Factors related to thumb pain in physiotherapists

Suzanne J. Snodgrass[1], Darren A. Rivett[1], Pauline Chiarelli[1], Angela M. Bates[2] and Lindsay J. Rowe[3]

[1]Discipline of Physiotherapy, The University of Newcastle [2]Discipline of Medical Radiation Science, The University of Newcastle [3]Department of Radiology, John Hunter Hospital, Newcastle, NSW

The aim of this study was to determine whether differences exist between physiotherapists with work-related thumb pain and physiotherapists without thumb pain. Twenty-four physiotherapists with work-related thumb pain (Pain Group) and 20 physiotherapists without thumb or wrist pain (Non-pain Group), who were working at least 20 hours per week in an outpatient musculoskeletal setting, were compared on a number of attributes: generalised joint laxity, hand and thumb strength, height, weight, working environment, hand position and force applied during mobilisation, mobility at individual thumb joints, extent of osteoarthritis at the thumb and radial-sided wrist joints, and demographic data including age, gender and years of experience. All physiotherapists in the Pain Group reported their thumb pain was related to and initially caused by the performance of manual techniques, and 88% had altered their manual techniques because of pain in the thumb. There was extreme variability in hand position and force applied during mobilisation, and a slightly high prevalence of osteoarthritis (22.7%) considering the mean age of the total sample (38.6 years). Statistically significant differences between groups included increased right carpometacarpal joint laxity (6.4%, 95% CI 0.19 to 12.6), decreased right tip pinch strength (0.84 kg, 95% CI 0.01 to 1.68), and lower body mass index (2.0, 95% CI 0.11 to 3.9) for the Pain Group. Other factors were not statistically different between groups. These results indicate that work-related thumb pain affects physiotherapists' ability to administer manual treatments, and suggest that decreased stability and strength of the thumb may be associated with work-related thumb pain. **[Snodgrass SJ, Rivett DA, Chiarelli P, Bates AM and Rowe LJ (2003): Factors related to thumb pain in physiotherapists. *Australian Journal of Physiotherapy* 49: 243–250]**

Key words: Thumb, Pain, Physical Therapy (Specialty), Manipulation Therapy, Case-Control Study

Introduction

Work-related injury to the thumb has become a recognised problem for physiotherapists who perform manual techniques in the treatment of patients with musculoskeletal disorders (Cromie et al 2000, Reglar and James 1999, West and Gardner 2001). Thumb pain may cause physiotherapists to alter the way they perform manual techniques. In fact, 43% to 91% of physiotherapists with thumb pain alter their manual techniques because of work-related thumb pain (Balon 1984, Neville and Rivett 1985, West and Gardner 2001). Changes to treatment applications due to musculoskeletal pain in the treating therapist, rather than to enhance the treatment benefit, may decrease the effectiveness of manual therapy techniques and lead to less efficient and less successful treatment of patients, potentially increasing healthcare costs. In addition, it has also been reported that one in six physiotherapists moves within or leaves the profession as a result of a work-related musculoskeletal disorder (Cromie et al 2000), with the hand being the second most common site of work-related injury for physiotherapists (Bork et al 1996, Holder et al 1999, West and Gardner 2001). This loss of physiotherapists from the workforce places an increased burden not only on the healthcare system that often has difficulty retaining qualified physiotherapists, but also on the education system that trains physiotherapists. Therefore, prevention of work-related injury in physiotherapists, particularly to the thumb and hand, should become a priority in order to ensure the continued health and quality of life of the members of the profession.

Of all the structures in the hand, the thumb joints are particularly vulnerable to biomechanical overload and work-related injury in physiotherapists, because forces are often transmitted directly through the thumb during the application of manual techniques (Snodgrass and Rivett 2002). The prevalence of work-related thumb pain in physiotherapists who regularly administer manual techniques has been reported to be 60% to 81% (Cromie et al 2000, Neville and Rivett 1985). Prevention of work-related injury to the thumb will be most effective if it is based on influencing the factors that contribute to the development of thumb pain in physiotherapists. The aim of this study was to determine if certain factors were associated with work-related thumb pain in physiotherapists. The factors considered have been proposed elsewhere as potential contributing factors (Snodgrass and Rivett 2002), and include generalised joint laxity, hand and thumb strength, height and weight,

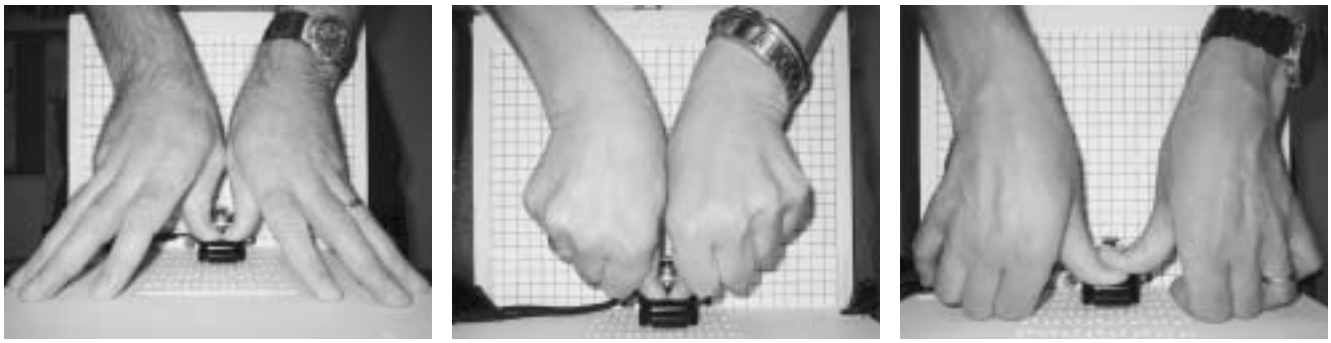

Figure 1. Examples of categorisation of hand position.
A: Thumbs not supported with index fingers, MCP joints touching, thumbs not overlapping
B: Thumbs supported with index fingers, MCP joints touching, thumbs not overlapping
C: Thumbs not supported with index fingers, MCP joints not touching, thumbs overlapping

working environment, hand position during mobilisation, force applied during mobilisation, specific mobility at individual thumb joints, and extent of osteoarthritis at the thumb and radial-sided wrist joints. This study also quantified levels of pain for physiotherapists with work-related thumb pain and explored their beliefs about the causes and consequences of their thumb pain.

Method

Participants Ethical approval was granted by The University of Newcastle Human Research Ethics Committee. Pilot studies were undertaken to refine data collection methods and estimate radiation dose levels for radiographic procedures. Physiotherapist participants were recruited from private practices and hospitals in the Hunter region of NSW, Australia. The recruitment process consisted of mailing letters of invitation to physiotherapists working at private practices listed in a telephone directory, speaking at a regional meeting of physiotherapists working in the public health system, and advertising in the regional physiotherapists' newsletter.

Consecutive volunteers were accepted for participation on the basis of meeting the inclusion/exclusion criteria. Participants were required to have worked in outpatient musculoskeletal physiotherapy practice over the previous year for an average of at least 20 hours per week. Participants were excluded if they had sustained an injury to the hand or forearm resulting in ongoing pain, functional limitation or permanent impairment, had undergone previous surgery to the hand or forearm, or were pregnant or breastfeeding at the time of data collection. Work-related pain in the thumb needed to have been present within the previous year for a participant to be included in the Pain Group. Work-related thumb pain was defined as pain that occurred either during the performance of the participant's duties as a clinical physiotherapist or within 48 hours of the performance of those duties, and perceived by the therapist to be related to work duties. Power and sample size calculations determined that approximately 20 physiotherapists would be required in each group to demonstrate clinically meaningful differences. The recruitment process continued for both groups until the target sample size for each group was achieved. In total, 24 physiotherapists were recruited for the Pain Group, and 20 for the Non-pain Group.

Measures were taken during two sessions of data collection for each physiotherapist participant. All measurements taken from radiographs and photographs were performed by a blinded investigator. Simple objective measurements, including the Beighton scale, height, weight, and all data recorded from the Jamar dynamometer[a] and the B & L pinch gauge,[b] were performed by one of the investigators.

Demographics Demographic data including age, gender, years of experience, and postgraduate qualifications were recorded using a custom-designed questionnaire. Physiotherapist height was measured with a stadiometer[c] and weight with a digital scale to allow for calculation of body mass index (BMI).

Pain Group assessment Participants in the pain group completed an additional section of the custom-designed questionnaire which asked them to report their perceived causes of thumb pain, the modifications they had made to work practices because of thumb pain and problematic manual techniques. Average severity of thumb pain over the previous three months was rated using a 100 mm visual analogue scale ranging from "no pain" to "excruciating pain." Frequency of thumb pain over the previous three months was rated by having participants select from defined categories. Pain Group participants also completed the Disabilities of the Arm, Shoulder, and Hand Outcome Measure (DASH) to quantify disability due to thumb pain. In addition, they completed the optional DASH Work Module, which contains questions related directly to work activities. Both the DASH and the DASH Work Module are scored from 0 (no disability) to 100 (maximum disability).

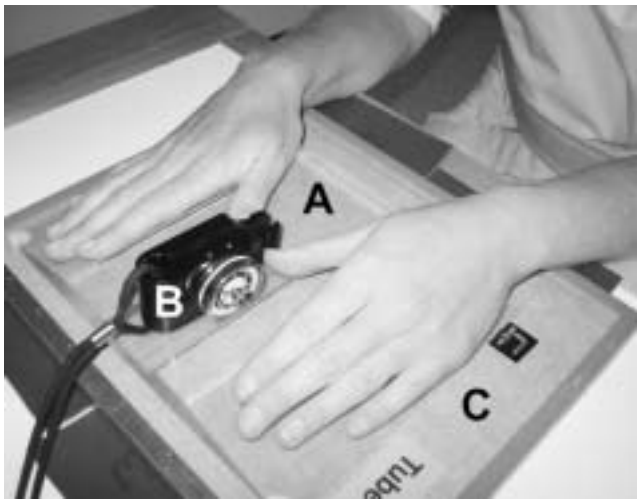

Figure 2. Set up used for CMC joint radiographic stress view.

A: Rigid translucent bolster

B: Fixed pinch gauge

C: Radiographic cassette

Figure 3. Radiograph used for measurement of CMC joint subluxation. The widest point of the base of the thumb metacarpal (B) was determined using bony landmarks (the ends of the fissile scar). The radial edge of the trapezium was represented by a line drawn between the distal radial and the proximal radial corners of the trapezium in this 2-dimensional view. The perpendicular distance (A) was measured between the radial edge of the trapezium and a parallel line intersecting line B. CMC subluxation = A/B x 100.

The DASH has demonstrated reliability, validity, and responsiveness in quantifying function for a variety of upper limb injuries (Beaton et al 2001a, 2001b).

Working environment The custom-designed questionnaire was also used to explore differences in the working environment between physiotherapists with thumb pain and those without thumb pain. Participants estimated the number of patient visits in their working week, and the number of hours they spent performing manual techniques per week. Participants were also questioned about the number of adjustable-height beds in their clinic, the number of physiotherapists working at any one time, and if they had adequate workspace available in order to position themselves comfortably for the performance of manual techniques.

Generalised joint laxity Generalised joint laxity was measured using the Beighton 9-point scale for hypermobility originally described by Beighton and Horan (Beighton et al 1983, Beighton and Horan 1969). Beighton's scoring system has generally been accepted as the gold standard for measuring orthopaedic indicators for genetically acquired joint laxity (Morgan and Bird 1994), and is often used to quantify joint hypermobility (Beighton et al 1973, Grahame et al 2000, Russek 1999). The Beighton scale is a rapid screening test, comprised of five different movements or positions, with a score allocated according to whether the subject can or cannot perform each movement on both right and left sides. A score of three or more can indicate a tendency towards hypermobility (Beighton et al 1973, Russek 1999).

Strength Hand and thumb strength were quantified using the Jamar hand-held dynamometer for testing grip strength, and the B & L pinch gauge for testing tip and key pinch strength. Three trials of each strength measure were performed, beginning with the dominant hand, and subsequently alternating hands. Procedures used for strength measurement have been described in a previous study that established the reliability and validity for these instruments (Mathiowetz et al 1984).

Mobilising hand position and force Chosen hand position during the performance of a commonly used manual technique was evaluated by having participants perform a standard posterior-to-anterior (PA) spinal mobilisation using the thumbs as described by Maitland et al (2001) while a photograph of their hands was taken from a controlled distance. Thumbs pressed down on the end of a secured pinch gauge which measured forces up to 27.2 kg. Participants were instructed to perform the technique as if they were treating the stiff lumbar or thoracic spine of a patient with no acute signs or symptoms, and to use the maximum pressure they would use on such a patient. These instructions were given so participants would potentially be using the maximal force they would use with their thumbs in a clinical setting. The mean force applied was determined from three photographic trials performed by each participant. Photographs were categorised for analysis by four physiotherapists who rated the hand positions on each photograph as to whether 1) at least one thumb was supported by the index finger, 2) the metacarpophalangeal (MCP) joints were touching, and 3) the thumb pads were overlapping (Figure 1). Table 1 provides data on the

Table 1. Reliability of measurements.

Measure	ICC(2,1)*	Kappa**	95% CI
CMC subluxation			
Intra-rater	0.89	–	0.74 to 0.95
Inter-rater	0.89	–	0.74 to 0.96
MCP extension			
Intra-rater	0.99	–	0.98 to 1.00
Inter-rater	0.97	–	0.91 to 0.99
IP extension			
Intra-rater	0.96	–	0.88 to 0.98
Inter-rater	0.97	–	0.90 to 0.99
Categorisation of mobilising hand position:			
Thumb support with index fingers			
Intra-rater	–	0.76	0.65 to 0.87
Inter-rater	–	0.75	0.67 to 0.82
MCP position (touching or not)			
Intra-rater	–	0.83	0.72 to 0.93
Inter-rater	–	0.92	0.83 to 1.00
Thumb overlap			
Intra-rater	–	1.00	n/a†
Inter-rater	–	0.96	0.84 to 1.00‡

*Intraclass correlation co-efficient. **Cohen's kappa is reported for intra-rater reliability, and the multi-rater kappa (Siegel and Castellan 1988) is reported for inter-rater reliability. †Not able to calculate 95% CI due to a kappa of 1 (perfect agreement). ‡95% CI truncated at 1.

Table 2. Description of participants.

	Pain group (n = 24) Mean (SD)	Non-pain group (n = 20) Mean (SD)
Age (years)	40.0 (8.7)	37.0 (9.7)
Gender* (females)	14 (58.3%)	11 (55.0%)
Height (cm)	170.1 (9.5)	171.9 (9.8)
Weight (kg)	72.0 (13.6)	79.1 (12.5)
BMI (kg/m^2)	24.7 (3.0)	26.7 (3.3)
Experience as a physiotherapist (years)	16.9 (9.7)	14.3 (10.7)
Experience, musculoskeletal (years)	13.3 (9.9)	11.1 (8.7)
Post-graduate qualification*†	5 (20.8%)	1 (5.0%)

*For categorical variables, number of participants with stated characteristic and percentage in each group is reported. †Post-graduate qualifications were defined as clinical post-graduate diplomas or degrees in musculoskeletal physiotherapy from universities or other tertiary institutions.

reliability of categorisation.

Thumb joint mobility Specific mobility of the thumb carpometacarpal (CMC) and MCP joints was quantified using measurements taken from stress radiographs of these joints. Radiographic procedures were performed by a single radiographer using standardised exposure parameters and film processing conditions. Measurements were made using AutoRad[d] software after digitising the films.

The radiographic CMC stress view used in this study, the Eaton-Littler view, is commonly used clinically to assist in quantifying the level of CMC osteoarthritis (Barron et al 2000, Eaton and Glickel 1987, Poole and Pelligrini 2000), and has been used to quantify CMC laxity in a previous study (Weiss et al 2000). The thumbs were placed on a custom-made bolster in a standardised position that was a 30 degree oblique rotation from the PA hand view (Figure 2). Participants were asked to press their thumb tips together, using the maximum force possible without moving the thumbs. This position causes the base of the first metacarpal to glide radially against the trapezium, particularly if the CMC joint has excessive laxity. A pinch gauge was placed between the thumb tips to measure the amount of force applied with the thumbs. The distance from the radial edge of the base of the first metacarpal to the radial edge of the trapezium represented the amount of CMC subluxation. This value was combined in a ratio with the width of the metacarpal and multiplied by 100 to determine the percent of the width of the base of the metacarpal that was radial to the radial edge of the trapezium (Figure 3).

The MCP stress view consisted of a lateral view of the MCP joint while it was stretched into extension using a standardised force. A custom-made device was used to stabilise the first metacarpal while the proximal phalanx was pulled into extension by the participant's opposite hand, using the pinch gauge to standardise the force applied at 2.5 kg. In the absence of a standardised protocol, a radiologist determined an appropriate method for measuring MCP extension from the radiographs, which used bony landmarks along the shafts of the first metacarpal and first phalanx.

Specific mobility at the interphalangeal (IP) joint of the thumb was measured from a digital photograph taken using a lateral view. IP range of motion photographs were taken at a controlled distance from the thumbs with the thumb pad pressing on a flat surface while the proximal phalanx was brought as close to vertical as possible, creating a stretch into IP extension. Measurements of IP extension were made digitally with UTHSCSA ImageTool[e], using the thumbnail and the dorsal edge of the proximal phalange as landmarks for measurement.

Osteoarthritis The presence of osteoarthritis in the thumb and radial-sided wrist joints was evaluated from the radiographs by a specialist radiologist, who was blinded to

Table 3. Modifications to work practices due to thumb pain in the Pain Group (n = 24).

Modification	n	%
Any modification to work practices	21	87.5
Modified manual techniques	21	87.5
Avoided some manual techniques	17	70.8
Used different manual techniques	12	50.0
Permanently modified manual techniques	8	33.3
Used splints or taping	8	33.3
Decreased use of manual techniques	7	29.2
Permanently avoided some manual techniques	5	20.8
Used hand tools or ergonomic aids	5	20.8
Decreased work hours	3	12.5
Had time off work	2	8.3
Changed work settings	1	4.2
Changed jobs	0	0

group and demographic information. Osteoarthritis was quantified by its presence or absence in the IP, MCP, CMC, trapezioscaphoid and scaphoradial joints.

Data analysis Data were analysed using SPSS 11.0 for Windows[f]. Radiographic and photographic measures demonstrated high to excellent reliability (Table 1); therefore data analysis was performed using one set of measurements from a single blinded individual. Differences between the Pain Group and the Non-pain Group were calculated using 2-tailed independent *t*-tests for measures of continuous data, and chi-square or logistic regression for categorical data.

Results

Demographics Physiotherapist demographics including age, gender, years of experience, and postgraduate qualifications did not statistically differ between the Pain and the Non-pain Groups (Table 2). Mean BMI, however, was statistically greater in the Non-pain Group (26.7, SD 3.3) compared to the Pain Group (24.7, SD 3.0, $p = 0.04$). Physiotherapists in the Non-pain Group were heavier (mean 79.1 kg, SD 12.5) and slightly taller (171.9 cm, SD 9.8) than those in the Pain Group (72.0 kg, SD 13.5; 170.1 cm, SD 9.5), but this was not statistically significant.

Pain Group responses Physiotherapists with work-related thumb pain tended to report a low severity but a high frequency of pain. The average severity of pain for participants in the pain group was 30.2 mm (SD 17.2). Ninety-two percent of the pain group experienced thumb pain at least once per week, and 45.8% had thumb pain at least daily when working. Disability/symptom scores on the DASH averaged 9.1 (SD 7.3), which is similar to the mean score of 10.1 (SD 14.7, n = 1706) for a normal population reported by Hunsaker et al (2002). However, scores on the DASH Work Module were considerably higher. The mean score for the Pain Group on the DASH Work Module was 21.9 (SD 13.5), compared to 8.8 (SD 18.4, n = 1610) for a normal population (Hunsaker et al 2002).

Table 4. Percent of Pain Group (n = 24) reporting aggravation from, or modification or avoidance of the following manual techniques.

Manual technique	Aggravation (%)	Modification (%)	Avoidance (%)
PA mobilisation*	100.0	62.5	45.8
Soft-tissue massage	79.2	41.7	20.8
Mulligan mobilisation†	25.0	0	8.3
Trigger point pressure therapy	16.7	0	0

*Posterior to anterior spinal mobilisation techniques described by Maitland et al (2001). †Mobilisation techniques described by Mulligan (1999).

Physiotherapists with thumb pain tended to modify their work practices rather than take time off work or change jobs, and only five (20.8%) physiotherapists in the Pain Group had sought treatment for their thumb pain (Table 3). All physiotherapists in the Pain Group reported manual techniques to be an initial cause as well as an aggravating factor for their thumb pain. Nearly all believed their thumb pain was related to patient load (92%) and type of client treated (96%). The most common manual techniques that were reported as aggravating, modified or avoided are summarised in Table 4.

Generalised joint laxity Twenty-five percent of participants in the Pain Group and 10% in the Non-pain Group received a score of 3 or greater on the Beighton hypermobility scale, and could be considered to demonstrate generalised joint laxity. This difference was not statistically significant possibly due to small sample size and the low prevalence of generalised joint laxity in the sample (18.2%), which is consistent with the reported prevalence in the normal population, ranging from 1 to 30% (Russek 1999).

Strength Hand strength was greater in the Non-pain Group across all strength measures, although only right tip pinch had statistical significance. Mean tip pinch strength of the right hand, which was also the dominant hand for all but three participants, was statistically less in the Pain Group (5.23 kg, SD 1.46), compared to the Non-pain Group (6.07 kg, SD 1.25), a difference of 0.84 kg (95% CI 0.01 to 1.68, $p = 0.05$). It should be noted, however, that joint pain can inhibit muscle contraction and force production (Richardson et al 1999, Stokes and Young 1984), and may have been a confounding factor. Nevertheless, there was minimal complaint of pain with strength testing, and when

participants with pain complaint were excluded from the analysis, there was no change in the statistical significance of the results.

Thumb joint mobility The Pain Group had increased mobility at the CMC joint of the right hand; mean right CMC joint subluxation in the Pain Group was 26.8% (SD 11.4), compared to 20.4% (SD 8.5) in the Non-pain Group, a difference of 6.4% (95% CI 0.2 to 12.6, $p = 0.04$). There was no difference in mobility at the MCP or IP joints. The right thumb appeared to be more problematic than the left for participants in the Pain Group, although many reported bilateral thumb pain (n = 17). Among those who complained of bilateral thumb pain, over half (53%) reported the right thumb to be the most painful, compared to 12% reporting the left thumb as more painful. (For others each thumb was equally painful.)

There were no significant differences between the groups for the working environment, or for hand position or force used during the performance of a PA mobilisation technique.

Discussion

The responses from the Pain Group agree with previous surveys which indicate physiotherapists' thumb pain is affected by the performance of manual techniques (Cromie et al 2000, West and Gardner 2001). By utilising a standardised questionnaire, this study was able to demonstrate that physiotherapists with thumb pain are experiencing higher than normal levels of disability in regards to their working life. Other key findings from this study were that physiotherapists with work-related thumb pain tend to have increased mobility at their right thumb CMC joint, decreased strength in tip pinch of the right hand, and a lower BMI. Factors that had been previously proposed to be related to thumb pain, such as the way a manual technique is performed or the volume of patients seen (Snodgrass and Rivett 2002), were not found to be significantly associated with work-related thumb pain in this sample of physiotherapists.

Participants were volunteers, rather than a randomly selected sample. Despite this method of recruitment, the age distribution and gender of participants was similar to that of the physiotherapist workforce in NSW, Australia. The sample was 56.8% female, which compares to 68.4% female physiotherapists working in medical centres or sports clinics in private practice in NSW (Statewide Services Development Branch 2000). Males and females were similarly represented in the Pain Group (14 females, 10 males) and the Non-pain Group (10 females, 10 males).

The working environment was not found to be different for physiotherapists with work-related thumb pain. However, working environment was quantified by physiotherapist report, and self-reported data can contain inaccuracies due to recall and other bias (Viikari-Juntura et al 1996). For example, participants estimated the amount of time they spent performing manual techniques, rather than recording their behaviour over time. Nevertheless, the number of hours spent performing manual techniques was not significantly different between the groups, although increased time spent performing manual techniques has been previously reported to increase the prevalence of work-related thumb pain in physiotherapists (Cromie et al 2000). In the survey by Cromie et al (2000), the greatest difference in prevalence was between those who performed manual techniques from 1 to 5 hours per week (about 25% prevalence) and 6 to 10 hours per week (over 50% prevalence), with the prevalence reaching a plateau of about 60% as hours spent performing manual techniques increased. In the present study, 89% of participants reported they performed manual techniques at least 10 hours per week, so both groups were perhaps performing manual techniques above a threshold of hours per week at which the risk of thumb pain becomes greater.

Hand position and force used during the mobilisation technique were extremely variable, with no pattern emerging for either group. It may be that hand position is influenced more by personal preference than by pain, or that different individuals find different hand positions more comfortable (Figure 1). Variability in force applied during mobilisation concurs with previous studies that have reported the forces applied by physiotherapists using the thumbs (Watson and Burnett 1990), a pisiform grip (Cook et al 2002, Matyas and Bach 1985), or their choice of hand grip (Simmonds et al 1995). The manual technique chosen for comparison in the present study was one that has been reported as problematic for physiotherapists with thumb pain (Neville and Rivett 1985), so it is possible that physiotherapists with thumb pain are using this particular technique more often, rather than performing it differently.

It is widely accepted that the amount of osteoarthritis visible on radiographs does not always correspond with pain complaints (Barron et al 2000, Pelligrini 1992, Poole and Pelligrini 2000). This may explain why there were almost as many occurrences of osteoarthritis in the Non-pain Group as the Pain Group. Osteoarthritis in the thumb CMC joint is generally more common in females, and in this study it was present only in female participants (n = 6, 8 CMC joints). Even though there were no differences in osteoarthritis between the groups, the prevalence of osteoarthritis in the females in this study might be considered higher than in a normal population. The prevalence of osteoarthritis in the CMC joint in women between the ages of 27 and 53 has been reported to be 2.1% (Sowers et al 2000), with a similar prevalence reported in another epidemiological study (van Saase et al 1989). When women of the corresponding age range from the present study were sampled, the prevalence of CMC osteoarthritis was 19%, although small study numbers may have had the effect of inflating this prevalence. Nevertheless, the higher prevalence of osteoarthritis in the present study sample may indicate that female physiotherapists are developing osteoarthritis at the CMC joint at an earlier stage and higher rate than the normal population.

The results of this study suggest that instability in the thumb CMC joint and weakness in the muscles about the thumb are related to thumb pain in physiotherapists. This study also suggests that the dominant hand may be more likely to demonstrate CMC instability and thumb weakness when work-related thumb pain is present. Instability at both the CMC and MCP joints has been linked to early degenerative changes and painful symptoms in the thumb (Moulton et al 2001, Pelligrini 2001). In fact, one survey of physiotherapists indicated that physiotherapists with pain may be instinctively using interventions that might control instability in the thumb, since 55% of physiotherapists with pain in the hand reported wearing a splint or support to control symptoms (West and Gardner 2001). Inadequate strength in the muscles about the thumb has also been previously associated with degenerative changes in the thumb, and exercise has been recommended as a conservative treatment for osteoarthritis and pain in the thumb CMC joint (Taylor 2000). Future research is needed to determine if increasing stability and strength in the thumb might prevent the development of work-related thumb pain or decrease its severity in physiotherapists.

Height and weight appear to have some relationship to work-related thumb pain, but more research is needed to determine how these parameters may be related to the performance of manual techniques. It should be noted that the design of this case-control study can only demonstrate an association between these factors and work-related thumb pain in physiotherapists. It cannot be determined whether observations of differences between the groups are a cause or an effect of having work-related thumb pain, as this would require a longitudinal study commencing at the time new physiotherapists began working.

Conclusion

Work-related thumb pain in physiotherapists continues to be a prevalent problem among physiotherapists who administer manual techniques. Factors that appear to be associated with thumb pain include CMC mobility and thumb strength. Research into the effectiveness of interventions for work-related thumb pain should consider addressing these factors.

Footnotes [a]Jamar dynamometer, Model No. 5030J1, Sammons Preston, Chicago, IL, USA [b]B & L Pinch Gauge, Model No. PG-60, B & L Engineering, Tustin, CA, USA [c]Portable height scale, Code PE87, Mentone Education Centre, Carnegie, Victoria, Australia [d]AutoRad Diagnostic, Eastman Kodak, Fremont, CA, USA [e]UTHSCSA ImageTool, 3.0, ©University of Texas Health Science Center in San Antonio, TX, USA [f]SPSS for Windows, Release 11.0.1, Standard Version, ©SPSS, Inc., 1989-2001.

Acknowledgements The authors would like to thank Dr Helen Warren-Forward from the Discipline of Medical Radiation Science at The University of Newcastle for her assistance with radiation dose calculations for the radiographic assessments.

Correspondence Suzanne Snodgrass, Discipline of Physiotherapy, Faculty of Health, The University of Newcastle, Box 24, Hunter Building, Callaghan New South Wales 2308 Australia, E-mail: Suzanne.Snodgrass@newcastle.edu.au

References

Balon MB (1984): Thumb and wrist symptoms of manipulative therapists. Unpublished research project submitted in partial fulfillment of a Postgraduate Diploma in Manipulative Therapy, Department of Physiotherapy at Lincoln Institute. La Trobe University, Melbourne, Australia.

Barron OA, Glickel SZ and Eaton RG (2000): Basal joint arthritis of the thumb. *Journal of the American Academy of Orthopaedic Surgeons* 8: 314–323.

Beaton DE, Davis AM, Hudak P and McConnell S (2001a): The DASH (Disabilities of the Arm, Shoulder and Hand) Outcome Measure: What do we know about it now? *British Journal of Hand Therapy* 6: 109–118.

Beaton DE, Katz JN, Fossel AH, Wright JG and Tarasuk V (2001b): Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder, and Hand outcome measure in different regions of the upper extremity. *Journal of Hand Therapy* 14: 128–146.

Beighton P, Grahame R and Bird H (1983): Hypermobility of joints. New York: Springer-Verlag.

Beighton P and Horan F (1969): Orthopaedic aspects of the Ehlers-Danlos syndrome. *The Journal of Bone and Joint Surgery* 51B: 444–453.

Beighton P, Solomon L and Soskolne CL (1973): Articular mobility in an African population. *Annals of the Rheumatic Diseases* 32: 413–418.

Bork BE, Cook TM, Rosecrance JC, Englehart KA, Thomason M-EJ, Wauford IJ and Worley RK (1996): Work-related musculoskeletal disorders among physical therapists. *Physical Therapy* 76: 827–835.

Cook C, Turney L, Ramirez L, Miles A, Haas S and Karakostas T (2002): Predictive factors in poor inter-rater reliability among physical therapists. *The Journal of Manual and Manipulative Therapy* 10: 200–205.

Cromie JE, Robertson VJ and Best MO (2000): Work-related musculoskeletal disorders in physical therapists: Prevalence, severity, risks, and responses. *Physical Therapy* 80: 336–351.

Eaton RG and Glickel SZ (1987): Trapeziometacarpal osteoarthritis: Staging as a rationale for treatment. *Hand Clinics* 3: 455–469.

Grahame R, Bird H and Child A (2000): The revised (Brighton 1998) criteria for the diagnosis of benign joint hypermobility syndrome (BJHS). *The Journal of Rheumatology* 27: 1777–1779.

Holder NL, Clark HA, DiBlasio JM, Hughes CL, Scherpf JW, Harding L and Shepard KF (1999): Cause, prevalence, and response to occupational musculoskeletal injuries reported by physical therapists and physical therapist assistants. *Physical Therapy* 79: 642–652.

Hunsaker FG, Cioffi DA, Amadio PC, Wright JG and Caughlin B (2002): The American Academy of Orthopaedic Surgeons outcomes instruments: Normative values from the general population. *The Journal of Bone and Joint Surgery (American)* 84A: 208–215.

Maitland GD, Banks K, English K and Hengeveld E (2001): Maitland's Vertebral Manipulation. (6th ed.) Oxford: Butterworth-Heinemann.

Mathiowetz V, Weber K, Volland G and Kashman N (1984): Reliability and validity of grip and pinch strength evaluations. *Journal of Hand Surgery* 9A: 222–226.

Matyas TA and Bach TM (1985): The reliability of selected techniques in clinical arthrometrics. *The Australian Journal of Physiotherapy* 31: 175–199.

Morgan AW and Bird HA (1994): Conference report: special interest group for joint hypermobility, Brighton. *British Journal of Rheumatology* 33: 1089–1091.

Moulton MJR, Parentis MA, Kelly MJ, Jacobs C, Naidu SH and Pelligrini VD (2001): Influence of metacarpophalangeal joint position on basal joint-loading in the thumb. *The Journal of Bone and Joint Surgery (American)* 83A: 709–716.

Mulligan BR (1999): Manual Therapy, "NAGS, SNAGS, MWMS" etc. (4th ed.) Wellington, New Zealand: Plane View Services Ltd.

Neville T and Rivett D (1985): A survey of thumb pain and dysfunction amongst manipulative therapists in N.S.W. Unpublished research project submitted as part of a Graduate Diploma in Manipulative Therapy at Cumberland College of Health Sciences. University of Sydney, Australia.

Pelligrini VD (1992): Osteoarthritis at the base of the thumb. *Orthopedic Clinics of North America* 23: 83–102.

Pelligrini VD (2001): Pathomechanics of the thumb trapeziometacarpal joint. *Hand Clinics* 17: 175–184.

Poole JU and Pelligrini VD (2000): Arthritis of the thumb basal joint complex. *Journal of Hand Therapy* 13: 91–107.

Reglar P and James G (1999): Thumb pain in physiotherapists: a preliminary study. *British Journal of Therapy and Rehabilitation* 6: 505–509.

Richardson C, Jull G, Hodges P and Hides J (1999): Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain: Scientific Basis and Clinical Approach. Edinburgh: Churchill Livingstone.

Russek LN (1999): Hypermobility syndrome. *Physical Therapy* 79: 591–599.

Siegel S and Castellan JN, Jr. (1988): Nonparametric Statistics for the Behavioral Sciences. (2nd ed.) New York: McGraw-Hill.

Simmonds MJ, Kumar S and Lechelt E (1995): Use of a spinal model to quantify the forces and motion that occur during therapists' tests of spinal motion. *Physical Therapy* 75: 212–222.

Snodgrass SJ and Rivett DA (2002): Thumb pain in physiotherapists: Potential risk factors and proposed prevention strategies. *The Journal of Manual and Manipulative Therapy* 10: 205–216.

Sowers M, Lachance L, Hochberg M and Jamadar D (2000): Radiographically defined osteoarthritis of the hand and knee in young and middle-aged African American and Caucasian women. *Osteoarthritis and Cartilage* 8: 69–77.

Statewide Services Development Branch, NSW Health (2000). Profile of the Physiotherapist Labourforce in NSW, 2000, State Health Publication No. (SWS) 020189. North Sydney, Australia.

Stokes M and Young A (1984): The contribution of reflex inhibition to arthrogenous muscle weakness. *Clinical Science* 67: 7–14.

Taylor J (2000): Restoration of dynamic stability in early osteoarthritis of the carpometacarpal joint of the thumb. *British Journal of Hand Therapy* 5: 37–41.

van Saase JLCM, van Romunde LKJ, Cats A, Vandenbroucke JP and Valkenburg HA (1989): Epidemiology of osteoarthritis: Zoetermeer survey. Comparison of radiological osteoarthritis in a Dutch population with that in 10 other populations. *Annals of the Rheumatic Diseases* 48: 271–280.

Viikari-Juntura E, Rauas S and Martikainen R (1996): Validity of self-reported physical work load in epidemiological studies on musculoskeletal disorders. *Scandinavian Journal of Work and Environmental Health* 22: 251–259.

Watson MJ and Burnett M (1990): Equipment to evaluate the ability of physiotherapists to perform graded postero-anterior central vertebral pressure type passive movements of the spine by thumb pressure. *Physiotherapy* 76: 611–614.

Weiss S, LaStayo P, Mills A and Bramlet D (2000): Prospective analysis of splinting the first carpometacarpal joint: An objective, subjective, and radiographic assessment. *Journal of Hand Therapy* 13: 218–227.

West DJ and Gardner D (2001): Occupational injuries of physiotherapists in North and Central Queensland. *Australian Journal of Physiotherapy* 47: 179–186.