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ORIGINAL ARTICLE

Incidence and predictors of contracture after spinal cord injury—a prospective cohort study

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Study design: Prospective cohort study.
Objectives: To determine incidence of contracture and develop prediction models to identify patients susceptible to contracture after spinal cord injury.
Setting: Two Sydney spinal cord injury units.
Methods: A total of 92 consecutive patients with acute spinal cord injury were assessed within 35 days of injury and 1 year later. Incidence of contracture at 1 year was measured in all major appendicular joints by categorizing range of motion on a 4-point scale (0—no contracture to 3—severe contracture), and in the wrist, elbow, hip and ankle by measuring range of motion at standardized torque. Multivariate models were developed to predict contracture at 1 year using age, neurological status, spasticity, pain and limb fracture recorded at the time of injury.
Results: At 1 year, 66% of participants developed at least one contracture (defined as ⩾1 point deterioration on the 4-point scale). Incidence of contracture at each joint was: shoulder 43%, elbow and forearm 33%, wrist and hand 41%, hip 32%, knee 11% and ankle 40%. Incidence of contracture determined by standardized torque measures of range (defined as loss of ⩾10 degrees) was: elbow 27%, wrist 26%, hip 23% and ankle 25%. Prediction models were statistically significant but lacked sufficient predictive accuracy to be clinically useful ($R^2 \leqslant 31\%$).
Conclusion: The incidence of contracture in major joints 1 year after spinal cord injury ranges from 11–43%. The ankle, wrist and shoulder are most commonly affected. It is difficult to accurately predict those susceptible to contracture soon after injury.
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INTRODUCTION

Contractures are a common complication of spinal cord injury. They are characterized by limited joint range of motion and deformity. Contractures are undesirable because they impair mobility and function, diminish effectiveness of locomotor training programs and lead to disability and pain.[1,2] It is important to quantify how frequently contractures occur and identify those most likely to develop contractures.

Few studies have examined the incidence or prevalence of contracture after spinal cord injury. A systematic review by Fergusson and colleagues,[3] published in 2007, identified three cross-sectional studies[4–6] which examined prevalence of contracture after spinal cord injury. Krause[5] used self-reports to measure prevalence of contracture in people with chronic spinal cord injury attending hospital outpatient clinics, Vogel *et al.*[6] used self-reports to measure prevalence of contractures at the elbow, hip and ankle in people who presented with pediatric-onset spinal cord injury to one of two hospitals and Bryden *et al.*[4] used goniometry to measure the prevalence of elbow flexion contracture in people with motor-complete C5 or C6 spinal cord injury who self-referred for neuroprosthetic and/or tendon-transfer interventions. These studies reported prevalence of contracture of between 15 and 50%. However, none of these studies described sampling methods and it appears possible that all could have been exposed to serious selection bias. The Tetrafigap Survey[7] of 6082 apparently consecutive admissions to French rehabilitation centers reported an 85% prevalence of 'awkward contractures' in people with chronic spinal cord injury (>2 years). However, the follow-up rate, calculated from data presented in the report, was just 37%. A cross-sectional study by Harvey *et al.*[1] reported a 48% prevalence of wrist and hand contracture in people presenting with C6 or C7 tetraplegia over a 15-year period. This study had a better follow-up rate of 72%. A prospective cohort study by Eriks-Hoogland *et al.*,[8] published after Fergusson's systematic review, provides more reliable estimates of the prevalence of contracture because it sampled 199 patients admitted to eight spinal cord injury units and had a 76% follow-up. The investigators used goniometry to quantify changes in shoulder range of motion in people with spinal cord injury up to 1 year after discharge. They reported up to 70% of participants with tetraplegia and 29% of participants with paraplegia lost at least 10 degrees of shoulder range of motion during or in the first year after discharge from inpatient rehabilitation. Data for joints other than the shoulder were not reported. Thus, there are few reliable

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data on incidence or prevalence of contracture after spinal cord injury.

It would be helpful to identify those at most risk of developing contracture so that they can be targeted for intensive preventive intervention. Although cross-sectional studies have shown associations between the presence of contracture and neurological deficit,[4,6,7] age[8] and spasticity,[9] there are few longitudinal data in spinal cord injury which report how well clinical measures obtained soon after spinal cord injury predict risk of subsequent contracture. Eriks-Hoogland *et al.* reported higher odds of shoulder contracture with increased age (odds ratio (OR) 1.6–1.8), tetraplegia (OR 2.3–11.9), spasticity of elbow extensors (OR 2.5–4.0), shoulder pain (OR 3.7–11.9) and longer time between injury and start of rehabilitation (OR 1.3–1.5).[8] Little else is known about those most likely to develop contracture after spinal cord injury.

The aims of the current study were, therefore, to (a) determine the incidence of contracture in a prospective cohort of consecutively recruited people 1 year after onset of spinal cord injury and (b) develop prediction models that would identify those likely to develop contracture.

MATERIALS AND METHODS

A prospective cohort study was conducted. Consecutive patients presenting with an acute spinal cord injury to two Sydney spinal cord injury units were recruited. Participants were assessed within 35 days of injury (baseline) and 1 year later (follow-up). They were eligible to participate in the study if they were admitted with a recent traumatic or non-traumatic spinal cord lesion and were at least 18 years old.

Measures of contracture

Contractures were identified using two methods. All measurements were carried out with the participant lying supine. The first method was a simple procedure used to quickly assess many joints. Passive range of motion was assessed in all major appendicular joints as the limbs were manually moved through range by an experienced physiotherapist. Passive range of motion was categorized on a 4-point ordinal scale in which 0 indicated no loss of range, 1 indicated a loss of up to one-third range, 2 indicated a loss of one- to two-thirds range and 3 indicated a loss of greater than two-thirds range. A goniometer was not used because the intention with these measurements (in contrast to the other instrumented measures) was to quickly screen the range of motion of many joints. Normal range was considered to be the range that the physiotherapists expected for a healthy person of similar age. This method was used to categorize range of motion of the shoulder, elbow and forearm, wrist and hand, hip, knee and ankle in up to three planes on both sides of the body. The development of contracture was defined as an increase of at least one point on the 4-point scale between the baseline measure and the 1-year follow-up. Inter-rater reliability of the 4-point scale was separately evaluated in 13 people with spinal cord injury, 9 people with multiple sclerosis and 5 people with stroke (total of 27 people). Two physiotherapists each assessed range of motion on the same day. Reliability of the 4-point scale was shown to be moderate (Kendall's tau = 0.62, bootstrapped 95% confidence interval (CI) 0.49–0.74).

The second method used to assess contractures involved measuring passive range of motion at standardized torque. This method was more time consuming, so it was used only for elbow extension, wrist extension and ankle dorsiflexion on both sides of the body. Elbow extension was measured using the method described by Moseley *et al.* (intraclass correlation coefficient = 0.98, 95% CI 0.93–1).[10] Wrist extension was measured using the method described by Harvey *et al.* (intraclass correlation coefficient = 0.85).[11] Ankle dorsiflexion was measured at 12 Nm of torque with a spring balance and cuff secured over the foot using a procedure similar to that described by Moseley and Adams.[12] Inter-rater reliability of the ankle dorsiflexion measurement method was separately evaluated in 13 people with spinal cord injury, 11 people with multiple sclerosis and 9 people with stroke (total of 33 people). Two physiotherapists each assessed ankle dorsiflexion on the same day. Reliability of the ankle dorsiflexion measurements was high (intraclass correlation coefficient = 0.86, 95% CI 0.74–0.93). Hip flexion with knee extension was also measured but torque was not standardized. Range of hip flexion was measured when the knee first started to bend (intraclass correlation coefficient = 0.95, 95% CI 0.87–0.98).[13] The development of contracture was defined as a loss in range of motion of at least 10 degrees between the baseline and 1 year follow-up measures.

Predictor variables

Potential predictors were selected *a priori* based on information from previous studies, clinical usefulness and ease of assessment in acute care settings. The predictors included neurological status, spasticity, age, pain and limb fracture measured at baseline. Neurological status was assessed using the International Standards for Neurological Classification of Spinal Cord Injury.[14] Motor scores in each limb (ranging from 0 to 25 with higher scores indicating more strength) were used to predict contracture in the limb. We chose to use motor scores because motor scores, unlike lesion level or the American Spinal Injury Association (ASIA) Impairment Scale score, are specific to each side of the body. The absence or presence of spasticity was assessed with the Tardieu scale and was treated as a dichotomous variable.[15] Pain was assessed by asking participants to verbally score pain intensity from 0 to 10 on a Numerical Rating Scale.[16] Participants were asked to rate average pain in the major upper and lower limb joints in the 24 h preceding baseline assessment. Range of motion of lower limb joints was assessed in all participants, but range of motion of upper limb joints was only assessed in participants with tetraplegia. Assessments were carried out by experienced clinicians. Follow-up outcome measures were assessed without reference to baseline values.

Statistical analysis

Estimates of the incidence proportions of contractures at 1 year were calculated for each joint using the two methods of contracture assessment. CIs for these proportions were corrected for the dependence of observations from the left and right sides of each participant.

Multivariate linear models were used to identify the best predictors of contracture at 1 year. The dependent variables in these models were ranges of motion measured at standardized torque at the wrist, elbow, hip and ankle. Data from left and right sides of the body were entered into the regression models; again, CIs were corrected for the dependence of observations from the left and right sides of each participant. A multivariate prognostic model was developed for each of the four joints using predictors measured at that joint. Bootstrapped backwards stepwise variable selection procedures[17] were used to generate a parsimonious linear regression model for each joint and to internally validate the models. This involved backwards stepwise variable selection (*P*-to-remove of 0.2) on each of 1000 bootstrap samples. Variables selected in at least 80% of models on the bootstrap samples were retained. Regression coefficients were zero-adjusted to improve model calibration.[18] The R^2 statistic of the full six-predictor model was used as a combined measure of discrimination (the ability to distinguish those likely to develop from those not likely to develop contracture) and calibration.

Study procedures were approved by the relevant hospital and university ethics committees. We certify that all the applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

RESULTS

Figure 1 shows the flow of participants through the study. A total of 128 patients were admitted between December 2008 and January 2010. Outcomes (range of motion or death) were obtained from 86% of eligible patients and 92% of participants. A complete case analysis was carried out. Five participants (three with tetraplegia and two with paraplegia) died before follow-up and were omitted from further analysis. Data were sometimes unobtainable for various reasons, including pain or fracture with cast immobilization. The proportion of data missing from upper or lower limb measures was at most 13%

and 9%, respectively. Incidence estimates were calculated only from survivors. Thus, estimates of incidence of contracture are conditional on survival. Participants were assessed at 3 weeks (median 19 days, inter-quartile range 15–26 days) and 1 year (median 377 days, inter-quartile range 360–398 days) after injury. The mean (s.d.) age of the 92 participants at baseline was 43 (19) years and 80% (74) were men. In all, 23% (21) of participants had motor-complete tetraplegia, 29% (27) had motor-incomplete tetraplegia, 26% (24) had motor-complete paraplegia and 22% (20) had motor-incomplete paraplegia. Neurological level ranged from C1 to S2.

Incidence of contracture after spinal cord injury

The incidence of joint contracture at 1 year assessed using the 4-point scale ranged from 11 to 43% (Table 1). The proportion of all participants who developed at least one contracture in any joint according to this definition was 66% (95% CI 55–77). The proportion of participants with paraplegia who developed at least one contracture in any joint according to this definition of contracture was 47% (95% CI 31–64) and they developed a median (inter-quartile range) of 0 (0–2) contractures. The proportion of participants with tetraplegia who developed at least one contracture in any joint according to this definition was 83% (95% CI 71–95) and they developed a median (inter-quartile range) of 3 (1.5–6) contractures. The incidence of joint contracture based on range of motion measured at standardized torque ranged from 23 to 27% (Table 2). The proportion of participants who developed at least one contracture in any joint according to this definition of contracture was 60% (95% CI 49–71). Contractures were most common at the ankle, wrist and shoulder. There were moderate correlations (Spearman's rho and bootstrapped 95% CI) of range of motion measured using the contracture scale and at standardized torque at each joint: elbow extension −0.56 (−0.78 to −0.34), wrist extension −0.72 (−0.89 to −0.54) and ankle dorsiflexion −0.52 (−0.70 to −0.34).

The prevalence of joint contracture at baseline and follow-up assessed using the 4-point scale is shown in Table 3. Contracture was defined as one point or more on the 4-point scale. At baseline, the prevalence of joint contracture ranged from 4 to 16% and at follow-up, prevalence ranged from 15 to 49%. The prevalence of joint contracture at baseline and follow-up based on range of motion measured at standardized torque is shown in Table 4. Contracture was defined as range of motion less than normative range.[19–21] At baseline, the prevalence of joint contracture ranged from 27 to 43% and at follow-up, prevalence ranged from 39 to 48%.

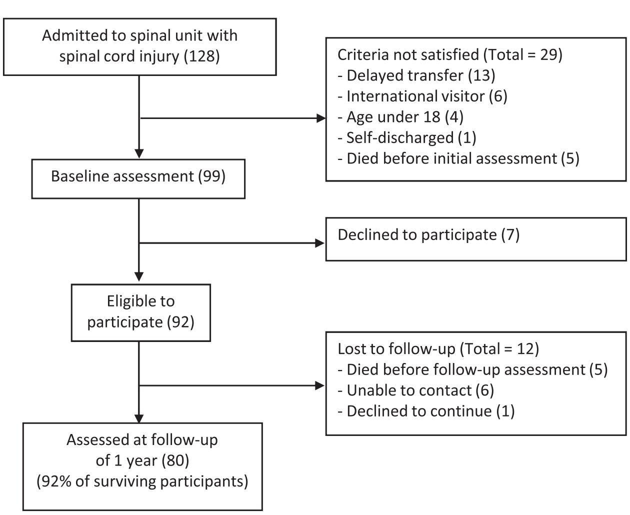

Figure 1 Diagram of flow of participants through the study.

Predictors of contracture after spinal cord injury

The analysis of univariate predictors identified several statistically significant predictors of contracture (Table 5). However, none explained enough of the variance of change in range to be clinically useful. In all cases, the r^2 values were $<14\%$.

Multivariate prediction models were only predictive at the elbow and wrist (Table 6). The model predicting elbow extension included age, upper limb motor score and spasticity. The model predicting wrist extension only included spasticity. The multivariate models were significantly associated with contracture at the elbow or wrist but did not explain enough of the variance of change in range to be clinically useful (R^2 of full models at the elbow and wrist were 31% and 16%, respectively).

DISCUSSION

This study is the first to provide robust estimates of the incidence of contracture in all major appendicular joints after spinal cord injury. Estimates of the incidence of contracture in major joints 1 year after spinal cord injury ranged from 11 to 43%. Participants with paraplegia developed a median of 0 contractures and participants

Table 1 Incidence of contracture at 1 year after spinal cord injury based on the 4-point scale

Joint	*Proportion of left-side joints developing contracture*	*Proportion of right-side joints developing contracture*	*Pooled estimate of incidence (in %) of contracture (95% CI)*
Shoulder	17/40	17/40	43 (28 to 57)
Elbow and forearm	13/40	13/40	33 (20 to 45)
Wrist and hand	15/39	17/39	41 (27 to 55)
Hip	24/78	27/79	32 (23 to 42)
Knee	7/78	11/79	11 (4 to 18)
Ankle	32/77	30/78	40 (30 to 50)

Incident contracture was defined as an increase of at least one point on the 4-point scale between baseline and follow-up. Contracture in lower limb joints was assessed in all participants but contracture in upper limb joints was only assessed in participants with tetraplegia. The denominators indicate the number of joints for which both baseline and follow-up data were available.

Table 2 Incidence of contracture at 1 year after spinal cord injury based on range of motion measured at standardized torque

Joint	*Proportion of left-side joints developing contracture*	*Proportion of right-side joints developing contracture*	*Pooled estimate of incidence (in %) of contracture (95% CI)*
Elbow extension	10/38	11/39	27 (17 to 37)
Wrist extension	9/38	11/38	26 (16 to 36)
Hip flexion with knee extension	18/75	17/76	23 (16 to 30)
Ankle dorsiflexion	22/72	15/74	25 (18 to 32)

Incident contracture was defined as loss of at least 10 degrees from baseline. Contracture in lower limb joints was assessed in all participants but contracture in upper limb joints was only assessed in participants with tetraplegia. The denominators indicate the number of joints for which both baseline and follow-up data were available.

Table 3 Prevalence of contracture after spinal cord injury at baseline and follow-up based on the 4-point scale

Joint	*Time*	*Proportion of left-side joints with contracture*	*Proportion of right-side joints with contracture*	*Pooled estimate of prevalence (in %) of contracture (95% CI)*
Shoulder	Baseline	8/43	6/43	16 (6 to 26)
	Follow-up	20/42	21/42	49 (34 to 63)
Elbow and forearm	Baseline	4/43	8/43	14 (4 to 24)
	Follow-up	14/42	17/42	37 (23 to 51)
Wrist and hand	Baseline	2/42	2/42	5 (−2 to 11)
	Follow-up	17/42	18/42	42 (28 to 55)
Hip	Baseline	9/83	10/84	11 (5 to 18)
	Follow-up	27/80	29/80	35 (25 to 45)
Knee	Baseline	4/83	3/84	4 (0 to 8)
	Follow-up	11/80	13/80	15 (7 to 23)
Ankle	Baseline	4/82	4/85	5 (0 to 9)
	Follow-up	34/79	33/79	42 (32 to 53)

Contracture was defined as a score of one point or more on the 4-point scale. Contracture in lower limb joints was assessed in all participants but contracture in upper limb joints was only assessed in participants with tetraplegia. The denominators indicate the number of joints for which baseline or follow-up data were available.

Table 4 Prevalence of contracture at 1 year after spinal cord injury based on range of motion measured at standardized torque

Joint	*Time*	*Proportion of left-side joints with contracture*	*Proportion of right-side joints with contracture*	*Pooled estimate of prevalence (in %) of contracture (95% CI)*
Elbow extension	Baseline	8/41	14/42	27 (15 to 38)
	Follow-up	15/41	19/41	41 (28 to 55)
Wrist extension	Baseline	12/41	20/41	39 (27 to 51)
	Follow-up	18/41	21/41	48 (33 to 63)
Hip flexion with knee extension	Baseline	19/80	26/81	28 (19 to 37)
	Follow-up	29/79	33/79	39 (29 to 49)
Ankle dorsiflexion	Baseline	29/77	39/81	43 (34 to 52)
	Follow-up	35/79	34/79	44 (34 to 54)

Contracture was defined as range of motion less than normative range. Contracture in lower limb joints was assessed in all participants but contracture in upper limb joints was only assessed in participants with tetraplegia. The denominators indicate the number of joints for which baseline or follow-up data were available.

with tetraplegia developed a median of 3 contractures. The proportion of participants who developed at least one contracture in any joint was 60% or 66% depending on the definition of contracture. The ankle, wrist and shoulder were most commonly affected. Predictive models based on simple clinical measures did not sufficiently discriminate those likely to develop contracture in a clinically useful way.

Previous epidemiological studies have suggested that the incidence of contracture after spinal cord injury is high. Perhaps the best estimate of the incidence of contracture comes from the study by Eriks-Hoogland *et al.*,[8] because these investigators recruited patients admitted to eight rehabilitation centers following spinal cord injury and had reasonable follow-up. The authors reported that up to 70% of participants with tetraplegia, had a limitation in shoulder range of motion in the first year after discharge from rehabilitation. Our study examined the incidence of contracture in a cohort of consecutive cases of spinal cord injury and estimated an incidence of shoulder contracture of 43% in participants with tetraplegia at 1 year after spinal cord injury. The difference in these proportions is probably

Table 5 Univariate predictions of range of motion at specific torque on baseline predictors for each joint, using linear regression

Joint and predictors	*Constant*	*Coefficient (95% CI)*	P	r^2 *(%)*
Elbow extension (40 participants, 77 joints)				
Age	2.31	−0.18 (−0.51 to 0.15)	0.28	4
ASIA motor UL	−12.76	0.65 (0.14 to 1.15)	0.01[b]	8
Pain UL[a]	−6.56	0.99 (−0.54 to 2.53)	0.20	2
Spasticity UL[c]	−6.82	24.62 (2.75 to 46.49)	0.03[b]	13
Fracture UL[c]	−5.29	2.79 (−2.45 to 8.04)	0.29	0
Wrist extension (40 participants, 76 joints)				
Age	6.21	−0.30 (−0.67 to 0.08)	0.12	6
ASIA motor UL	−14.86	0.74 (0 to 1.48)	0.05	6
Pain UL[a]	−6.63	−0.06 (−2.90 to 2.78)	0.96	0
Spasticity UL[c]	−6.99	9.99 (1.07 to 18.90)	0.03[b]	1
Fracture UL[c]	−6.37	1.88 (−5.27 to 9.03)	0.60	0
Hip flexion with knee extension (76 participants, 151 joints)				
Age	11.92	−0.24 (−0.47 to 0)	0.05	6
ASIA motor LL	5.79	−0.47 (−0.84 to −0.09)	0.02[b]	6
Pain LL[a]	1.47	0.56 (−0.98 to 2.10)	0.47	0
Spasticity LL[c]	3.49	−2.84 (−10.09 to 4.41)	0.44	0
Fracture LL[c]	1.56	16.44 (−11.44 to 44.31)	0.24	2
Ankle dorsiflexion (74 participants, 146 joints)				
Age	−8.48	0.20 (0.05 to 0.34)	0.008[b]	7
ASIA motor LL	−2.97	0.33 (0.06 to 0.60)	0.02[b]	5
Pain LL[a]	−0.81	0.71 (−0.39 to 1.80)	0.20	0
Spasticity LL[c]	−0.01	−0.39 (−5.42 to 4.64)	0.88	0
Fracture LL[c]	−0.25	1.25 (−12.28 to 14.78)	0.86	0

Abbreviations: LL, lower limb; UL, upper limb.
Positive coefficients indicate contracture is less likely with an increase in the predictor.
[a]Regression models for pain had one less participant and one less joint.
[b]Significant regression coefficients ($P<0.05$).
[c]Dichotomous predictors.

because we defined contracture differently or because contracture was assessed at different time periods after spinal cord injury. We extended the findings of Eriks-Hoogland *et al.* by determining the incidence of contracture in the elbow and forearm, wrist and hand, hip, knee and ankle joints. Two separate definitions of contracture were used as no universally accepted definition of contracture exists. Range of motion was measured at all major joints with a simple contracture scale and then more precisely and reliably at standardized torque.

Baseline range of motion was assessed as soon as possible after spinal cord injury (median 19 days after injury). However, it is possible that contractures may have already developed between the onset of injury and assessment. As we were interested in the incidence of contracture, we measured the rate of development of new contractures that were not apparent at the baseline assessment. The incidence of contracture over the first year after injury was probably underestimated because we defined incident contractures as a loss of range between baseline and follow-up, but baseline measures of range of motion were not taken immediately after injury. Some participants may have developed contractures between time of injury and their baseline assessment. For example, Table 3 indicates 16% of shoulder joints that scored at least one point on the 4-point scale at baseline. Presumably, this largely reflects contractures that developed between time of injury and baseline measures. Although we tried to minimize the contribution of spasticity to range of motion measures by moving the limb slowly and asking participants to remain relaxed, our clinical

Table 6 Multivariate predictions of range of motion using linear regression models

Joint and predictors	*% of bootstrapped samples which retained predictor*	*Zero-corrected regression coefficient (95% CI)*	R^2 *of full model*
Elbow extension (39 participants, 76 joints)			31
[a]Age	80	−0.25 (−0.54 to 0)	
[a]ASIA motor UL[b]	84	0.64 (0 to 1.17)	
Pain UL	26	—	
[a]Spasticity UL[b]	88	25.00 (0 to 55.89)	
Fracture UL[b]	37	—	
Constant	100	−4.30 (−18.82 to 11.80)	
Wrist extension (39 participants, 75 joints)			16
Age	60		
ASIA motor UL[b]	72		
Pain UL	18		
[a]Spasticity UL[b]	84	12.87 (0 to 28.04)	
Fracture UL[b]	19		
Constant	100	−4.31 (−24.67 to 19.20)	

Abbreviations: LL, lower limb; UL, upper limb.
Positive coefficients indicate contracture is less likely with an increase in the predictor.
[a]Predictors retained in >80% of bootstrapped samples.
[b]Dichotomous predictors.

measures could not discriminate between contractures caused by elevated tone or changes to the passive properties of soft tissues. It is impractical, in epidemiological research, to distinguish between losses in range of motion due to these two mechanisms. Nonetheless, one observation suggests that the observed losses in range of motion were not primarily due to spasticity: there was a very weak association ($r^2 < 0.06$) between spasticity and contracture at follow-up.

The second aim of our study was to identify factors which predict contracture. The aim of prognostic studies is to accurately predict an outcome, given the presence of one or more predictors.[22] They do not seek to explain causal mechanisms and therefore are not subjected to confounding.[22] In the current study, univariate and multivariate models identified several significant predictors of contracture. However, the models could not discriminate those that are more likely to develop contracture with sufficient accuracy to be clinically useful. We were surprised that the predictors performed so poorly (as demonstrated by the low R^2 values). The large proportion of unexplained variance in outcomes could be due, at least in part, to error in measurement of the predictors or range of motion outcomes. However, potential predictors and outcomes were measured using methods that were at least as reliable as those which could be routinely collected in clinical practice. The potential predictors for this study were chosen on the basis of clinical rationale, usefulness and ease of assessment in acute settings. It is possible that there are better predictors of contracture that are yet to be identified. The inability to determine strong predictors of contracture may reflect that the development and progression of contracture itself is a complex, multi-factorial process.[23]

The data from this prospective cohort study indicate that contracture is common after spinal cord injury. It is difficult to accurately predict who will develop contracture using simple clinical measures. Future research is needed to better understand factors associated with development of contracture.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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