Examination of shoulder positioning after stroke: A randomised controlled pilot trial

Catherine M Dean[1], Fiona H Mackey[2] and Pesi Katrak[3]

[1]*The University of Sydney* [2]*Illawarra Regional Hospital, Wollongong* [3]*Prince Henry Hospital, Sydney*

Shoulder pain and stiffness is a serious problem in patients following stroke. The purpose of this study was to investigate the effect of a shoulder positioning protocol on shoulder joint pain and range in the affected upper limb. Twenty-eight subjects were randomly assigned to the experimental or control groups and participated in a multidisciplinary rehabilitation program. In addition, the experimental group received prolonged positioning of the shoulder daily for six weeks. Resting pain, pain on dressing, pain-free active abduction and passive external rotation range were measured on entry to the study and after six weeks. Twenty-three subjects completed the study. The differences between the groups were not statistically significant ($p < 0.05$), however, because of low statistical power the results are inconclusive. **[Dean CM, Mackey FH and Katrak P (2000): Examination of shoulder positioning after stroke: A randomised controlled pilot trial. *Australian Journal of Physiotherapy* 46: 35-40]**

Key words: Cerebrovascular Disorders; Hemiplegia; Rehabilitation; Shoulder Joint

Introduction

Shoulder pain and stiffness is a serious and frequent problem in patients following stroke (Andrews and Bohannon 1989, Roy et al 1994). The incidence has been reported to be as high as 84 per cent (Griffin and Reddin 1981). Shoulder pain and stiffness often prevent the patient's full participation in rehabilitation and contribute to poor outcome in upper limb function following stroke. The purpose of the present pilot study was to investigate the effect of a shoulder positioning protocol on shoulder pain and active and passive shoulder range of motion in the affected arm of patients following stroke.

Shoulder pain and stiffness may be due to several factors following stroke. Glenohumeral joint subluxation due to lack of muscular activity around the shoulder is common, although a strong relationship between subluxation and pain has not been supported (Zorowitz et al 1996). Trauma to the glenohumeral joint may also arise from inappropriate exercise such as overhead pulleys (Kumar et al 1990) or inappropriate handling of the patient by staff during transfers.

After stroke, weakness of the upper limb muscles results in patients having difficulty in moving the affected arm away from the side of the body. The patient's arm is effectively immobilised with the shoulder internal rotator, adductor and extensor muscles in a shortened position. Muscles immobilised in a shortened position in animals undergo morphological, physiological and biochemical changes (Herbert and Balnave 1993, Williams and Goldspink 1978 and 1984) which have a deleterious effect on muscle function (Gossman et al 1982). Since stroke patients may spend up to 85 per cent of the day with the affected arm by the side (Ada et al 1987) it is likely that similar changes may be occurring in their shoulder muscles. There is some evidence to support this proposal, since Andrews and Bohannon (1989) have reported a decrease in passive external rotation range of motion in the affected shoulder after stroke. Further, there is evidence for a relationship between loss of range (stiffness) and pain in the shoulder (Bohannon 1988, Zorowitz et al 1996). In particular, Zorowitz and colleagues (1996) found that shoulder pain was strongly correlated with loss of external rotation range.

Evidence from both animal and human studies suggests that prolonged, low load positioning with muscles in a lengthened position may prevent or reverse the adaptations that occur when muscles are immobilised in a shortened position (eg Light et al 1984). We hypothesised, therefore, that regular

shoulder positioning may reduce or prevent some of the secondary musculoskeletal adaptations following stroke and thereby reduce pain and stiffness in the hemiplegic shoulder. Unfortunately, there is little information available to assist in determining an effective amount and type of positioning. Reports of effective stretches have varied from 30 minutes daily on mouse soleus (Williams 1988) to six hours per day on plantarflexors of children with cerebral palsy (Tardieu et al 1988). In light of the paucity of data, we decide to test a protocol which was clinically feasible, for a total of one hour per day.

Methods

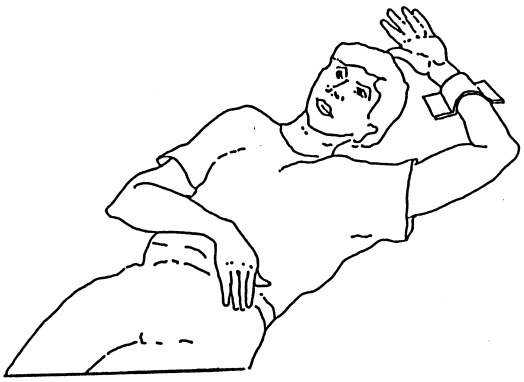
Subjects All patients admitted to a Sydney hospital for rehabilitation following stroke were considered for the study. The selection criteria for the study were: 1) fewer than 10 weeks from the onset of stroke; 2) score of less than 5 on the upper-arm function item of the Motor Assessment Scale (MAS) for stroke (Carr et al 1985); 3) no pre-morbid shoulder pain; 4) no pre-morbid restriction of shoulder movement; 5) passive range of shoulder abduction and flexion greater than 90 degrees; and 6) able to comprehend and use a visual analogue scale (VAS) for pain. Subjects with a brainstem stroke were excluded from the trial. These criteria were used to ensure selection of subjects who could complete the positioning and assessment procedures and who had decreased upper limb function and were, therefore, at risk of developing shoulder stiffness. Patients meeting the selection criteria were invited to participate and those who agreed gave informed consent. All procedures were in accordance with approved institutional ethical guidelines. The trial was terminated prematurely after 18 months, due to impending hospital closure.

Twenty-eight patients agreed to participate in this study and were randomly allocated to the control or the experimental group. To minimise recruitment bias, group allocation was completed by a person independent of the recruitment process. Briefly, once a subject was enrolled in the study, the recruiter telephoned another person who used random number tables to determine the subject's group allocation. Fourteen subjects were allocated to the experimental and control groups. Five subjects were lost from the study due to: discharge prior to completion (3), death (1) and misdiagnosis (1). Four of the five had been assigned to the experimental group, hence the final sample consisted of 13 subjects in the control group and 10 in the experimental group. The groups were similar in age, time since stroke and MAS scores on entry to the study (Table 1).

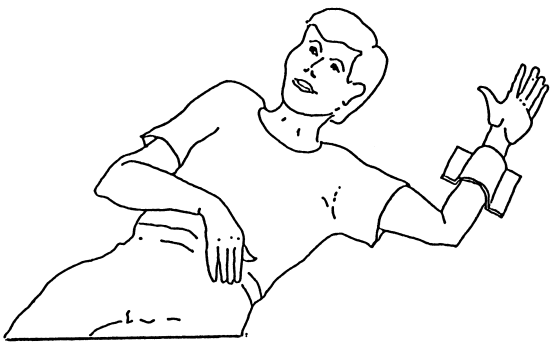
Table 1. Subject characteristics.

Characteristic		Group	
		Control	Experimental
N		13	10
Age	(years)		
	Mean (SD)	58.2 (10.5)	58.1 (12.5)
	(Range)	(40-75)	(35-72)
Time since stroke (days)			
	Mean (SD)	35.3 (11.9)	32.1 (13.4)
	(Range)	(20-65)	(16-54)
Side of hemiparesis			
	Left:Right	6:7	6:4
Gender			
	Male:Female	11:2	5:5
MAS score item 5 (on entry)			
	Mean (SD)	0	1
	(Range)	(0-3)	(0-4)

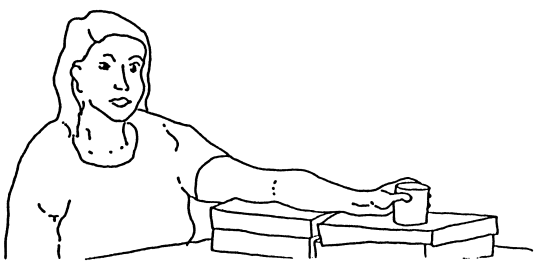
Subjects in both groups participated in a multidisciplinary rehabilitation program consisting of physiotherapy, psychology, occupational therapy and consultations with a social worker and speech therapist as indicated. Both groups participated in active training of reaching and manipulation tasks as determined by the treating therapists, however, no formal stretches were applied to the shoulder joint complex. In addition, the experimental group received prolonged positioning to the affected shoulder each day, five days a week for six weeks. This protocol involved 20 minutes in each of the three positions depicted in Figure 1. The positions placed different muscle groups in a lengthened range and placed the glenohumeral joint at or above 90 degrees of flexion and/or abduction. In addition, two positions were in supine and placed the glenohumeral joint in maximum tolerable external rotation. In each position, the arm was supported by a sloping board, plinth or table and held in position with sandbags.



Position 1



Position 2



Position 3

Figure 1. Illustration of the three positions in the protocol; Position 1: lying supine, shoulder in maximum tolerable abduction and external rotation, elbow flexed; Position 2: lying supine, shoulder abduction to 90 degrees, maximum tolerable external rotation, elbow flexed; Position 3: sitting, shoulder forward flexed 90 degrees, elbow extension, wrist extension, and a cylinder in hand to provide a web space stretch.

Physiotherapy staff and aides were responsible for positioning subjects during their attendance in the rehabilitation gym between 8.00am and 4.30pm. There was no specific order of positions, only the requirement that the three positions were completed each day.

Dependent variables Pain and range of motion were measured on all subjects on two occasions: entry to the study and at the end of six weeks. Measurements were made by an assessor who was blinded to the subject's group allocation. This assessor did not work in the rehabilitation department and made measurements when the rehabilitation gym was closed and staff were absent.

Pain at rest and pain on dressing were both measured using a VAS as described by Zusman (1986). Subjects were asked to indicate the magnitude of pain by pointing to a position on a 10cm line. This point was measured from the left edge to the nearest millimetre. For pain at rest, subjects were instructed to score their pain at the time of testing. For pain on dressing, subjects were required to score the pain incurred during dressing that morning. The type of garments worn was not standardised, however, subjects typically wore the same type of clothing, ie loose fitting garments such as tracksuits.

Active and passive range of motion of the affected shoulder were measured in supine. Active abduction range was measured with a standard goniometer with the elbow extended. The pain-free range of passive external rotation was measured using a procedure previously described by Andrews and Bohannon (1989) and reported to have high intra- and inter-rater reliability. Briefly, subjects were positioned in supine with the shoulder abducted 45 degrees, elbow flexed 90 degrees and forearm pronated. The subject's shoulder was externally rotated passively to pain threshold which was defined as the start of any pain, and the range measured using a gravity goniometer.

Data analysis Intention to treat analysis was implemented - that is, regardless of breaches in the protocol for either group, data from all subjects completing both pre- and post-assessments were included in analyses according to original group assignment. There were two known breaches of protocol for subjects in the control group: one subject received shoulder positioning for one week at a nursing home and another subject was observed in a stretching position on one occasion. Data from these two subjects were analysed as part of the control group.

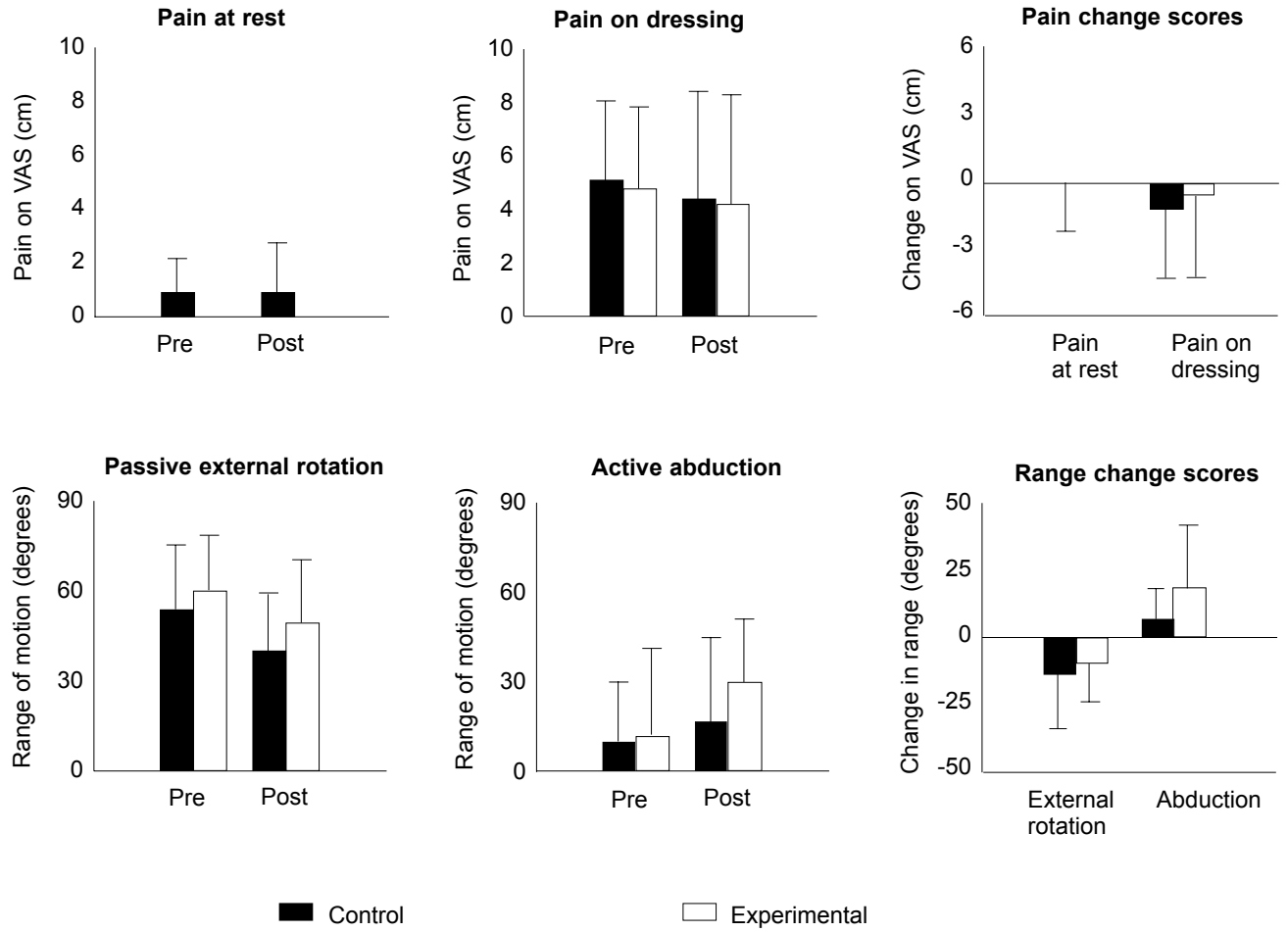


Figure 2. Means and standard deviations for both groups on entry (pre) and at the end (post) of the study for pain at rest, pain on dressing, passive external rotation and active abduction. In the third panel are means and standard deviations for change scores for all variables.

Change scores for pain and range of motion variables were calculated by subtracting the score on entry to the study from the score at six weeks. Pain data for one subject in the experimental group were missing, therefore for that group, pain scores were analysed for nine subjects and range of motion for 10 subjects. The difference in change scores between the groups were compared using two-tailed *t*-tests for independent samples. Significance was set at $p < 0.05$.

Results

Pain On entry to the study, no subject in the experimental group had pain at rest and the control group had a low level of pain with the mean of around 1cm on the VAS. After six weeks, scores for both groups were essentially unchanged (Figure 2). The mean pain on dressing for both groups on entry to the study was around 5cm (control = 5.1, experimental = 5.3) and had decreased slightly for both groups at six weeks (Figure 2). Changes in pain scores were not significantly different between the groups (pain at rest $t_{(20)} = -0.50$, $p = 0.985$; pain on dressing $t_{(20)} = -0.10$, $p = 0.923$).

Range of motion Mean active abduction range on entry to the study was around 10 degrees for both groups (control = 9, experimental = 11) and increased by 7 and 18 degrees for the control and experimental groups respectively over the six weeks (Figure 2). Mean pain-free passive range of shoulder external rotation was 54 degrees in the control group and 59

degrees in the experimental group on entry to the study, and decreased by 14 degrees for the control group and 11 degrees for the experimental group over the six-week period (Figure 2). Changes in active and passive range of motion of the affected shoulder were not significantly different between the groups (active abduction range $t_{(21)} = -1.56$, $p = 0.135$; passive external rotation range $t_{(21)} = -0.43$, $p = 0.639$).

Discussion

The major finding of this study is that the effect of the positioning protocol on shoulder pain and stiffness remains unclear. While the results suggest there was no effect, there are a number of factors including level of statistical power, selection of dependent variables and dosage of positioning, which may have contributed to the non-significant results.

Statistical power, that is, the ability to detect an effect, was low due to small sample size and the variability within the groups (Howell 1987). While the differences between the groups on the dependent variables were not statistically significant at the $p < 0.05$ level, these results cannot be used to propose that the positioning did not have an effect. The fact that, on average, at the end of the study the experimental group had more active and passive range of motion than the control group suggests that a significant difference between the groups may have been detected if the sample size had been larger. Arguably, the smallest difference in shoulder range which could be considered clinically significant over a six week positioning program would be 10 degrees. On the basis of the data collected in this study, in order to have 80 per cent power to detect a 10 degree difference in the range of motion variables, 46 subjects per group would be necessary.

In addition to measuring range of passive external rotation, it may have been useful to measure range of passive flexion and abduction. As a result of the selection criteria, on entry to the study all subjects could achieve passive shoulder abduction and flexion greater than 90 degrees. Compliance with the positioning protocol over the six weeks meant that at the end of the trial, subjects in the experimental group had maintained this range, however, this was not measured in subjects in the control group. Measurement of passive flexion and abduction at the end of the six weeks may have identified significant differences between the groups.

On the other hand, it may be that the dose, ie the amount of time that the subjects spent in each position, was insufficient. Light et al (1984) found that two hours a day of prolonged low load stretching improved knee extension during treatment of knee contracture. The finding that the experimental group did show some loss of external rotation range, despite completing the positioning protocol, suggests that the dose may have been insufficient to have an effect.

In conclusion, the effect of a shoulder positioning protocol on shoulder pain and stiffness following stroke remains unclear. Since the incidence of hemiplegic shoulder pain is high, further research is warranted to determine the efficacy of a clinically feasible shoulder positioning protocol.

Acknowledgements The assistance of Rosemary Winlaw, Cathie Sherrington, Andrew Webster and Sue Harris before and during the trial is gratefully acknowledged. In addition, the authors would like to thank George Argyrous for his assistance with the statistical data analysis, and Virginia Fowler for comments on the manuscript. Preliminary results of this work were presented at the 12th International Congress of the World Confederation for Physical Therapy in Washington DC, USA, June 1995.

Authors Catherine Dean, School of Physiotherapy, The University of Sydney, Lidcombe, New South Wales 1825. E-mail: c.dean@cchs.usyd.edu.au (for correspondence). Fiona Mackey, Physiotherapy Department. Illawarra Regional Hospital, Crown Street, Wollongong, New South Wales 2500. Pesi Katrak, Deputy Director Rehabilitation Medicine, Prince Henry Hospital, Anzac Parade, Little Bay, New South Wales 2036.

References

Ada L and Canning C (1990): Anticipating and avoiding muscle shortening. In Ada L and Canning C (Eds): Key Issues in Neurological Physiotherapy. Sydney: Butterworth Heinemann, pp. 219-236.

Ada L, Ward D, Mackey F, Perrott R and Van Vliet P (1987): Analysis of secondary shoulder dysfunction following stroke. *Australian Synapse* (Bulletin of the Australian Physiotherapy Association National Neurology Study Group) 5: 19-21.

Andrews A and Bohannon RW (1989): Decreased shoulder range of motion on paretic side after stroke. *Physical Therapy* 69: 768-772.

Bohannon RW (1988): Relationship between shoulder pain

and selected variables in patients with hemiplegia. *Clinical Rehabilitation* 2: 111-117

Carr JH, Shepherd RB, Nordholm L and Lynne D (1985): Investigation of a new motor assessment scale for stroke patients. *Physical Therapy* 65: 175-180.

Gossman MR, Sahrmann SA and Rose SJ (1982): Review of length associated changes in muscle. *Physical Therapy* 62: 1799-1809.

Griffin J and Reddin G (1981): Shoulder pain in patients with hemiplegia. *Physical Therapy* 61: 1041-1045

Herbert RD and Balnave RJ (1993): The effect of position of immobilisation on resting length, resting stiffness, and weight of soleus muscle of the rabbit. *Journal of Orthopaedic Research* 11: 358-366.

Howell DC (1987): Statistical Methods for Psychology. (2nd ed.) Boston: PWS-Kent Publishing Company.

Kumar R, Metter EJ, Mehta AJ and Chew T (1990): Shoulder pain in hemiplegia: the role of exercise. *Archives of Physical Medicine and Rehabilitation* 69: 205-208.

Light KE, Nuzik S, Peronius W and Barstrom A (1984): Low load prolonged stretch versus high load brief stretch in treating knee contracture. *Physical Therapy* 64: 330-333.

Roy CW, Sands MR and Hill LD (1994): Shoulder pain in acutely admitted hemiplegics. *Clinical Rehabilitation* 8: 334-400.

Tardieu C, Lespargot A, Tabary C and Bret MD (1988): How long must the soleus muscle be stretched each day to prevent contracture? *Developmental Medicine and Child Neurology* 30: 3-11.

Williams PE (1988): Effect of intermittent stretch on immobilised muscles. *Annals of Rheumatic Diseases* 47: 1014-1016.

Williams PE and Goldspink G (1978): Changes in sarcomere length and physiological properties in immobilised muscles. *Journal of Anatomy* 127: 459-468.

Williams PE and Goldspink G (1984): Connective tissue changes in immobilised muscle. *Journal of Anatomy* 138: 343-350.

Zorowitz RD, Hughes MB, Idank D, Ikai T and Johnston MV (1996): Shoulder pain and subluxation after stroke: correlation or coincidence? *American Journal of Occupational Therapy* 50: 194-201.

Zusman M (1986): The absolute visual analogue scale (AVAS) as a measure of pain intensity. *Australian Journal of Physiotherapy* 32: 244-246.