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Original Article

Prostate atrophy and spinal cord lesions

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Study design: A single blinded, quantifiable survey of prostate size in spinal cord injury (SCI) patients.
Objective: A small prostate gland is sometimes found on routine digital rectal examination (DRE) in SCI patients. Interruption of neurohormonal supply to the prostate gland might lead to atrophy. To test this interpretation, transrectal ultrasonic (TRUS) examinations have been carried out in SCI patients stratified by severity of paralysis.
Subjects: Nine severely paralyzed spinal cord-injured men (levels at T10 or above and ASIA A, B, or C) were compared with 12 less severely paralyzed men (levels lower than T10 at any grade or ASIA D at any level). The groups were age matched.
Methods: All patients were examined with a 90° sector TRUS probe that measured the prostate gland in three dimensions and calculated the prostate volume and weight. Prostate-specific antigen (PSA) levels were also measured.
Results: By TRUS the prostate size was smaller in the severely paralyzed (range 8–16 g, mean 13 g) than in the less severely paralyzed (range 10–70 g, mean 28 g), $P = 0.02$. The PSA level of the severely paralyzed group tended to be lower (0.5–2.1, mean 0.7 ng/ml *versus* 0.5–10.4, mean 2.2 ng/ml), $P = 0.08$.
Conclusion: The prostate gland of severely paralyzed SCI patients is small. Interruption of neurohormonal pathways due to extensive cord damage may be a factor.
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Keywords: spinal cord injury; prostate gland; neuroendocrinopathy; paraplegia; tetraplegia

Introduction

The rapid growth of the prostate gland at puberty reaches an average of 23 g at age 28 years[1] and is followed by continued growth at an average rate of 0.2 g per year.[2] However, routine digital rectal examination (DRE) in adult men with spinal cord lesions occasionally reveals a small prostate gland. Since severe spinal cord injury (SCI) paralysis can protect against cancer of the prostate gland through a neurohormonal effect,[3] a similar paralysis might explain a reduced prostate size. To document the small size of the prostate gland and to test for a causative factor, we have examined patients by the transrectal ultrasonic (TRUS) technique and compared the results in patients with and without cord lesions that could interrupt the neurohormonal supply to the prostate gland.[4]

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Methods

Patients hospitalized on the spinal cord injury (SCI) service of this institution who were willing to undergo TRUS were recruited. The patient age, cause of paralysis, duration, level and grade of paralysis, method of urinary drainage, prostate-specific antigen (PSA), and DRE were recorded. Also noted were previous urological surgeries. Patients whose surgery included prostate resection were excluded from this survey. Patients with bladder neck incision or external sphincter resection were included.

To quantify prostate size, TRUS was carried out. The examiner was unaware of the subject's detailed neurological status or the hypothesized significance of this status. The patient was placed in the lithotomy position on an examination table for TRUS. The instrument was a 6.2 MHz 90° sector scanner transrectal ultrasound probe (General Electric RT 4000), which permitted the measurement of prostate diameters in the transverse, anterorposterior and cephalocaudad directions, the

calculation of the prostate volume, and a conversion to prostate size in grams.[4]

To estimate accuracy of DRE for detection of a small prostate gland, DRE was compared with TRUS. DRE was carried out in the lateral decubitus position by two physicians who were unaware of TRUS results. The gland was described as small or not small by DRE. The gland was designated as small by TRUS if the gland size was calculated at <17 g. This threshold was chosen because all of the severely paralyzed patients, who were hypothesized to have small glands, had gland sizes <17 g.

This survey was approved by the institution's human studies committee. All participating patients gave their informed consent.

Comparisons for prostate size as determined by TRUS was made between the severely paralyzed patients – defined as those whose level of paralysis was T10 or higher and whose grade of paralysis was ASIA A, B, or C – and those less severely paralyzed – defined as those whose level was T11 or lower with any grade of paralysis or whose grade was ASIA D at any level of paralysis. Prostate size of the severely paralyzed was also compared with able-bodied patients referred to the urology clinic of this institution during the period of the survey of SCI patients. Furthermore, size in the severely paralyzed was compared with reports of TRUS in unselected able-bodied subjects[4] and with prostate weights in autopsied subjects.[1] When possible, data were expressed as the mean and standard deviation for these comparisons and analysis was carried out by the Student *t*-test.

The sensitivity of DRE for the detection of a small prostate gland was expressed by the proportion of examinations of prostate glands <17 g in size by TRUS, which were designated as small by DRE. The comparison was assessed by the Fisher exact test. The software *Primer of Biostatistics* was used for all statistical analyses.[5]

Results

Table 1 characterizes the paralyzed and nonparalyzed comparison groups. All are similar in age. Among the paralyzed patients the severely paralyzed had more bladder outlet surgery – transurethral myotomy of the external sphincter and/or the bladder neck – than the less severely paralyzed. The differences in urinary drainage between these groups were not significant.

The size of the prostate gland by TRUS examination revealed smaller prostate glands in the severely paralyzed than in the less severely paralyzed (Table 2). An overlap in the range of prostate sizes was noted – 8 to 16 g in the severely paralyzed as compared with 10–45 g in the less paralyzed. Three patients in the latter group had exceptionally small prostate glands, 10–12 g, the remainder being 17 g or greater. The prostate glands in the severely paralyzed were also smaller than those of the nonparalyzed urological patients and of the autopsied subjects.

Table 1 Characteristics of paralyzed and nonparalyzed subjects compared for prostate size

	Paralyzed subjects		*Nonparalyzed subjects*		
	Severe	*Less severe*	*Urological*	*Not urological*	*Autopsied*[a]
Number	9	12	12	158	77
Years of age	64±9	61±11	68±9	60–69	56–75
Years of paralysis*	15±10	9±9			
Bladder outlet surgery**	7	1			
Drainage by catheter***	2	0			
Traumatic cause****	8	11			

[a]Weighed directly
*$P=0.17$, **$P=0.01$, ***$P=0.21$, ****$P=1.00$

Table 2 Prostate size by transurethral ultrasound or prostate specific antigen in subjects with and without myelopathy

	Paralyzed subjects		*Able-bodied subjects*		
	Severe	*Less severe*	*Urological*	*Not urological*	*Autopsied*[a]
Number	9	12	12	158	77
TRUS (g)[b]	13±3	28±18	44±26		31[a]
PSA (ng/ml)[c]	0.7±0.9	2.2±2.2	7.9±5.7	2.9±1.7	

[a]Weighed directly
[b]For severe *versus* less severe paralysis $P=0.02$; *versus* urological patients $P<0.01$
[c]For severe *versus* less severe paralysis ($n=10$) $P=0.08$; *versus* urological or non-urological subjects $P<0.01$

Similarly, the PSA levels suggested a trend toward smaller gland size in the severely paralyzed relative to those of the less severely paralyzed. When compared to the nonparalyzed urological patients and the healthy able-bodied, the difference was easily significant.

DREs were carried out in 15 SCI patients, the remainder being unavailable for logistical reasons. The DRE correctly distinguished small from not small prostate sizes as determined by TRUS in 23 of 29 examinations, an accuracy of 79%. DRE was carried out in 10 patients with a small prostate gland. The DRE was correct in 14 of 19 examinations for a sensitivity of 74%.

Discussion

The size of the prostate gland, as quantified by TRUS, is clearly smaller in the severely paralyzed patients than in the less severely paralyzed, as defined for the purpose of this survey. The difference is greater, as expected, when compared with the nonparalyzed urological patients and with unselected autopsies, adjusted for age. Furthermore, the PSA levels as an indicator of prostate gland size[6] supported this observation, being lower in severely paralyzed than in the less severely paralyzed and much lower than reported levels for nonparalyzed subjects, either urological or healthy. These comparisons imply that the prostate gland atrophies after severe paralysis. But since examinations from the onset of paralysis over a period of years have not been carried out, it is not clear when the atrophy occurs – early in the course of paralysis, like testosterone deficiency, for instance,[7] or progessively over the years.

A conceivable mechanism for prostate atrophy is neurohormonal. The rich autonomic innervation of the prostate gland includes afferent sympathetic tracts to the hypothalamus, entering the spinal cord at T10 and above.[8,9] Interruption of these tracts by complete spinal cord lesions above T11 interferes with the cycle of gonadotropin-releasing hormone secretion by the hypothalamus, leutenizing hormone release by the pituitary gland, and testosterone production by the testes.[10,11] Testosterone being a growth factor for the prostate gland that is reduced in the severely paralyzed,[7] a neurohormonal explanation is plausible.

A limitation of the survey reported here is the lack of confirmation of testosterone deficiency in the severely paralyzed. But furthermore, the suggested hormonal imbalance may be insufficient to explain prostate gland atrophy. It will be noted that the testosterone reduction in the aged able-bodied is associated with the prostate gland enlargement.[12] Moreover, denervation of the sympathetic supply to the prostate gland (by SCI) might itself explain the atrophy.[13]

Other explanations for the reduced size of the prostate gland can be suggested. First, the more severely paralyzed group of SCI patients had undergone bladder outlet surgery more often and may have lost prostate tissue as a result. However, care had been taken to exclude patients in whom the prostate gland may have been resected rather than incised during bladder neck surgery. Second, it has been reported that the heavy use of alcohol can induce hypogonadism in men and prostatic atrophy in animals.[14,15] Four patients in the severely paralyzed and three in the less severely paralyzed patient groups (all with gland size <17 g) were known to be heavy users of alcohol prior to paralysis and therefore may have sustained prostatic atrophy prior to paralysis. However, when these subjects are excluded the difference in the prostate size between the groups persists, $P<0.01$. Testosterone levels may have been low for both the alcoholic and the severely paralyzed. Third, an intermittently elevated hydrostatic pressure of the prostatic urethra with dyssynergia might lead to prostatic atrophy. Like the small prostate gland, the degree of dyssynergia is related to severity of SCI.[16] Unfortunately, urodynamic examinations were not available in the patients reported. Thus, three factors – previous surgery, alcoholism, and dyssynergia – can be suggested as additional explanations for the small prostate gland of the SCI patient. Attempts to replicate the observation of the small prostate gland in the SCI patient would include tests for these potential factors.

Benaim *et al*[17] have reported neither prostate nor endocrine abnormalities associated with SCI. However, their patients were not stratified by severity of paralysis, leaving open the possibility that the prostate size and hormonal status in the severely paralyzed were obscured by averaging values for the combined SCI population.

The moderate sensitivity of the DRE for a small prostate gland as measured against TRUS is somewhat better than the reported correlation between DRE and prostate size in the able-bodied.[18] Although DRE is limited in its precision, the recognition of a small prostate gland in the SCI patient at bedside can lead to a fuller understanding of the extent of paralysis, effects of prostate surgery, complications of alcohol use, or the magnitude of dyssynergia.

Conclusion

Severe SCI can induce atrophy of the prostate gland. Etiological considerations are neurohormonal effects of the spinal cord lesion, prostate resection, alcohol abuse, or dyssynergia. Both severe paralysis and alcohol abuse can reduce prostate size via testosterone deficiency. Confirmation of a suspected small prostate gland and follow-up investigation can expand the medical understanding of the individual patient.

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