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# Neurological Bypass for Sensory Innervation of the Penis in Patients With Spina Bifida

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**Purpose:** Most male patients with spina bifida have normal sexual desires. During puberty they begin to realize that they can achieve erection and sexual intercourse but without any sensation in the penis. We hypothesized that restored sensation in the penis would greatly contribute to their quality of life and sexual health. In this prospective study we investigated the outcome of a new operative neurological bypass procedure in patients with spina bifida.

**Materials and Methods:** In 3 patients who were 17, 18 and 21 years old with a spinal lesion at L5, L4 and L3-L4, respectively, the sensory ilioinguinal nerve (L1) was cut distal in the groin and joined by microneurorrhaphy to the divided ipsilateral dorsal nerve of the penis (S2-4) at the base of the penis. All patients underwent preoperative and postoperative neurological and psychological evaluations.

**Results:** By 15 months postoperatively all patients had achieved excellent sensation on the operated side of the glans penis. They were unequivocally positive about the results and the penis had become more integrated into the body image. In 2 patients masturbation became more meaningful and 1 became more sexually active with and without his partner.

**Conclusions:** The newly designed neurological bypass procedure in patients with spina bifida resulted in excellent sensibility in the glans penis. The new sensation appeared to contribute to the quality of the patient sexuality and sexual functioning as well as to the feeling of being a more normal and complete individual who is more conscious of the penis. This new operation might become standard treatment in patients with spina bifida in the future.

*Key Words:* spinal dysraphism, penis, sensation, quality of life, sexuality

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Advances in medicine and multidisciplinary treatment have increased life expectancy and quality of life in patients with spina bifida. Most of them have normal sexual desires and fantasies, and they are actively interested in sex.<sup>1</sup> Normal serum testosterone has been found in male patients with spina bifida.<sup>2</sup> Of these patients 70% can achieve erection<sup>1-4</sup> with dripping ejaculation in about 54%<sup>2,3</sup> and orgasm in 20%.<sup>1</sup> Patients with spina bifida with low vs high lesions have increased sexual function and reproductive capacity,<sup>1,2</sup> and they live a relatively normal life. Puberty is often highly frustrating since these patients begin to realize that they can achieve erection and ejaculation with possible sexual intercourse but without any sensation in the penis.

Surprisingly to our knowledge no study in the literature has dealt specifically with absent penile sensation in patients with spina bifida. In a nonpathological situation sensory impulses are transmitted from the glans penis through the 2 DNPs and pudendal nerves to the sacral roots S2-S4 and ultimately to the sensory cortex. In patients with spina

bifida this route is interrupted by the spinal lesion. We hypothesized that, if this spinal lesion could be bypassed, restored sensation in the penis would greatly contribute to quality of life and sexual health.

To achieve this we designed an operative procedure in which the sensory ilioinguinal nerve is cut distal and joined by microneurorrhaphy to the divided DNPs at the base of the penis (fig. 1). The DNP was chosen and not the perineal nerve to the anterior part of the shaft because it is the most important sensory nerve to the glans penis. The ilioinguinal nerve was chosen for its length, its anatomical position, the high level of entrance into the spinal cord (L1) and the cross-sectional caliber match with the DNP (S2-S4). Inguinal hernia surgery has shown that the ilioinguinal nerve can be cut without adverse effects in patients. In this prospective study we investigated the outcome of this new surgical intervention in patients with spina bifida.

## METHODS

### Patient Selection

We selected well motivated patients with no signs of psychopathology on psychological tests and no negative sexual experiences, except frustration as a consequence of the condition, who had a spinal lesion between L1 (ilioinguinal nerve) and S2 (DNP). This level combines absent penile sensation with normal sensation in the groin.

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Study received Medical Ethics Committee approval.

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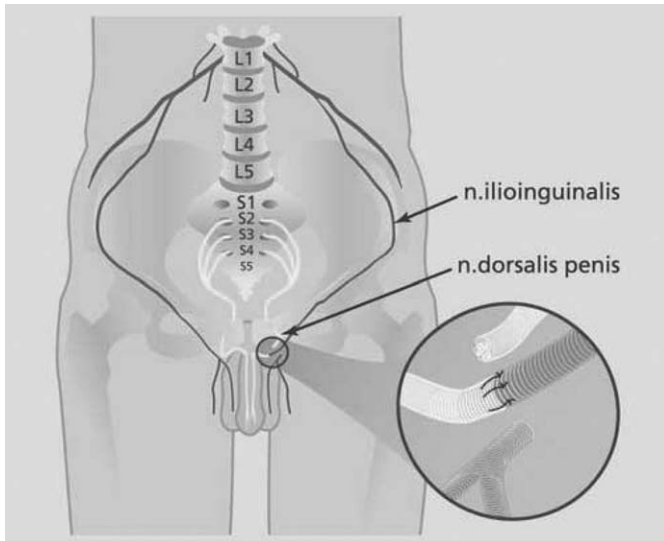


FIG. 1. Experimental design. Sensory ilioinguinal nerve (*n.ilioinguinalis*) at L1 is cut distal and joined by microneurorrhaphy at base of penis to divided dorsal nerve of penis (*n.dorsalis penis*). Ilioinguinal nerve enters spine at L1 and dorsal nerve enters spine at S2-S4.

The Medical Ethics Committee permitted performance of the procedure in 3 patients, who were 16 to 21 years old. This age was chosen because 1) in patients older than 16 years no parental consent for joining the study was needed, 2) sexuality is important for adolescents and young adults, and 3) the chances of nerve regeneration are significantly better in younger individuals.<sup>5,6</sup>

### Neurological Assessment

We used simple nonquantitative neurological sensory tests for touch, that is pointed vs blunt stimuli, and temperature, that is warm (37°C) vs cold (4°C) stimuli. For testing purposes the groin area, penile shaft and glans penis were subdivided into smaller regions. After blindfolding the patient each region was stimulated 3 times at random intervals. If all 3 stimuli were correctly experienced, it was concluded that

sensation was present in that particular region. The distal part of the urethra was tested separately using a soft cotton-wool stick. In addition to sensation, we noted where the stimulus was experienced (groin, penile shaft or glans penis) and if the stimuli was ever experienced erotically.

### Psychological Assessment

Patients were evaluated twice, including once preoperatively and once 1 year postoperatively, using a self-constructed, semistructured interview to measure various aspects of sexuality.<sup>7</sup> Apart from this interview certain questionnaires were used, including the Dutch Personality Questionnaire,<sup>8</sup> the Child Behavior Checklist,<sup>9</sup> the Youth Self-Report version of the Child Behavior Checklist,<sup>10</sup> the Hospital Anxiety and Depression Scale,<sup>11</sup> and an adapted version of the Groningen Arousalability Scale.<sup>12</sup>

### Surgical Technique

Surgery was performed with the patient under general anesthesia. The incision was made over the course of the right or left ilioinguinal nerve to the base of the penis. After exposure the ilioinguinal nerve was cut distal and the ipsilateral DNP was cut proximal. The 2 nerve ends were approximated at the base of the penis and joined by microneurorrhaphy (fig. 2). The fascia and skin were then closed.

### Study Protocol

After patients were selected and written informed consent was obtained neurological and psychological evaluations were performed, followed by ilioinguinal nerve transposition to the DNP on 1 side of the penis. Postoperative neurological testing was done after 5 to 8 months and again after 12 to 15 months. Psychological assessment was repeated 12 months after the operation.

### RESULTS

Postoperatively all patients achieved excellent sensation in the glans penis on the operated side. The groin area, medial mons pubic region and lateral part of the scrotum had less or

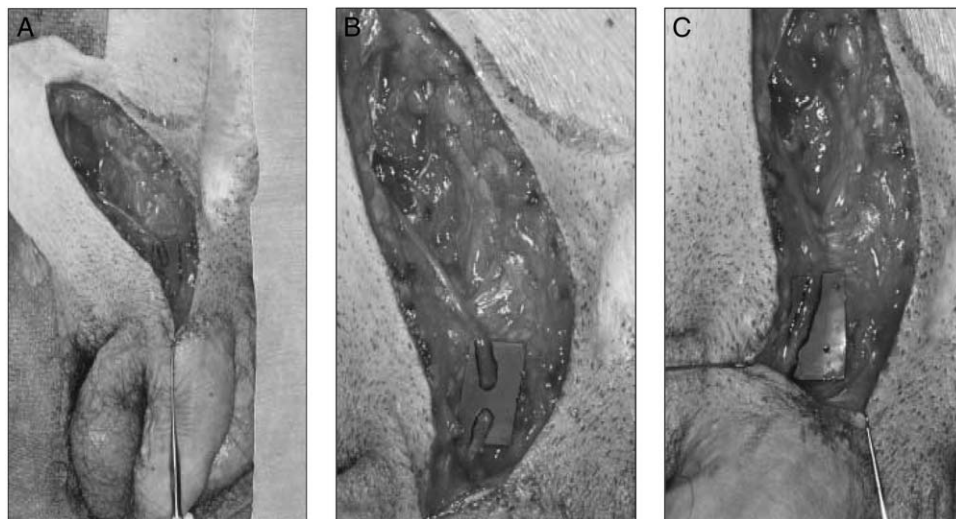


FIG. 2. Surgical technique. A, incision over course of right ilioinguinal nerve to base of penis and nerve exposure. B, detail of distally cut ilioinguinal nerve and proximally divided ipsilateral dorsal nerve of penis. C, 2 nerve ends joined by microneurorrhaphy.

no sensation compared to the nonoperated side. Patients did not experience any discomfort, pain, hyperesthesia or paresthesia. The [table](#) lists the results of preoperative and postoperative psychological evaluations.

### Case 1

Patient 1, who was 18 years old, had level L4 motor and sensory deficiencies. Sexual experiences were limited and he rarely masturbated due to lack of sensation.

In the 8 months following surgery the left side, ie the operated side, of the glans penis and the distal part of the urethra attained excellent sensation, although no sensation was observed in the shaft. The stimuli were experienced as if the left groin was being touched and in a private environment this qualified as tactile but not erogenous in nature. At 15 months after intervention no new sensory changes had occurred.

Patient 1 reported being happy with the sensation in the penis. He was more conscious of the penis, making it a real part of his body. He felt less handicapped. During self-catheterization he noticed the introduction of the catheter into the distal part of the urethra, which was experienced as something positive. At the second psychological assessment session patient 1 was still not sexually active (see [table](#)).

### Case 2

Patient 2, who was 17 years old, had level L5 motor and sensory deficiencies. Patient 2 had no sexual relationship and he was not sexually active. When masturbating, he could ejaculate (dripping) and achieve orgasm, which gave him a vague sort of "orgasmic feeling" in the lower abdomen.

After 5 months the left side, ie the operated side, of the glans penis and the distal part of the urethra had achieved excellent sensation. The stimuli felt as if the left groin was being touched but in some regions of the glans penis it felt as if the sensation was "climbing up to the glans penis." However, in the shaft no sensation developed.

At 12 months after intervention stimulating the corona region was experienced as a "groin feeling," whereas stimuli in the meatus region gave the impression that the glans penis was being touched. Also, the distal shaft of the penis had gained some "groin" sensation. The new sensations were qualified as tactile in nature.

Patient 2 was happy with the new sensation in the penis. During self-catheterization he noticed the introduction of the catheter as a cold object, which was experienced as

positive. The sensations had become totally integrated into his body perception and they could be considered a step toward being a more normal and complete individual. He masturbated slightly more because the sensations in the penis during masturbation were pleasant and orgasm had become more sexually exciting. Patient 2 reported having slightly less sexual desire but about as many sexual thoughts. It was easier for him to become aroused (see [table](#)).

### Case 3

Patient 3, who was 21 years old, had level L3-4 motor and sensory deficiencies. He reported feeling some sexual desire and arousal but he had no strong sexual motivation. The erections were rigid enough to enable him to be fully sexually active with his wheelchair bound girlfriend but achieving orgasm was difficult. Ejaculation gave him a "tingling feeling inside." Achieving orgasm gave him a sense of relief and relaxation.

Five months after operation the right side, ie the operated side, of the glans penis and the distal part of the urethra had attained excellent sensation. The stimuli were felt as if the right groin was being touched and they qualified as tactile in nature.

At 12 months after intervention stimulation of the corona region was experienced as if the glans penis was being touched, whereas the meatal area felt as if the groin area was being touched. In a private environment the sensations were experienced not only as tactile, but also as erogenous. However, in the shaft no sensation was recovered.

The new sensations made sexual activity more pleasurable for patient 3. Orgasm was experienced as pleasant. He was conscious about the new feelings and elicited them often. During masturbation he felt sensations that might be considered erogenous. Only after treatment did he realize what he had been missing before surgery. He became sexually more active and the sexual relationship with his girlfriend improved significantly. His girlfriend reported that she had never realized how little he had felt before his operation. Each agreed that their sexual relationship had become more open and meaningful (see [table](#)).

## DISCUSSION

The effects of a new procedure were studied in 3 patients with spina bifida who had no penile sensation before surgery. By transposing the ilioinguinal nerve and connecting it

*Preoperative and 1 year postoperative evaluations*

	Pt 1		Pt 2		Pt 3	
	Preop	Postop	Preop	Postop	Preop	Postop
No. masturbations/mo	2	2	1	5	1	6
No. times sexually active with partner/mo	0	0	0	0	1	5
Erection quality (0—flaccid—10—erect)	5	6	8	8	6	9
No. morning erections/mo	2	2	0	1	3	15
Ejaculation	No	No	Dripping	Dripping	Dripping	Dripping
Orgasm	No	No	Yes	Yes	Yes	Yes
No. sexual dreams/mo	1	2	2	1	1	0
No. sexual thoughts/mo	2	3	10	10	1	6
Sexual desire (0—little—10—much)	5	5	7	5	3	7
Satisfaction (0—not—10—very satisfied):						
Sexual functioning	6	4	6	8	6	8
Sexual life	5	4	4	3	6	10
Sexuality importance (0—not—10—very important)	5	6	7	5	5	9

to the ipsilateral DNP excellent sensibility was achieved in the glans penis. Sensation was present on the operated side of the glans penis only and not on the shaft or the contralateral side. This can be explained by the unilateral anatomy of the DNP, which consists of 1 dorsal axonal bundle to the glans penis and distal urethra, and 1 lateral to the shaft. However, these axons never cross the midline.<sup>13</sup> It is likely that the axonal growth from the ilioinguinal nerve only traveled through the dorsal bundle, thus, not reaching the shaft.<sup>3</sup> This distal part of the DNP, which probably had never functioned, could be used for conduction activity as long as the perineurium tube was intact.

In addition to gaining sensation, there was also a loss of sensation due to the division of the ilioinguinal nerve. This did not cause symptomatic sensory loss or chronic pain in our patients, a phenomenon that is described in the literature.<sup>14</sup>

At first the stimuli of the glans penis were experienced as if the groin was being touched, but after 12 months 2 patients had remapped sensibility to the glans penis. Detailed sensory testing revealed that in patient 2 the corona region gave a "groin" sensation, whereas the meatal area had developed a "glans" sensation. The opposite was true in patient 3. These sensory changes might have been the result of different stages of sensory reorganization due to the neural plasticity of the brain. This phenomenon of cortical reorganization is attributable to reinforcement or revelation of former relatively weak or ineffective connections. Ebner et al noted that cumulative change in many synapses of the somatic sensory cortex leads to a change in their receptive field, which is interpreted as a reorganization of the map of the cortical representation of the body surface.<sup>15</sup> This capacity of the human brain to adapt to peripheral input seems to last a lifetime and it depends on the pattern and frequency of use.<sup>16</sup> This might explain the differences between patient 1 and the other 2 patients. Patient 1 was less motivated and less active in stimulating the penis, while masturbation was more frequent in the other 2 patients. Patient 3 was sexually active with a partner. These activities can be seen as sensory education programs, in which visualization and motivation have a considerable role.<sup>17</sup> However, age is the most important factor for predicting sensory and functional recovery.<sup>5,6</sup> Transposing the nerve at an earlier age, preferably before the age of puberty, is likely to contribute to more effective sensory reeducation of the brain and make erogenous sensation more feasible.

Postoperatively all patients retained the ability to achieve erection and ejaculation, if present, was unchanged. The ability to attain erection depends on preservation of the psychogenic and/or reflexive pathways of erectile function. Psychogenic erections are regulated by a sympathetic spinal center at Th10-L2.<sup>18</sup> They travel further along the hypogastric nerves to reach the penis by way of the pelvic plexus. In our patients psychogenic erection was likely to be preserved because the spinal lesions was lower than Th10-L2.

On the other hand, reflexive erections are elicited by direct penile/genital stimulation through the somatic-afferent DNPs and pudendal nerves. They are mediated in the sacral spinal segments S2-S4 and modulated by supraspinal influences. Efferent parasympathetic and somatic fibers run to the penis and perineal musculature, producing a reflexive erection.<sup>19</sup> Due to the role of the DNP in reflexive erections and ejaculation, and considering that one must retain the

capacity of erection at all costs, it was decided not to operate bilaterally, but rather leave 1 DNP intact.

However, in future patients measuring the bulbocavernosus reflex can predict whether 1 unilateral reflex pathway is intact. This may help determine the risk of losing the reflexive pathway of erection by using 1 or 2 DNPs to sensitize the penis. This risk would probably be low since the bulbocavernosus reflex is often negative in patients with spina bifida.<sup>20</sup>

All patients were unequivocally positive about the results of the operation. They felt sensations in an area where they had never had any sensation before, they felt less handicapped and the penis had become more integrated into their body image. Even sensations during introduction of the catheter contributed to the sense of being complete. This is important since most patients with spina bifida use intermittent self-catheterization to empty the bladder. In 2 patients masturbation had become more meaningful. Since it was difficult to measure because these patients had never experienced erogenous feelings before, the new sensations did not qualify as erotic. However, in patient 3 the new sensations stimulated him to be more sexually active, making the sexual relationship with his girlfriend more meaningful.

## CONCLUSIONS

Since unilateral sensation in the glans penis developed all patients, we can conclude that the operation was a technical success. Whether it will result in more satisfaction about sexuality in general does not only depend on the technical success of the operation. In some patients the frustration of not being able to experience sexual feelings may spread to other life areas, such as not being able to find a sexual partner. Naturally we cannot solve such problems by an operation. However, having increased sexual sensation in the penis may still contribute to quality of life in this group of patients.<sup>2</sup> To date this novel surgical technique might be seen as experimental since it involves a small group. On the other hand, the technique of nerve transpositions in hand surgery and neurorrhaphy in a free flap reconstructed penis are well known.<sup>5</sup> To validate the new intervention we are currently treating a larger group of patients with spina bifida and traumatic spinal lesions starting at age 12 years using a more detailed neurological evaluation. In the traumatic group the results will be interesting since they had previously achieved sexual activity. These studies may answer the question of whether this new operation should become standard treatment for patients with spina bifida/spinal lesions in the future.

### Abbreviations and Acronyms

DNP = dorsal nerve of the penis

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## EDITORIAL COMMENT

This article deals with a topic, ie sexual outcome and sexual life, which has been underestimated by urologists caring for individuals with spina bifida. While working with patients with spina bifida for up to 25 years, I have experienced the frustration of having no answers to the request of these individuals to improve their genital sensation and sexual performance. The idea of applying neuroorrhaphy to the sensitive pudendal nerve is fascinating and it seems promising.

Some concern arises with regard to the capability of a distal part of a nerve that has not been functioning for a long time in terms of restoring its conduction activity. However, these authors report good subjective results and they aim to apply the technique in younger patients with a potentially better perspective of success.

A limit to evaluate results in terms of quality of life is that erection is not only related to an intact pathway, but also it is of psychogenic origin. Children cannot have an effective brain education related to something that they do not know. It might be interesting to see how this technique works in adults who had previously had regular sexual activity.

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