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Is physical function a more appropriate measure than volume excess in the assessment of breast cancer-related lymphoedema (BCRL)?

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Abstract

The aim of this study was to objectively measure impairment of arm function in women with breast cancer-related lymphoedema (BCRL), and investigate possible associations between this, arm volume excess, and psychological morbidity as measured by the Medical Outcomes Study 36-item short form (SF-36) questionnaire. A total of 48 patients were recruited. Manual dexterity was significantly impaired in the affected arm, independent of dominant or non-dominant arm involvement, but was not associated with arm volume excess. Psychological morbidity was significantly impaired in the domains of 'physical function' and 'bodily pain' when compared with population controls. Degree of impairment in the 'physical function' domain correlated with the absolute level of objectively tested manual dexterity. Impairment of manual dexterity appears to have a greater impact than arm volume excess on the overall psychological morbidity associated with BCRL, suggesting that greater emphasis should be placed upon arm function in the assessment, treatment targeting, and monitoring of patients with this condition.

Keywords: Breast cancer; Lmphoedema; Psychological morbidity; Arm function

1. Introduction

The incidence of breast cancer continues to rise in the UK [1]. As disease management has improved, leading to the well-publicised recent decline in breast cancer deaths [2], greater emphasis has been placed upon the side-effects of treatment. Breast cancer-related lymphoedema (BCRL), due to impaired lymphatic drainage from the arm secondary to axillary surgery and/or radiotherapy, remains a common complication, occurring in around 24% of cases [3]. Affected patients have an unsightly, uncomfortable arm, prone to repeated episodes of infection, with the rare, but potentially fatal, complication of secondary lymphangiosarcoma [4]. Treatment is centred upon application of the conservative principles of skin care, massage, exercise and compression hosiery [5]. Assessment of BCRL is based primarily upon measurement of arm volume excess compared with the unaffected contralateral limb. This is a reliable and reproducible measure that can be used in the initial diagnosis (although no universally accepted definition exists, a volume excess of greater than 10% is generally accepted), and in monitoring the response to treatment.

A diagnosis of breast cancer is a cause of great emotional distress [6], and has been shown to lead to increased psychological morbidity in areas of both anxiety and depression [7]. Specific problems associated with surgery to the breast, affecting self-esteem and sexuality [8], add to concerns about the malignancy. Onset of BCRL is commonly delayed for months or even years after treatment, which can cause concern regarding possible tumour recurrence. Patients may blame themselves if swelling develops after an identifiable precipitating event (minor infection involving the arm or an unusual degree of exercise) [9,10]. Therefore, it is not surprising that BCRL has been shown to be associated with increased psychological morbidity in comparison with breast cancer patients without lymphoedema [8,10–12]. Pain, poor social support, dominant hand involvement and avoidance-style coping mechanisms all seem to be predictors of a greater level of dysfunction [13].

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Attempts to demonstrate an association between arm volume excess and psychological morbidity have hitherto failed [10,14]. A study which measured psychological morbidity (using the Nottingham Health Profile Part 1 (NHP-1) questionnaire) in BCRL sufferers before and after standard conservative treatment failed to show any association between reduction in arm volume and improved psychological state [12]. The authors did, however, report a significant improvement in the overall NHP-1 score, as well as in individual dimensions of energy, pain and physical mobility. Prior to treatment, greatest variation from population controls was seen in the physical mobility dimension, whilst no significant difference was demonstrable post-treatment. No studies have been reported which objectively measure the impact of BCRL on physical function.

This study was designed to test the hypothesis that impairment of arm function has a greater influence than degree of arm swelling *per se* upon the psychological well-being of those affected with BCRL. It aims to objectively measure the effect of BCRL on the physical function of the affected arm, and to investigate possible associations between this, arm volume excess and psychological morbidity.

2. Patients and methods

A total of 48 patients were recruited from the Cambridge Breast Unit and from the Lymphoedema Service at Arthur Rank House, Cambridge. For the purposes of this study, BCRL was defined as clinically obvious swelling of all or part of the upper limb following surgery for breast cancer, which resulted in referral to the lymphoedema service. The project received Local Research Ethics Committee approval, and all participants provided written informed consent.

2.1. Arm volume measurement

From an initial mark 20 cm proximal to the cuticle of the middle finger, arm circumference was measured at 4-cm intervals up the arm with a spring-loaded tape measure, and the volume was subsequently calculated using a pre-programmed calculator. This is an established technique, which has consistently shown good correlation with the water displacement method [15–17]. Results are expressed as percentage volume excess of the swollen arm compared with the unaffected contralateral limb, and can be further broken down into forearm and upper arm measurements.

2.2. Physical function

This was measured by asking participants to perform a timed test of manual dexterity, using a technique initially developed by Occupational Therapists for the assessment and monitoring of stroke patients [18]. In a standardised fashion, participants performed a timed test, removing a number of nuts from fixed bolts, and then replacing them (Fig. 1). This was then repeated

Fig. 1. Fixed bolt apparatus for the assessment of manual dexterity.

with the other hand. Normative data derived from a UK population exists for dominant and non-dominant hands and across a range of age-groups [18]. In order to correct for variable physical ability and co-morbidity of participants, results for affected and unaffected arms were calculated relative to age-matched control data for dominant and non-dominant hands.

2.3. Psychological morbidity

Participants were asked to complete the Medical Outcomes Study 36-item short-form health survey (SF-36) [19]. This is a well established self-administered questionnaire, shown to be robust across a range of populations, that assesses eight health concepts: physical limitations, social limitations, limitations in usual role activities because of physical or emotional problems, bodily pain, general mental health, vitality and general health perceptions.

2.4. Statistical methods

Due to the skewed nature of the data, the Wilcoxon Signed Rank test was used to test for differences in manual dexterity between the affected and unaffected arm. A P value of <0.05 was taken to represent statistical significance. 95% Confidence intervals (CIs) on proportions of subjects that were above the population mean were used to look at the SF-36 scores. Spearman's rank correlation was used for continuous measures. Analyses were carried out in Statistical Package for the Social Sciences (SPSS) V11 and StatXact V4.

3. Results

The mean age of the patients at the time of assessment was 61 years (range 34–88 years). The mean time since original breast cancer treatment was 8 years (1–37 years), such that a wide range of surgical techniques, with or without adjuvant radiotherapy, had been used in the management of these patients.

Patients reported time to onset of arm swelling ranging from immediately postoperative to 22 years later. In all, 42% of participants described onset of swelling within the first 3 months following surgery, 62% by 1 year, and 76% by 3 years. A total of 11 women (23%) were able to identify a precipitating event such as excessive use of the arm, infection following a cut or gnat bite, and in one case siting of an intra-venous cannula in the ipsilateral arm when undergoing hysterectomy. The dominant arm was involved in 46% of cases, non-dominant in 54%.

When participants were asked what they perceived as the main problem regarding their arm swelling, a wide variety of responses were given. Most related to either ache or discomfort in the arm, or to problems with performing certain tasks; unscrewing jars and turning taps, driving, hanging up washing, and in one case juggling. One participant had been obliged to give up her work as a dog groomer due to arm discomfort, whilst another who worked in a canteen had great difficulty in adjusting overhead switches. Only one patient cited cosmetic appearance as a major problem.

3.1. Arm volume

Median volume excess measurements of affected arms are shown in Table 1. Dominant arm involvement had no significant effect upon the extent or distribution of swelling.

3.2. Manual dexterity

Times for completion of the manual dexterity task were significantly longer for the affected than for the unaffected limb, irrespective of dominant or non-dominant arm involvement (Table 2). The general performance level of the study group (as represented by task completion-time for the unaffected arm) was worse than that predicted from population control data.

3.3. Quality of life

More than half of the participants scored below the mean for the population on four of the eight domains of the SF-36 (general health, physical function, bodily pain and vitality). More than half scored above the population mean for the other four domains (role limitations due to physical problems and emotional problems, social function and mental health) (Table 3). These differences

Table 1
Median (inter-quartile range) arm volume excess compared with contralateral arm

Subject group	Volume excess (%)		
	Arm	Forearm	Upper arm
All ($n=48$)	8.2 (3.3, 17.0)	10.2 (2.4, 23.7)	6.6 (1.7, 14.0)
Dominant ($n=22$)	6.3 (4.3, 14.4)	9.8 (3.1, 21.2)	6.2 (2.1, 11.6)
Non-dominant ($n=26$)	9.7 (3.2, 18.8)	11.9 (0.9, 32.1)	7.9 (2.4, 14.5)

Table 2
Median (inter-quartile range) arm dexterity scores compared with age-matched population controls (P-value Wilcoxon signed rank test)

Subject group	Dexterity score (%)		P value
	Affected	Unaffected	
All ($n=48$)	+18.5 (1.3, 37.5)	+10.5 (0.3, 23.2)	0.003
Dominant ($n=22$)	+21.5 (0.2, 32.5)	+7.5 (0.0, 19.2)	0.049
Non-dominant ($n=26$)	+16.5 (4.6, 38.0)	+11.2 (5.4, 26.8)	0.039

obtained statistical significance for the impaired scores in the physical function and bodily pain domains, and were independent of hand dominance. There was also significant improvement in the role limitations due to emotional problems domain in the dominant arm-affected sub-group.

4. Associations

4.1. Arm volume excess versus manual dexterity impairment

There was no association between arm volume excess and manual dexterity impairment (ipsilateral dexterity score/contralateral dexterity score) (Spearman correlation coefficient, $r_s = 0.03$ (95% CI −0.28, 0.35)). Fig. 2 displays a plot of arm volume excess against manual dexterity impairment. Fitting of a trendline appears to show a weak trend of greater dexterity impairment with increased volume excess, but this is eliminated by omission of a single outlying value.

4.2. Psychological morbidity

In order to provide a guide as to the impact on overall patient psychological well-being, mean scores for the eight domains of the SF-36 were calculated for each patient. Analysis reveals a non-significant negative association with dexterity impairment ($r_s = -0.26$ (−0.53, 0.01)), whilst with arm volume excess a significant positive correlation was observed ($r_s = 0.33$ (0.05, 0.61)) (i.e. in this study, it unexpectedly appears that greater arm volume excess is associated with an improved psychological well-being).

Table 3
Proportion (95% confidence interval (CI)) of people in each group with scores below the population mean (significant figures in bold)

SF-36 domain	Proportion (95% CI) below population mean		
	All	Dominant	Non-dominant
General health	0.65 (0.52, 0.80)	0.64 (0.41, 0.83)	0.65 (0.44, 0.83)
Physical function	**0.67 (0.52, 0.80)**	0.64 (0.41, 0.83)	0.69 (0.48, 0.86)
Role—physical	0.48 (0.33, 0.63)	0.45 (0.24, 0.68)	0.50 (0.30, 0.70)
Role—emotional	0.35 (0.22, 0.51)	**0.23 (0.08, 0.45)**	0.46 (0.20, 0.59)
Social function	0.40 (0.26, 0.55)	0.41 (0.21, 0.64)	0.38 (0.20, 0.59)
Bodily pain	**0.75 (0.60, 0.86)**	**0.77 (0.55, 0.92)**	**0.73 (0.52, 0.88)**
Vitality	0.52 (0.37, 0.67)	0.45 (0.24, 0.68)	0.58 (0.37, 0.77)
Mental health	0.38 (0.24, 0.53)	0.41 (0.21, 0.64)	0.35 (0.17, 0.56)

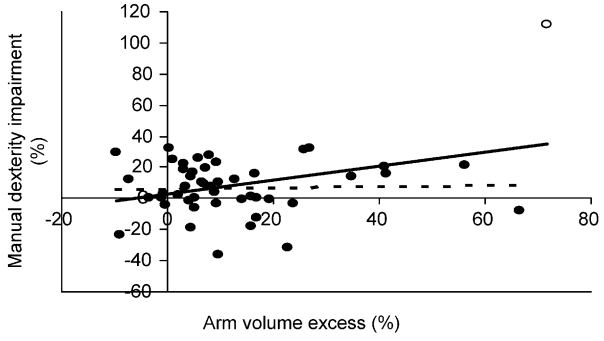

Fig. 2. Manual dexterity impairment (affected arm score−unaffected arm score) versus arm volume excess. Trendline fitted with — and without - - - outlying value ○.

4.3. Physical function domain score

No significant association was observed between 'physical function' domain score and either arm volume excess ($r_s = 0.15$ (−0.14, 0.44)) or manual dexterity impairment ($r_s = -0.16$ (−0.45, 0.12)). However, a significant negative association was demonstrated with the ipsilateral dexterity score ($r_s = -0.34$ (−0.61, −0.06)).

5. Discussion

The prevalence of BCRL remains around 24%, although the extent of the swelling appears to be reducing [3]. Greater awareness of the condition is leading to identification of smaller areas of localised swelling, which may impact upon the patient without significantly altering overall arm volume. Few of the patients involved in this study had the classically brawny arm of long-standing lymphoedema. Indeed the median figure for arm volume excess of participants is below the generally recognised definitive value of 10%. The results presented here, therefore, are relevant to any breast cancer unit, rather than just to specialist lymphoedema services seeing the most extreme cases of BCRL.

Objective testing of arm motor function in this study has demonstrated significant impairment in the affected arm compared with the contralateral control arm. The degree of this impairment is not associated with the degree of arm volume excess. Psychological morbidity testing has demonstrated significant impairment in the 'physical function' domain, compared with population controls. This is again not associated with the degree of arm volume excess, nor with the degree of impairment of dexterity in the affected compared with the contralateral arm. There is, however, a significant association with the absolute dexterity score in the affected arm. Perhaps not surprisingly, patients perceptions of their own physical impairment is related most closely to the actual level of physical function, as opposed to the degree of impairment attributable to BCRL.

An increase in psychological morbidity in BCRL sufferers is well documented [8,10–12]. It might be expected that the extent of this increase would correlate with the degree of arm swelling although previous studies have failed to demonstrate this [10,14]. This study, on the

contrary, demonstrates a significant positive association between arm volume excess and psychological well-being. This rather unexpected result is difficult to explain, but there is undoubtedly a marked difference between this and the, albeit non-significant, negative association between dexterity impairment and psychological well-being. Comparison of these two associations provides compelling evidence that impairment of physical function has a greater impact than degree of arm swelling on the psychological morbidity associated with BCRL.

6. Conclusions

Breast cancer-related lymphoedema causes significant impairment of both objectively-tested arm dexterity and of patients perception of their own physical function, even in the absence of excessive degrees of swelling. Present-day assessment, treatment, and monitoring of BCRL concentrates on the excess volume of the arm, which does not appear to correlate with the level of physical dysfunction. Although current treatment methods have been shown to significantly improve patients' perceptions of their own physical function [12], objective testing of arm function before and after treatment has never been performed. The results of this study suggest that greater emphasis should be placed upon arm function in the assessment, treatment targeting, and monitoring of patients with this still common condition.

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