

ARTICLE



# What is the clinical meaning of a negative bulbocavernosus reflex in spinal cord injury patients?

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**STUDY DESIGN:** This is a retrospective cohort study.

**OBJECTIVE:** To highlight some issues about the clinical meaning of a negative bulbocavernosus reflex (BCR) in spinal cord injury (SCI) patients.

**SETTINGS:** Research group University Antwerp Belgium.

**METHODS:** The study included 170 patients in whom the BCR was examined at a mean of 7 years post SCI. Changes over time were explored in a subset of patients.

**RESULTS:** BCR was negative in 45%. There was no influence of age and gender, nor could a relation be found with the American Spinal Injury Association Impairment Scale score. The anal sphincter reflex (ASR) was positive in 13% of patients with negative BCR. With a mean interval of 45 weeks, BCR changed in 32% of a subset of 44 patients (14 became positive, 3 negative), while the neurological condition did not change and no treatments had been given that could influence the outcome. The data show that a negative BCR may not only be due to a disrupted reflex nervous pathway (which in some patients is different from that of ASR), but may also be caused by a difficulty to provoke the reflex.

**CONCLUSION:** A negative BCR test indicates interruption of the reflex neurologic pathways, but can also depend on the ease to elicit the reflex. By also doing ASR, this dilemma can be partly solved.

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## INTRODUCTION

The bulbocavernosus reflex (BCR) is part of a clinical neuro-urological examination [1]. It is a multisynaptic spinal reflex mediated predominantly by S2–4 [2]. But occasionally, the synapses may lie as high as L5, and the efferent innervation can include S5 [3]. Afferent impulses are conveyed from the glans penis/frenulum or the clitoris via the dorsal genital nerve or the perineal nerve [4]. They stimulate motor neurons of the external anal sphincter and BCR muscles by the pudendal nerve's deep perineal and inferior hemorrhoidal branches [5]. While the efferent limb runs in the anterior sacral roots, it is unclear whether the afferent limb lies in the posterior sacral roots: the reflex may survive a complete posterior rhizotomy below T10. The alternative afferent pathways in such cases are so far unknown [6].

Publications recently linked physiologic, diagnostic and outcome data regarding urologic, sexual and other functions to the BCR. Wang et al. found in suprasacral injury patients with detrusor areflexia that 63.0% have a normal BCR [7]. BCR and somatosensory-evoked potential also have some relationship with clinical findings in spinal cord injury (SCI) patients, but neither these data can accurately predict detrusor overactivity/detrusor sphincter dyssynergia nor detrusor areflexia [8]. BCR has been used for intraoperative monitoring for the prediction of post-operative voiding function in adult patients with lumbosacral spinal tumor [9]. And for the prediction of cauda equina syndrome [9], the

diagnostic value for cauda equina syndrome has been shown by Zusman et al. [10]. Greciet et al. found that late recovery of the BCR in the postoperative period may be associated with poorer neurological and functional outcomes for individuals sustaining a motor-complete traumatic SCI, for which the prognosis estimation is limited [11]. Electrophysiological BCR was also studied as an outcome measurement for focal vibrations aiming at improving sexual function [12]. We evaluated a group of patients with negative BCR in order to better understand the clinical meaning of such findings.

Case presentation: we made a retrospective study in a consecutive cohort of SCI patients investigated by the same physician for 12 months. The cohort consisted of 170 SCI patients, 119 males and 51 females, age  $46 \pm 17$  years old, with a different American Spinal Injury Association Impairment Scale score (AIS).

## METHODS

Patient age and gender, time since SCI, and AIS were gathered from the files, along with the outcome of the BCR, done during a pre-urodynamic clinical neurological assessment. Also, the anal sphincter reflex (ASR) data were included. For both reflexes, a fingertip had been brought in the anus. The BCR was elicited by briskly squeezing the glans penis/clitoris and was considered present if contraction was felt by the examiner around the intra-anal finger. The ASR was provoked by touch stimulation around the anal opening and was considered positive if the sphincter grabbed the

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intra-anal finger. The score used was 0 = absent, 1 = present but not strong, 2 = strong [5]. Patients were informed about which tests were planned and how they were performed. The examination was blinded for the patient, and if there was some doubt whether the examiner noticed a reflex contraction or voluntary squeezing, a mock test without stimulation was added.

Institutional Review Board permission was granted (Edge 001176).

Statistical analysis was done with SPSS27, using  $\chi^2$  to evaluate categorical and one-way ANOVA for continuous variables. Statistical significance was set at  $p < 0.05$ .

Ethics: all applicable institutional and government regulations were applied.

## RESULTS

The examination was done mean  $7 \pm 12$  years post SCI (min 3 weeks, max 62 years).

BCR was negative in 45%. The overall outcome of the reflex was not different between gender (BCR  $p = 0.366$ , for ASR  $p = 0.091$ ), or dependent of age (BCR  $p = 0.675$ , for ASR  $p = 0.27$ ). Most patients had the same result of ASR and BCR (Table 1) (87%,  $\chi^2 p < 0.001$ ). In 10 patients, BCR was found absent and ASR present, and in 5 patients vice versa, representing together 9% of the cohort. The reflexes could easily be differentiated from a voluntary muscle contraction. In AIS A (complete SCI) above the sacral level BCR was absent in 45%, while in conus/cauda lesions, BCR was present in 40%. In AIS B-D (incomplete) SCI above the sacral level, BCR was absent in 50%, in conus/cauda lesions present in 70%. Over the following months, the test was repeated twice in 32 patients, three times in 8 and four times in 4. The results and the interval (number of weeks) between testing are given in Table 2. BCR changed over time in 39% ( $n = 17$ ): 14 became positive, and 3 negative while the neurological condition did not change and no treatments had been given that could influence the outcome.

## DISCUSSION

It is essential to differentiate between an upper motor neuron (UMN) and a lower motor neuron (LMN) lesion to guide the rehabilitation and long-term management after an SCI [13]. It is not possible to differentiate based on the neurological level of injury alone. A correlation between the reflexes and detrusor and striated sphincter activity during urodynamics has been shown before [14]. The anocutaneous reflex has been associated with bladder continence in children with myelomeningocele [15]. A detailed clinical examination, including sacral reflexes, is required [5, 16]. It is uncertain, however, if ASR and BCR are helpful for the prediction of bowel or bladder function after SCI [17]. In the introduction, several publications have been given that used BCR in diagnostic and predictive settings. But further studies on the clinical predictive value of ASR and BCR should be done.

Our findings confirm that AIS cannot predict the result of the reflexes. The AIS score, a standard neurological examination used by rehabilitation teams to assess the sensory and motor levels

**Table 1.** Results of BCR and ASR at the first testing of our cohort of SCI patients.

	BCR			Total
	0	1	2	
ASR 0	66	3	2	71 (42%)
1	7	48	4	59 (35%)
2	3	3	34	40 (23%)
Total	76 (45%)	54 (32%)	40 (23%)	170

0 = absent, 1 = present but not strong, 2 = strong.  $\chi^2 p = 0.001$ . ASR anal sphincter reflex, BCR bulbocavernosus reflex.

affected by a SCI, is based on voluntary muscle contraction and somatic sensation preservation and is not directly related to reflex function [16].

The presence of reflexes is indicative of a saved sacral spinal reflex arc, while the absence is thought to indicate a lesion of the reflex arc and could also help to distinguish between conus medullaris and cauda equina syndromes. The role of pyramidal lesions in a negative outcome is suggested by some [17], but this is contested by Hattori et al., who showed in a large cohort that the central afferent way of the anal reflex has a solid relationship to the superficial sensory tract, but that the central efferent system had almost no connection with pyramidal or extrapyramidal tracts [18].

We found in our study a negative BCR in almost half of the cohort. After SCI, negative reflexes can become active again at an early stage in a caudal to rostral sequence, which is considered to be a sign of awakening from spinal shock. A change to positivity was seen in 32% (14/44). But in 7% (3/44), an original positive BCR could not be demonstrated anymore during follow-up. Not all authors find the clinical utility of the appearance of the reflex very important [19, 20]. In some patients with high SCI, reflexes can still be negative after many weeks and become positive many weeks later. Such observation was also made in this study, but not only for high lesions. We found that when tests were repeated over time reflexes could change while there was no direct indication of a spontaneous or a treatment-induced change in the neurological condition (e.g., no injections of botulinum toxin or implantation of a baclofen pump).

Though identical in most of our patients BCR differed from ASR in 15 patients (9%). The knowledge of the BCR reflex pathway was given in the introduction. ASR has afferent pathways in the pudendal nerves, synapses in the sacral spinal cord and travels via the inferior hemorrhoidal nerve to the external anal sphincter [21, 22]. The peripheral nerves involved and the connected spinal cord pathways of both reflexes are thus very similar, but not identical, and it is possible that this can account for a difference in clinical outcome after SCI. Different techniques to test the reflexes may probably change the outcome as different neurologic pathways are examined [6, 13]. Studies comparing the results with different techniques to provoke the reflexes have not been published. In our study, the same techniques were used in all so that this factor cannot have played in the differences found.

A BCR is not easily elicited in healthy people. Blaivas et al. [23] could not elicit a detectable BCR in 2% of non-disabled men and in 19% of non-disabled women. Bors and Comarr stated that up to

**Table 2.** Results of repeated tests in 44 patients.

<i>Two times tested (n = 32) with interval of 39 ± 72 weeks</i>	
The same outcome in both tests	23
Negative ASR and BCR have become positive	4
Positive ASR and BCR become negative	2
Negative BCR becomes positive with ASR unchanged	2
Positive BCR becomes negative with ASR unchanged	1
<i>Three times tested (n = 8) with interval between two and three of 22 ± 18 weeks</i>	
The same outcome in both tests	2
Negative ASR and BCR become positive	6
<i>Four times tested (n = 4) with interval between three and four of 40 ± 34 weeks</i>	
The same outcome in both tests	2
Negative ASR and BCR become positive	2
Number of patients.	
ASR anal sphincter reflex; BCR bulbocavernosus reflex.	

30% of men with a normal neuroaxis have no clinically detectable BCR [6]. Hackler found a reduction or absence of detectable clinical reflexes in up to 30% of persons with an intact neuroaxis [24]. In our cohort, reflexes were absent in  $\pm 40\%$  during follow-up, which corresponds with what was reported in a previous series [14]. Blaivas et al. [23] found the BCR presence or absence strongly related to the level and completeness of the SCI. We did not find such relation: in our patients with a complete SCI above sacral level, many had negative ASR and BCR, while in an incomplete lesion, reflexes were not detected in half, confirming what had already been found before [14]. In our patients with conus-cauda lesions, ASR and BCR were present in 40% of complete lesions and absent in 30% of incomplete lesions. The findings in repeated testing show that for unknown reasons a different outcome of the reflexes can be found during follow-up when no neurologic changes had occurred. These data may strongly indicate, in our opinion, that BCR is not easily elicited in some SCI patients, as seen in healthy. Also, a problem of provoking ASR exists but based on our findings would be less frequent than for BCR. Data on difficulties to elicit ASR are not available in literature. The difficulty to provoke the reflexes complicates findings of a neuro-urological examination and shows that negative reflexes do not necessarily relate to a lesion of the reflex arc. Difficulties in the detection may increase the risk of errors in the neurological diagnosis if only one of the reflexes is examined [1]. Especially the difficulty in demonstrating BCR makes this test less reliable [8]. The result also depends on circumstances: the BCR is more difficult to elicit in circumcised men and men with persistent foreskin retraction [25]. When ASR is also done it will improve the information for a great part. We think that doing both ASR and BCR can give a better diagnosis because the ASR and BCR are partly neurologically different, are not interchangeable and that each may be difficult to demonstrate but that doing both reflexes limits this risk. Graves suggested testing first the reflex the clinician is most comfortable with and test the other in case of a negative result [1]. The data discussed above challenge this, as absence in one reflex can in itself be a meaningful diagnostic sign. It has been recommended that if a reflex is absent, the examination should be repeated several times, but data on the value of such repetition are not available [23]. In negative findings, we often tried again immediately, but no different outcome was found. While some have advocated electromyography as more reliable, its general clinical application is impossible in routine patient care [26, 27].

A questionnaire survey about the SCI anorectal examination filled out by physicians showed that BCR was done in 50% and ASR in 90% [28]. It has been suggested that the choice of which is done could depend on psychological factors related to the comfort level of the clinician and a supposed comfort level of the patient [29]. These suggestions are surprising as “good clinical practice” rules for these examinations have been clearly defined [30]. The physician’s discomfort can be countered by recognizing that performing the reflexes is neurologically needed, and performing both is preferable. Properly informing the patient and explaining how and why the tests are done and why a chaperone is to be present will positively affect the patient’s comfort.

We summarize that differences between ASR and BCR can exist in some patients with SCI. They may be due to a lesion of different neurological pathways, related to different stimulation methods, but also influenced by a difficulty to provoke the reflexes. Examining only one of the reflexes increases the risk of an incorrect neuro-urological diagnosis, as a negative test could wrongly suggest that all sacral reflex arcs are destroyed, and a positive test that also the pathways of the other reflex are unharmed. In our opinion, both reflexes should be examined in order to secure a maximum of reliable diagnostic information. They are easy to perform in a standardized way without the need of extra invasive manipulation.

Our study has limitations. It only deals with SCI patients and does not permit conclusions related to other types of neuropathy. The evaluation was done retrospectively, but the way of testing did not change over time. Differentiation between scores 1 and 2 has been made, but this is subjective and was only found in a small number (Table 1).

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#### **AUTHOR CONTRIBUTIONS**

WJJ collected the file data, put them in a database, made evaluations, wrote the text, and rewrote the revision text. JQ commented on the text, made corrections, and

helped rewrite the revision text. WM commented on the study design, made evaluations, corrected the text, and helped rewrite the revision text. RA evaluated the text, made suggestions/corrections, and rewrote revision text.

#### **COMPETING INTERESTS**

The authors declare no competing interests.

#### **ADDITIONAL INFORMATION**

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