

ORIGINAL ARTICLE

The diagnostic accuracy of self-report for determining S4–5 sensory and motor function in people with spinal cord injury

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Study design: A diagnostic accuracy study.

Objectives: The objective was to determine the ability of people with SCI to accurately self-report S4–5 sensory and motor function.

Setting: Outpatient clinic, Sydney, Australia.

Methods: A consecutive series of thirty-four people who had sustained a SCI more than 1 year before the study, and who were attending an outpatient medical clinic were recruited. They were assessed on two occasions. On the first occasion, ability to self-report S4–5 sensory and motor function was assessed with four questions. On the second occasion, a rehabilitation physician performed a physical examination to determine participants' S4–5 sensory and motor function. The rehabilitation physician was unaware of the results of participants' self-report. Participants' self-reports were compared with results from the physical examination using likelihood ratios.

Results: The likelihood ratios (95% CI) associated with a positive response to the sensory and motor questions were 1.92 (1.0–3.6) and 2.4 (1.2–4.9), respectively. The likelihood ratios associated with a negative response to the sensory and motor questions were 0.1 (0.0–0.6) and 0.4 (0.1–1.2), respectively.

Conclusion: People with SCI are reasonably accurate at self-reporting S4–5 sensory and motor function, although there is a high rate of false positives for S4–5 motor in those with motor levels below T10. In some situations it may be appropriate to use self-report rather than a physical examination to determine S4–5 sensory and motor function.

Spinal Cord (2012) **50**, 119–122; doi:10.1038/sc.2011.121; published online 11 October 2011

Keywords: diagnostic accuracy; spinal cord injury; neurology; assessment

INTRODUCTION

A rectal examination forms an essential part of the International Standards for Neurological Classification of Spinal Cord Injury (SCI).^{1,2} It is used to determine S4–5 sensory and motor function, and alone determines whether a person has a complete or incomplete SCI. It is also used to distinguish between different types of SCI and, importantly, to distinguish an American Spinal Injuries Association Impairment Scale (AIS) B lesion from an AIS C, D or E lesion. The reliance of the classification on S4–5 is based on its prognostic value. Those with S4–5 sensory or motor function have a better chance of neurological recovery than those without.¹

There is little doubt that appropriately trained staff need to carefully undertake the S4–5 examination in people with recent SCI or in those receiving interventions which may influence the neurological recovery. However, there are situations where it may be reasonable to compromise on accuracy and rely on self-report. For example, it may be reasonable to rely on self-report if trying to classify a person's neurological status for a community-based research project which is not targeting neurological recovery. A small degree of inaccuracy may be inconsequential and warranted to avoid rectal examinations. Of course at issue is the extent of inaccuracy in classification when relying on self-report: the focus of this study.

It is worth exploring ways of avoiding rectal examinations where possible because they are invasive and unpleasant examinations with associated risks. For example, they can cause rectal bleeding and

stimulate bowel motions. There are also logistical and practical problems associated with rectal examinations. For example, in some countries they can only be performed by medical personnel. This adds a logistical problem and sometimes expense to community-based research projects if medical personnel need to be organised solely for this examination. In addition, the test needs to be performed in a supine position and in a room with privacy. This requires appropriate equipment, facilities and personnel to assist in moving disabled patients out of wheelchairs and onto beds. It also requires additional time. These complexities and the associated cost could be avoided if self-report was a reasonable way of determining S4–5 sensory and motor function. Therefore, the purpose of this study was to determine the accuracy of relying on self-report to determine S4–5 sensory and motor function. Specifically, the aim of this study was to determine how accurately people with SCI can self-report S4–5 sensory and motor function when compared with the gold standard: a physical examination performed by a rehabilitation physician.

METHODS

A study of the diagnostic accuracy of self-report S4–5 sensory and motor function was undertaken following the research design features recommended by The Standards for Reporting of Diagnostic Accuracy Initiative.³ In all, 34 people who had sustained a SCI at least 1 year before and were attending a SCI outpatient clinic were recruited for inclusion in the study. They were excluded if they had multiple co-morbidities or limited ability to co-operate. The study

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Received 20 July 2011; revised 16 September 2011; accepted 17 September 2011; published online 11 October 2011

received ethical approval from the appropriate institutions and written informed consent was obtained from all participants. The authors certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Self-report of S4–5 sensory and motor function was assessed between 1 day and 2 weeks, before attendance at a SCI outpatient clinic. The assessments were conducted by phone or as part of a face-to-face interview with a research assistant experienced in SCI. Participants were asked four questions about their sensory and motor S4–5 function (see Appendix). A written script of the questions and instructions was used, and expressed in terminology appropriate for lay people. Participants were asked to answer 'yes', 'no' or 'uncertain' to each question. Three of the four questions (Q1a, Q1b, Q1c) were used to ascertain whether the participant had S4–5 sensation. The questions were:

Question 1a: Could you feel anything if I were to lightly touch the skin just around your anus with cotton wool?

Question 1b: Could you distinguish between the sharp and blunt end of a safety pin if I were to alternatively touch you with the sharp and blunt end of a safety pin on the skin just around your anus?

Question 1c: Could you feel pressure if I were to insert a gloved finger into your rectum and apply pressure to the wall of your anus?

The responses to these questions (Q1a, Q1b and Q1c) were tallied, where a 'yes' response to *any* question was indicative of a positive result for S4–5 sensation and a 'no' or 'uncertain' response to *every* question was indicative of a negative result for S4–5 sensation.

One question (Q2) was used to ascertain whether the participant had S4–5 motor function. The question was:

Question 2: Can you tighten the muscles of your anus as if you were going to hold in a toilet motion or enema or prevent the passing of wind? where a 'yes' response was indicative of a positive result for S4–5 motor function and a 'no' or 'uncertain' response was indicative of a negative result for S4–5 motor function.

Subsequently, one of two rehabilitation physicians performed a sensory and motor physical examination of S4–5 when participants attended an SCI outpatient clinic. Participants were attending the clinic either as part of routine follow-up or because they had specific medical problems. The examination was done according to the accepted clinical guidelines for the examination of S4–5, as outlined in the International Standards for Neurological Classification of SCI. It involved testing for light touch and pinprick on the right and left S4–5 dermatomes using a 0–2 scale; testing for deep anal pressure on a 'yes' or 'no' criteria; and testing the ability of participants to contract the anal sphincter during a rectal examination on a 'yes' or 'no' criteria. Participants were not asked any additional questions which might influence the rehabilitation physicians' interpretation of the S4–5 sensory or motor clinical tests. The rehabilitation physicians were unaware of participants' self-reports and asked not to discuss these with the participants.

Data analysis

Participants' self-reports for S4–5 sensory and motor function were compared with the results of the S4–5 sensory and motor examination using likelihood ratios.^{4–6} Likelihood ratios associated with a positive response to the motor or sensory questions 'rule in' S4–5 sensory and motor function, whereas negative likelihood ratios 'rule out' S4–5 sensory and motor function.^{6–8}

RESULTS

Overall, 34 of 116 consecutive people attending a SCI outpatient clinic between November 2010 and June 2011 were recruited. The reasons for exclusion were refusal to participate (21), impaired cognition or drug dependency (3), inability to contact the participant before appointment (17), multiple co-morbidities or other medical issues (12), less than 1 year post injury (20), limited English (5) or failure to attend an appointment (4). The characteristics of participants are provided in Table 1. Participants were at a median (interquartile range) of 2 (2–6) years since injury. Ten participants had AIS A injuries and the remaining had either AIS B (11), C (5) or D (8) injuries.

Table 1 Characteristics of participants

Age (mean, s.d.)	43 (15)
Time (years) since injury (median, IQ range)	2 (2–6)
<i>AIS classification (n, %)</i>	
AIS A	10 (29%)
AIS B	11 (32%)
AIS C	5 (15%)
AIS D	8 (24%)
<i>Neurological level (n, %)</i>	
C1–C8	16 (47%)
T1–T12	17 (50%)
L1–S5	1 (3%)
<i>Number of previous neurological examinations involving a rectal examination in the last year</i>	
0	19
1–5	11
5–10	0
Unsure	4
<i>Mean number of previous neurological examinations involving a rectal examination since the time of injury</i>	
0	5
1–5	19
5–10	0
> 10	1
Unsure	9
<i>Reason for attending clinic</i>	
Routine follow-up	32
Minor medical problem	1
Major medical problem	1

The accuracy of self-report for S4–5 sensation and motor function are shown in Tables 2 and 3. The likelihood ratios (95% CI) associated with a positive response to the sensory and motor questions were 1.9 (1.0–3.6) and 2.4 (1.2–4.9), respectively. The likelihood ratios associated with a negative response to the sensory and motor questions were 0.1 (0.0–0.6) and 0.4 (0.1–1.2), respectively.

DISCUSSION

The results of this study indicate that people with SCI more than 1 year post injury are reasonably accurate at self-reporting S4–5 sensory and motor function. While self-report cannot be relied upon for 100% accuracy, in certain situations and in certain patients, it may be reasonable to compromise on accuracy to avoid the need for a rectal examination. The decision to use self-report or perform a rectal examination depends on the implications of an error and the subsequent incorrect classification. For example, it is clearly very important to avoid errors and make a correct classification if the results are part of a large cohort study designed to monitor neurological change. It is also important to avoid errors if neurological classification is an outcome measure for studies targeting neurological recovery. There are however situations where it might be acceptable to run the small risk of error. For example, where the results are merely being used to describe the characteristics of a sample for a community-based research project or where S4–5 motor or sensory function has little relevance to clinical-decision making.

Table 2 Accuracy of participants' self-report of S4–5 sensory function compared with the results of the physical examination

	Physical examination		Total
	Positive	Negative	
<i>Self-report</i>			
Positive	23	5	28
Negative	1	5	6
Total	24	10	34

Table 3 Accuracy of participants' self-report of S4–5 motor function compared with the results of the physical examination

	Physical examination		Total
	Positive	Negative	
<i>Self-report</i>			
Positive	6	8	14
Negative	2	18	20
Total	8	26	34

The interpretation of likelihood ratios requires nomograms.⁹ Nomograms are widely used in other areas of medicine and can be used to derive the probability that a person has S4–5 sensory or motor function without performing a rectal examination. Clinicians need to initially estimate the probability of a person having S4–5 sensory and motor function based on clinical judgement. For example, if previous rectal examinations in a person 2 years after injury have consistently detected S4–5 motor function and the person reports no neurological change in the last 2 years, then the baseline chance of S4–5 motor function may be as high as 80% based on clinical judgement alone. If the person then confirms S4–5 motor function through self-report, it is possible to use a nomogram and the results of this study to estimate a 95% probability that the person does in fact have S4–5 motor function.¹⁰ Therefore, unless 100% accuracy is essential, there is probably little justification for a rectal examination to confirm what is already known from past history and self-report. There is however imprecision around our estimates of the positive and negative likelihood ratios reflected by the 95% confidence intervals. A larger sample with a more even representation of people with and without S4–5 sensory and motor function is required to attain more precise estimates.

An underlying assumption of this study is that a rectal examination is the gold standard. No one has yet compared the accuracy of rectal examinations and self-report with the results of more sophisticated neurophysiological tests. There is a possibility that in people with established SCI and intact cognition, self-report may be more accurate than rectal examination and that people with SCI may be better at detecting early signs of an incomplete SCI than examiners. People with SCI who rely on anal medications or stimulation for bowel care may be particularly good at accurately reporting S4–5 sensory and motor function. This may help explain the relatively high number of participants who reported S4–5 sensory 5 or motor function 8,

which was not detected by the examiners (that is, false positives). Alternatively, the false positives for the motor S4–5 may reflect the inability of people with SCI to distinguish between reflex and voluntary contraction of the anal sphincter and the false positives for the sensory S4–5 may reflect the inability of people with SCI to distinguish between vague sensations arising from the sympathetic nervous system and sensations associated with light touch, pinprick and deep anal pressure. Interestingly, 6 of the 8 false positives for motor function were from participants with motor levels below T10. These patients were unlikely to have intact reflexes of the anal sphincter. Nonetheless, exclusion of people with low motor levels may have substantially improved the likelihood ratios. Alternatively, there may be other patient characteristics that can be easily used to screen patients to determine suitability for relying on self-report. This may be an appropriate direction for future research.

Importantly, the results of this study cannot be generalised to all people with SCI more than 1 year post injury.¹¹ The results are relevant and applicable only to people in circumstances similar to those used in this study. The key characteristic of our sample is that all participants had undergone 3–6 months of inpatient rehabilitation involving education about the classification of SCI. In addition, 11 participants had undergone a S4–5 sensory or motor clinical examination in the last year. These examinations perhaps heighten participants' awareness of their S4–5 sensory and motor function and increased the accuracy of their self-report. In addition, people deemed unlikely or able to co-operate were excluded. Rectal examinations are always going to be required in this later group of individuals.

The results of this study do not as yet provide conclusive evidence for relying on self-report in all patients, but they do pave the way for exploring the potential use of self-report for determining S4–5 sensory and motor function in some patients and in situations where accuracy is not of paramount importance. Of course, some may argue that accuracy is always of paramount importance; however, this approach fails to acknowledge the invasive nature of rectal examinations along with their associated costs and risks. All these factors need to be considered. This study indicates that the probability of misclassifying a person is less when using self-report if other aspects of the person's clinical presentation provide a high baseline certainty of S4–5 sensory and motor function. Further work is now required to refine the questionnaire and repeat the study on a larger and more representative sample of people with and without S4–5 sensory and motor function and from different clinical settings. Work also needs to be directed at identifying the types of patients in whom self-report can be relied upon.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

The work was supported by Motor Accidents Authority of NSW.

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APPENDIX

Script for administration of the S4-5 sensory and motor questionnaire (S45Q)

I am going to ask you 4 questions about your sensation and strength in and around your anus.

The questions are of a personal nature.

If at any time you feel uncomfortable answering any questions, or for any reason would prefer not to answer these questions, please let me know and I will cease asking anything more.

The questions are important for determining the extent of your spinal cord injury.

They tell us whether nerve messages are getting past your injury all the way down to the end of your spinal cord.

The only other way to gain the same information is for a clinician to test the strength and sensation of your anus. This involves a rectal examination.

The questions will help avoid the need for a rectal examination although regardless, the final decision about a rectal examination is always yours.

Sometimes irrespective of your answers to the questions, we recommend that you have a rectal examination.

If you do not understand any of the terminology we are using, then please just answer 'uncertain'.

Are you happy to proceed and for me to ask you the questions?

Yes

no

(circle appropriate answer)

The questions are:

Question 1a: Could you feel anything if I were to lightly touch the skin just around your anus with cotton wool?

Yes

no

uncertain

(circle appropriate answer)

Question 1b: Could you distinguish between the sharp and blunt end of a safety pin if I were to alternatively touch you with the sharp and blunt end of a safety pin on the skin just around your anus?

Yes

no

uncertain

(circle appropriate answer)

Question 1c: Could you feel pressure if I were to insert a gloved finger into your rectum and apply pressure to the wall of your anus?

yes

no

uncertain

(circle appropriate answer)

Question 2: Can you tighten the muscles of your anus as if you were going to hold in a toilet motion or enema, or prevent the passing of wind?

yes

no

uncertain

(circle appropriate answer)