floor & distal arm in line with the ulna[7,8]

The MMT of individual muscles of shoulder complex was analysed according to Kendall's method.

Data Analysis

Statistics were performed using Graph pad & Statistical software package (SPSS) version 17. Significance level was set at ≤0.05 and confidence interval was 95%. Paired "t" was used to analyse & compare ROM & strength of shoulder complex pre & post MRM. To determine differences between variables of

Table 1: Comparison of MMT Pre & Post MRM by Paired "t" test

VARIABLES	PRE (M ± SD)	POST (M ± SD)	" t " VALUE	"p" VALUE
Upper trapezius &Levator scapulae	9.81 ± 0.60	9.63 ± 1.20	1	0.341
Middle trapezius	7.81 ± 1.60	5.72 ± 1.10	5.33	0.0001
Lower trapezius	7.45 ± 1.91	5.63 ± 1.02	3.76	0.004
Rhomboids	7.45 ± 1.75	4.90 ± 0.70	6.95	0.0001
Serratus anterior	9.54 ± 1.21	5.36 ± 1.28	8.66	0.0001
Pectoralis minor	9.18 ± 1.47	5.36 ± 1.28	10.84	0.0001
Pectoralis major (U.F)	9.54 ± 0.82	6 ± 1.61	8.59	0.0001
Pectoralis major (L.F)	9.18 ± 1.53	4.90 ± 0.83	10.51	0.0001
Latissimus dorsi	8.63 ± 1.43	4.72 ± 0.64	9.42	0.0001
Middle deltoid & Supraspinatus	9.54 ± 0.68	6.72 ±1.10	10.69	0.0001
Anterior deltoid	9.36 ± 0.80	7 ± 1.09	5.75	0.0001
Posterior deltoid	9.45 ± 0.93	8 ± 1.34	4.27	0.002
Teres major & Subscapularis	8.81 ± 1.47	7.27 ± 1.42	4.22	0.002
Teres minor & Infraspinatus	8.18 ± 2.08	6.27 ± 1.48	4.37	0.001
Coracobrachialis	9.45 ± 0.82	8.36 ± 1.43	2.63	0.025

Table 2: Mean & SD of Difference between Pre and Post Values of MMT by ANOVA

VARIABLES	MEAN ± SD	"F" VALUE	"p" VALUE
Upper trapezius & levator scapulae	0.181 ± 0.60	12.055	<0.0001
Middle trapezius	2.09 ±1.30		
Lower trapezius	1.81 ±1.60		
Rhomboids	2.54 ± 1.21		
Serratus anterior	4.18 ± 1.60		
Pectoralis. Minor	3.81 ± 1.16		
Pectoralis Major(U.F)	3.54 ± 1.36		
Petoralis.Major(L.F)	4.27 ± 1.34		
Latissimus dorsi	3.90 ±1.37		
Middle Deltoid & Supraspinatus	2.81 ± 0.87		
Anterior deltoid	2.36 ± 1.36		
Posterior deltoid	1.45 ± 1.12		
Teres major & subscapularis	1.54 ± 1.21		
TeresmInor& infraspinatus	1.90 ± 1.44		
Coracobrachialis	1.09 ± 1.37		

Fig 1: Comparison of MMT Pre & Post MRM by Paired "t" test

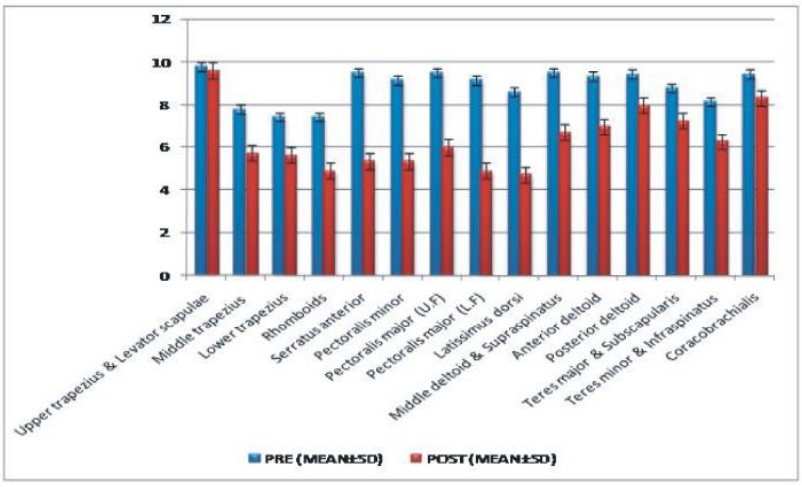


Fig 2: Mean & SD of Difference between Pre & Post Values of MMT by "ANOVA"

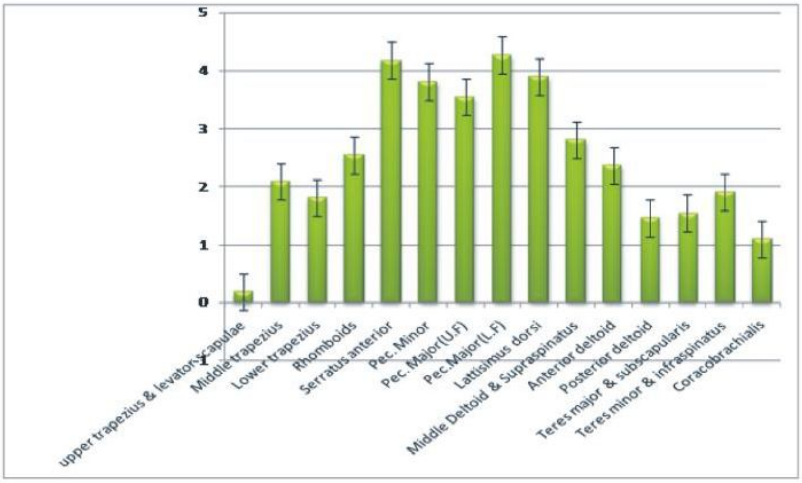


Table 3: Comparison of ROM Pre & Post MRM by Paired "t" test

VARIABLES	PRE (MEAN ± SD)	POST (MEAN± SD)	t- VALUE	p- VALUE
Flexion	176 ± 8.20	116.22± 19.44	11.625	<0.05
Extension	49.75 ±5.24	42.38 ± 6.7	5.255	
Abduction	170.50 ±24.58	103.15 ± 20.45	7.539	
Horizontal adduction	84.50 ± 13.11	70.60 ± 11.65	7.417	
Medial rotation	63.96 ± 5.43	58.30± 6.68	3.497	
Lateral rotation	83.20 ± 9.36	72.24 ± 12.84	4.576	

Table 4: MEAN & SD of Difference between Pre & Post Values of ROM by "ANOVA"

VARIABLES	M ± SD	F VALUE	p VALUE
Flexion	59.77 ± 1.70	39.72	< 0.0001
Extension	7.37 ± 4.65		
Abduction	67.35± 29.63		
Horizontal adduction	13.90 ± 6.21		
Medial rotation	5.60 ± 5.32		
External rotation	10.95 ± 7.93		

Table 5: Inter Variable Comparison of ROM by Post – hoc Tukey Comparison Test

COMPARISON	MEAN DIFF.	"q" VALUE	"p" VALUE
Flexion Vs Extension	52.4	11.5	<0.05
Flexion Vs Abduction	-7.58	1.66	>0.05
Flexion Vs Horizontal adduction	45.87	10.07	<0.05
Flexion Vs Medial rotation	54.16	11.89	<0.05
Flexion Vs Lateral rotation	48.81	10.72	<0.05
Extension Vs Abduction	-59.982	13.17	<0.05
Extension Vs Horizontal adduction	-6.527	1.43	>0.05
Extension Vs Medial rotation	1.764	0.38	>0.05
Extension Vs Lateral rotation	-3.58	0.78	>0.05
Abduction Vs Horizontal adduction	53.45	11.73	<0.05
Abduction Vs Medial rotation	61.74	13.55	<0.05
Abduction Vs Lateral rotation	56.4	12.38	<0.05
Horizontal adduction Vs Medial rotation	8.29	1.82	>0.05
Horizontal adduction Vs Lateral rotation	2.94	0.64	>0.05
Medial rotation Vs Lateral rotation	-5.34	1.17	>0.05

Fig 3: Comparison of ROM Pre & Post MRM by Paired "t" Test

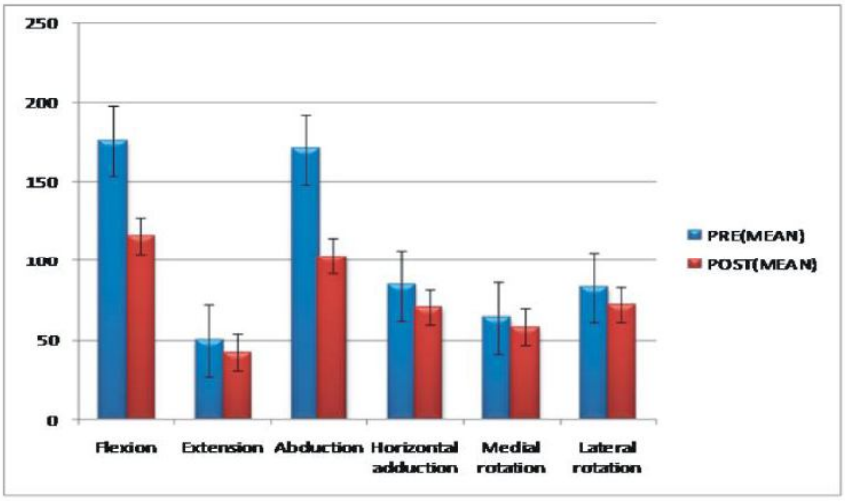
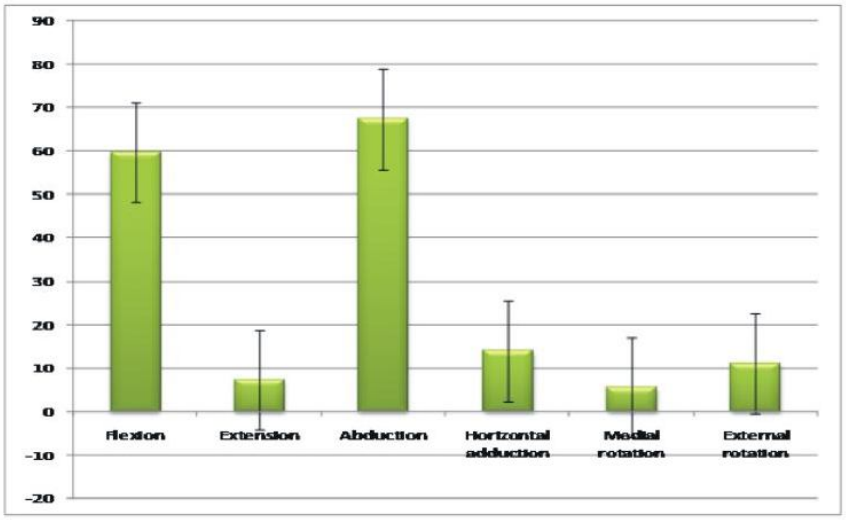


Fig 4: Mean & SD of Difference between Pre & Post Values of ROM by "ANOVA



ROM & MMT, a 2 way repeated measures analysis of variance (ANOVA) was performed followed by post hoc for multiple comparison between variables.

Results

Overall analysis of various scores showed that ROM & MMT values of shoulder complex decreased significantly after MRM.

Discussion

Breast cancer is the most frequent neoplasm among women; it is traditionally treated by surgery ranging from quadrantectomy to widened modified radical mastectomy, of which common sequels are changes in articular range of motion, muscle strength decrease, lymphedema, and adherences. Shoulder movement power & strength impairment is a commonly reported consequence of surgery for breast cancer. This impairment of shoulder complex can be attributed to many factors.[9]

According to A.C Voogd *et al* cancer patients are vulnerable to overall decrease in activity which is also referred as inactivity disuse syndrome or immobility syndrome. Earliest & most frequent result of immobility/ inactivity usually occurs in musculoskeletal system and also muscle at rest lose strength rapidly which leads to generalized weakness. Fatigue also affects 70% of cancer patients during chemo & radiotherapy or after surgery & in response to fatigue patients down regulate their level of daily activities.[10]

Activity avoidance advice post surgery may be disservice, as upper extremity strength may worsen over time with decreased use. C.R. Merchant stated that intent to protect the limb from maximal exertion can also have an impact on muscular effort.[11]

Most significant reduction in strength were found in pec. major & minor, latissimus dorsi, serratus anterior & rhomboids. Explanation for reduced strength of pectorals & latissimus dorsi can be provided on the basis of surgical technique of "MRM" as it involves incision of lower lateral fibers of pec major & detachment of origin of pec minor which enables sufficient retraction of these muscles to provide excellent axillary exposure.MRM also involves a transverse or slight oblique incision that extends to a point slightly beyond edge of latissimus dorsi muscle & hence may be a factor in reducing its strength.[3,12]

Scapular retraction stretches the muscle & tissue across the anterior chest wall which may initiate stretch pain around the surgical site & leads to decrease in strength of rhomboids. Reduction in strength of serratus anterior muscle can be due to transient traction injury to long thoracic nerve during the surgery. Insignificant reduction in strength of upper trapezius muscle can be explained on the basis of study done by Barbara A Springer *et al* which states that breast cancer survivors exhibit greater EMG activation of upper trapezius than did healthy subjects during upper limb low load functional tasks.[5,13]

The reduction in "ROM" of shoulder complex after "MRM" can be supported by various studies. N.Ryttov *et al* stated that damage to pec.major fascia & protective axillary connective tissue may contribute to limited arm & shoulder movement. Following surgery with axillary lymph node dissection 73% of women reported restricted shoulder mobility, tightness, edema, pain, numbness of arm & limitations in daily life activities and these complaints could be due to tissue & nerve damage and also due to possible brachial plexus traction during the procedure.[14,15]

Other factors leading to impairment of ROM are surgical aggression, inactivity or immobilization of limb & protective posturing.[16,17] (Bankoff *et al* & Betty smoot *et al*). Another possible explanation for reduction in ROM can be that post mastectomy groups used adaptive strategies as drain is inserted in incision on chest wall to enable drainage of seroma & women are encouraged

not to elevate their arm above head in early post-op period & furthermore even after drain removal women are instructed to protect their affected limb to prevent lymphedema & this reduced frequency & amplitude of elevations of arm following surgery & during every day activities contributes to altered kinematics & adaptive changes to motor patterns.(Jack corsbie *et al*). Complex kinematic distortions, particularly during abduction in coronal plane, in which relationship between scapular & glenohumeral movements are changed, leads to highly significant reduction in range of shoulder complex abduction.[18,19,20]

Conclusion

The Present study concluded that the MRM can significantly reduce strength of various muscles as well as ROM of shoulder complex. Hence it appears that rehabilitation protocol after MRM should undergo careful construction so as to involve ROM exs & strength training of individual muscles, tailored according to patient's impairments. Therefore continued well being of breast cancer patients after surgery depends on need for an individualized & specific exercise intervention to help restore patients to fully functional state & in-turn improving over all quality of life of breast cancer survivors.

Clinical Implications

Upper extremity weakness & restricted shoulder mobility is a well known sequel, found in almost all the subjects after the treatment of breast cancer. General ROM & strengthening exercises were use to be followed after the surgical treatment, but not much of the importance was given to development of specific rehabilitation protocol for breast cancer survivors. The following study will help in formulating specific, systematic & individually tailored & controlled rehabilitation protocols for breast cancer patients which in turn will help in preventing disabilities & will also enhance working ability, overall wellbeing & functioning among breast cancer patients & improve their quality of life. It will also help in pre-op. training of muscles for early recovery of shoulder function in breast cancer survivors.

Future Research

1) Future research is necessary with a comparatively large sample size.
2) Influence of operated side (dominant or non-dominant) on ROM & strength of shoulder complex should be evaluated.
3) Specific & scientific rehabilitation protocol should be generated for patients undergoing MRM.

Conflict of Interest & Ethical Approval

There was no conflict of interest was reported among all authors. This research work is approved by ethical committee of HIPMS, HIHT University (UK) India,

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